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Smith, S. A.
Ashbrook, F. M.

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Intermediate frequency amplifier overload characteristics

O.S.R.D., N.D.R.C., Div. 14, Washington, D. C.

U.S. Eng. Unclass. Jan'46 40 tables, diagrs, graphs

The performance of i-f amplifier tubes under conditions of jamming or interference is important in receiver design. Curves are presented which aid in analyzing overloading effects within an i-f amplifier and others are presented which make a comparison of various i-f tube types with regard to overloading. Data for the curves were obtained by measuring the pulse gain of a test stage over a wide range of c-w (jamming signal) input voltages. The apparent cause of complete "collapse" of some tubes is discussed along with a description of circuits which seem quite non-collapsible.

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INTERMEDIATE FREQUENCY AMPLIFIER OVERLOAD CHARACTERISTICS

REPORT
1032

RADIATION LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE - MASSACHUSETTS

V 17882

NDRC
Div. 14
OSRMar-262

Radiation Laboratory

Report 1032 January 31, 1946

INTERMEDIATE FREQUENCY AMPLIFIER

OVERLOAD CHARACTERISTICS

Abstract

The performance of i-f amplifier tubes under conditions of jamming or interference is important to know in receiver design. Herein are contained curves Fig. 6 to Fig. 17 which aid in analyzing overloading effects within an i-f amplifier, and curves Fig. 18 to Fig. 22, which make a comparison of various i-f tube types with regard to overloading. The data for these curves has been made by measuring the pulse gain of a test stage over a wide range of c-w (jamming signal) input voltages. Pulse gain decreases as the c-w voltage increases, and at the point where the pulse gain is zero, the c-w output of the test stage is at a maximum. This test procedure and the equipment used is described in detail. A discussion of the apparent cause of complete "collapse" of some tubes is also included along with the description of circuits which seem quite non-collapsible.

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Title page
6 numbered pages
31 figures

V 17882

INTERMEDIATE FREQUENCY AMPLIFIER

OVERLOAD CHARACTERISTICS

The overload characteristics of i-f amplifier tubes are of considerable importance under certain circumstances. With certain types of jamming, such as CW, amplitude or frequency modulated CW of low or moderately high frequency, it is recognized that damaging loss of minimum detectable signal occurs when the i-f amplifier overloads. That is, the jamming signal becomes so large in the later stages of the i-f amplifier that the dynamic range of these tubes no longer can handle a signal of this size. The apparent reason for this will be discussed in more detail later. Thus high output capability (or a good overload characteristic) of the last i-f amplifier stages increases the ability of the amplifier to withstand these types of jamming without the aid of special anti-jamming devices.

With this problem in mind, a considerable amount of data has been taken from time to time on a number of popular i-f tubes and a number of experimental tube types. It was decided to present to the tube to be tested a situation as near like the actual jamming case as possible. Therefore, the overload characteristics were measured by applying a small pulse signal and a variable amplitude c-w signal. The results have been some very interesting curves which are not only applicable to anti-jamming technique, but to the amplification of various signals and the design of amplifiers with flat limiting characteristics (that is, one stage will not overdrive the following one) as well.

The test setup and procedure can best be described by use of the block diagram shown in Fig. 1.

The 30 mc. pulse signal generator was of a very special variety, there being only one at the time; since then, more have been built entitled the Mk 3 Test Pulser. This signal generator had a maximum output of 4 volts and was equipped with an internal attenuator. This output was a 30 mc. pulse of 1 microsecond duration reaching maximum amplitude in the first 1/4 of a cycle and maintaining a constant amplitude throughout the remaining pulse. The output was at an impedance level of 75 ohms, and there was no c-w leakage.

The 30 mc. c-w signal generator was a GR #805. It is a well-known and reliable signal generator with an internal attenuator and various output impedances.

The mixing pad, however, made the output impedance of both signal generators rather unimportant. The circuit of this pad is shown in Fig. 2. As used in these tests, the two signal generators were connected to points B and C; and point A was connected to the grid of the first driver stage where it was terminated in 75 ohms. Used in this manner, the mixing pad had an attenuation of 12 db.

The driver consisted of four single-tuned 6AK5 amplifier stages which were quite ordinary except for the B+ voltages applied and high cathode currents drawn. As it turned out, this was probably the best tube that could have been chosen for this use, since the driver represented an overloading problem in itself. Constant exposure to rather high voltage CW seemed to cause rapid deterioration of the driver tubes, thus requiring a new set every few days. A typical driver stage is shown in Fig. 3. Of course, the center frequency of the driver was 30 Mc/sec. Its overall bandwidth was 1.8 Mc/sec and the gain should have been 96 db, but probably varied from time to time.

To measure the output capability of any given tube, it was found most straightforward and convenient to measure both pulse and CW at the input to the test stage and at the output. By means of diode detectors at these points, this was easily done. These detectors were made as nearly alike as possible. Fig. 4 shows how they were placed in the circuit along with a pentode test stage. It was found for all practical purposes that the rms voltage measured at the input to the detectors was equal numerically to the d-c voltage measured across the 6AL5 load resistors. The rms input voltage was measured over all the range of voltages encountered in these tests by a modified model 52 Measurements Corporation vacuum tube voltmeter. At the same time, the d-c output of the detectors was measured by means of a high resistance Simpson d-c voltmeter. Since the readings were so close numerically, the d-c meter was used for all tests because it was more convenient to use from the standpoint of switching and availability. The video pulse appearing across the diode load was measured by means of an ordinary Model 24E synchroscope with an internal video amplifier, while the two switches made the measurement of input and output voltages quite convenient.

Upon choosing a certain type of tube to try in the test stage circuit, a suitable cathode biasing resistor, R_k, had to be chosen so that the tube currents would be within ratings. For some tube types no current characteristics were available, necessitating a series of current versus grid bias measurements. Next, a suitable load resistor R_L had to be chosen to keep the bandwidth the same as other tubes tested which may have had different output capacities. However, for many tubes of the miniature variety, the output capacities were so constant from tube to tube that no change in R_L was necessary.

The taking of data consisted mainly of four measurements: (1) The input c-w voltage to the test stage, which was set at values varying from the minimum to the maximum output of the c-w generator; (2) the pulse amplitude at the input to the test stage, which was kept constant for each setting of input CW; (3) the output c-w voltage of the test stage for each setting of input c-w voltage; (4) the output pulse amplitude of the test stage for each setting of input c-w voltage. Also, measurements were made from time to time of the cathode, screen and plate currents of the test stage when no CW was applied at all and again when the tube was badly overloaded with CW.

If this data is plotted (that is, c-w voltage input versus c-w voltage output and pulse gain) on ordinary linear graph paper (Fig. 5), it can be seen that something very interesting is happening; that is, as c-w

input increases, pulse gain decreases. However, the curves are so compressed at the beginning that the trends are not nearly as clear as if the beginning of the curves were expanded with respect to the rest of the curve. Thus, the use of so-called square root graph paper was hit upon to present the data in the best possible manner. This paper was laid off in such a way that the following relationship holds true:

$$D = KX^{\frac{1}{2}}$$

where D is the distance in units of linear measurement, K, from the origin to any point, X, along the abscissa or ordinate.

The curves of pulse gain are actually curves of the ratio of pulse output to pulse input normalized to unity. That is,

$$\text{Relative pulse gain} = \frac{P_1/P_2}{P_3/P_2}$$

where P_1 = pulse output at any setting of c-w input

P_2 = pulse input at same setting of c-w input

P_3 = pulse output before CW was applied (initial pulse output).

For purposes of plotting the curves, the ratio of P_1 to P_3 was all that was necessary, but for additional information the ratio of P_1 to P_2 was also nice to have. The ratio of P_1 to P_3 has been termed relative pulse gain. It is this ratio, along with c-w voltage output, that has been plotted against c-w input voltage. A number of these curves for various tube types are shown on the following sheets of square root paper (Fig. 6 through Fig. 16). The values used to plot these curves are generally the average of several different tubes of the same type. Both the relative pulse gain and c-w output curves are extrapolated at signal levels too small to bring the input detector into its linear operating range.

It can be seen from these curves that, with many tubes, at the point where there was no increase in c-w output for an increase in c-w input, the pulse gain was zero. In some cases, however, the pulse never completely disappeared but only seemed to be differentiated. Fig. 17 is an attempt to show the appearance of the pulse output during the various stages of overloading. In almost every case, after passing through zero or a differentiated state, the normal pulse appeared again as the c-w input was still further increased; and the pulse gain can then be thought of as negative. However, for convenience, these values were plotted as positive, and it can be seen that they quickly reach a small maximum and then slowly fade away.

To compare the overload characteristics of the various tube types, it is necessary to take into consideration the difference in gain that the test stage had from tube to tube. Since it was necessary to hold either the gain or the bandwidth constant from tube to tube, it was decided to hold bandwidth constant. This means that for most miniature tubes the load resistor was in the order of twice that of the larger tubes with bigger

capacities. The difference was accounted for in the curves by normalizing. The initial gain of the test stage was multiplied by the c-w voltage input scale and divided by ten to fit the paper. When this is done, the resulting curves* can be used to compare the relative merits of each tube type as far as overload characteristics are concerned. A typical data sheet is shown in Fig. 22, showing columns of measured data and the values derived from this.

In taking the data for these overload curves**, it became evident that in amplifier design it was not only the last stage, but commonly the next to the last and even the third from the last stages, that caused the pulse gain to be reduced. These curves now provide a very convenient means for determining such overall characteristics. If the overload curves for each of the three stages in question are placed such that the output of the third from the last stage is lined up with the input of the second stage, and the output of this stage is coincident with the input to the last stage, then it is a simple matter to trace an assumed c-w signal from input to output and note the relative pulse gain of the last three stages in the receiver. The curves shown in Fig. 23 through Fig. 29 are the result of the procedure described above, using 6AC7's and 6AG7's in various combinations over all the range of c-w input voltage available at the third from the last stage. To compare the various combinations, it is necessary to compensate for the differences in initial overall gain of the combinations, as has been done for a single tube. This has been accomplished by multiplying the c-w voltage input scale by the initial gain of the combination and dividing it by the smallest initial gain of any combination. The smallest gain in these curves was 360 times, hence the normalized gain ratios 60:36, 81:36, 100:36, etc., as marked on the curves.

If 6AC7's are used in the last three stages of the i-f amplifier, as shown in Fig. 23, the initial gain is quite high (1000 times); but, with a slight amount of c-w interference or jamming, the last stage quickly loses its ability to amplify pulses. This means the overall gain is zero when the last stage collapses. If the plate voltage of the last tube is increased, the resulting curve in Fig. 24 shows the overall point of collapse has been increased approximately three times before the last stage collapses. Fig. 25 shows that by simply inserting a 6AG7 in place of the 6AC7 in the last stage, the point of overall collapse has been again increased three times. This curve is also interesting in that it shows that the next to the last stage caused the overall pulse gain to drop. Fig. 26 shows that increasing the plate voltage on the next to the last stage has doubled the point of overall zero pulse gain, but the 6AC7 is still unable to stand up and has again caused the overall pulse gain to rapidly decrease and finally hit zero. By inserting a 6AG7 in the next to the last stage and increasing the screen voltage*** on the last stage, as shown in Fig. 27, the overall pulse gain is quite satisfactory and does not go to zero within the limits of the test equipment. This curve also shows that it is now the last stage which is again responsible for the decrease in pulse gain. Fig. 28 shows a step in

* See Fig. 18 to Fig. 22.
** The uncompensated type, as in Fig. 6 to Fig. 17.
*** Increases dynamic range more than it attracts electron stream.

the wrong direction. The last stage has collapsed, to be sure, the reason being that the next to the last stage now has the power to overload it by virtue of the trade in screen voltages. Again raising the screen voltage of the last stage, as in Fig. 29, achieves a curve similar to Fig. 27 with little or no improvement.

The early failure of the 6AC7 and 6AG5 tubes seems to be due to the misdirection of the electron stream by the grid. A 6AC7, for example, may have a screen current of 50 ma and a plate current of about 4 ma, with a high input c-w voltage. This shift in current to the screen is not due to the excessive voltage swings of the plate, because, when a condenser is put from plate to ground, the currents remain approximately the same. The 6AG5's were drawing about 3.3 ma plate and 33 ma screen current when the last points on their curves were taken. Apparently the electron stream is striking the screen structure near the supporting posts because the tubes can run in this overloaded condition for quite long periods without burning out the screen. However, they will become rather gaseous. A magnet (1800 gauss) was placed over the 6AG5 such that its lines of force were perpendicular to the central parts of the plate structure, and the c-w input voltage for which the pulse gain fell to zero changed from 1.4 volts to 7 volts. This is about the same result that was produced by raising the plate voltage relative to the screen.

In the 6AK5 and 6AG7, however, the plate structure almost completely surrounds the cathode, and these tubes were quite reluctant to show signs of overloading. When they finally did overload, they had a ratio of plate to screen current quite similar to the 6AC7 or 6AG5. Previous to overloading, the large plates evidently were responsible for attracting a considerable portion of the electron stream, thus postponing the point of complete collapse until long after the 6AC7 or 6AG5 had done so. It had been predicted that the 6AG5 would collapse early, on the basis of the measurements on the other three tubes and the knowledge of their internal construction.

In further support of this misdirection hypothesis is the experiment with the grounded plate grounded grid triode combination. The circuit as used in the test stage is shown in Fig. 30. This combination, although it has an initial pulse gain of only 2.5 times, absolutely refused to approach a state of collapse. Even at full output of the signal generator, this triode combination still had a pulse gain of approximately one half of its initial gain, and the c-w voltage output was still increasing. No other curves are better, except those for the 6AK5 run at the over-rated voltage of 250. This curve compares favorably with the triode combination, but at the time the signal generator reached maximum output, the tube was showing signs of collapsing. In contrast to this, the triode combination did not.

This non-collapsible combination not withstanding, the 6AK5 run within ratings seems to be the best tube of all when other factors, such as economy of space and cost (because of high initial gain), availability and general all-round knowledge of the use of the 6AK5, are considered.

Since triode combinations are hard to overload, the circuit shown in Fig. 31 has been proposed as possibly better than the combination discussed above. This circuit has never been tested with respect to overloading,

but it has produced phenomenal results as a low noise figure input circuit. This circuit, on paper, at least, should be better because it utilizes only triodes and, therefore, should not overload easily. The first triode in Fig. 31 is used as a plate amplifier having a gain of approximately one. The triode in Fig. 30, however, is a cathode follower with a gain of approximately 1/2. Since the second triode in each circuit must have the same gain, the overall gain of the proposed combination will be twice that of the first combination. This means, of course, if nothing else changes, that the overload characteristic of the second combination will be twice as good as the first one. That is, it will take twice as much c-w interference to produce the same reduction in pulse gain.

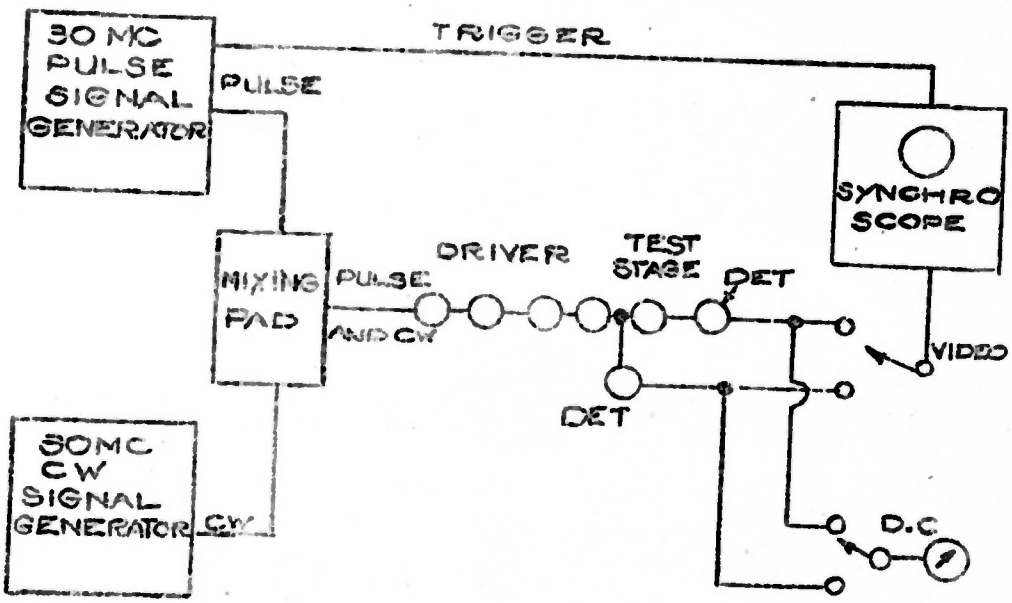
There are some interesting features about these overload curves in general. One of these is the fact that the 6AJ5* run at 28 volts has approximately as good a characteristic as the 6AC5 with 105 volt plate and screen voltage.

The curves of the experimental tube SD828 show that with 105 volt operation it compares favorably, although not consistently, with the 6AC5 run at 150 volts screen and 250 volts plate. These SD828's are in a very small envelope with no base; instead they have leads which can be soldered right into a circuit.

S. A. Smith
W. M. Ashbrook

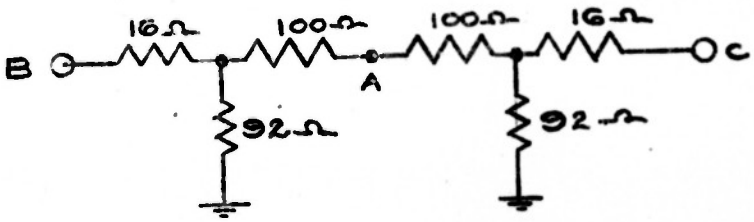
November 28, 1945

* 6AJ5 is designed for use as an amplifier with low operating voltage.



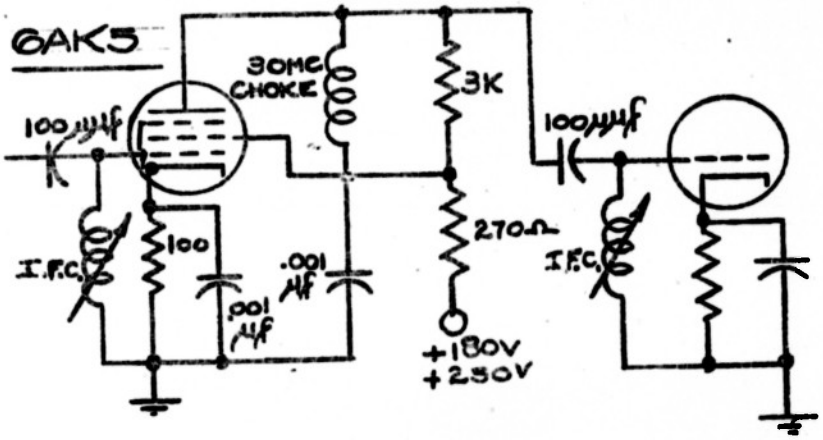
BLOCK DIAGRAM OF TEST SET UP

FIG. 1



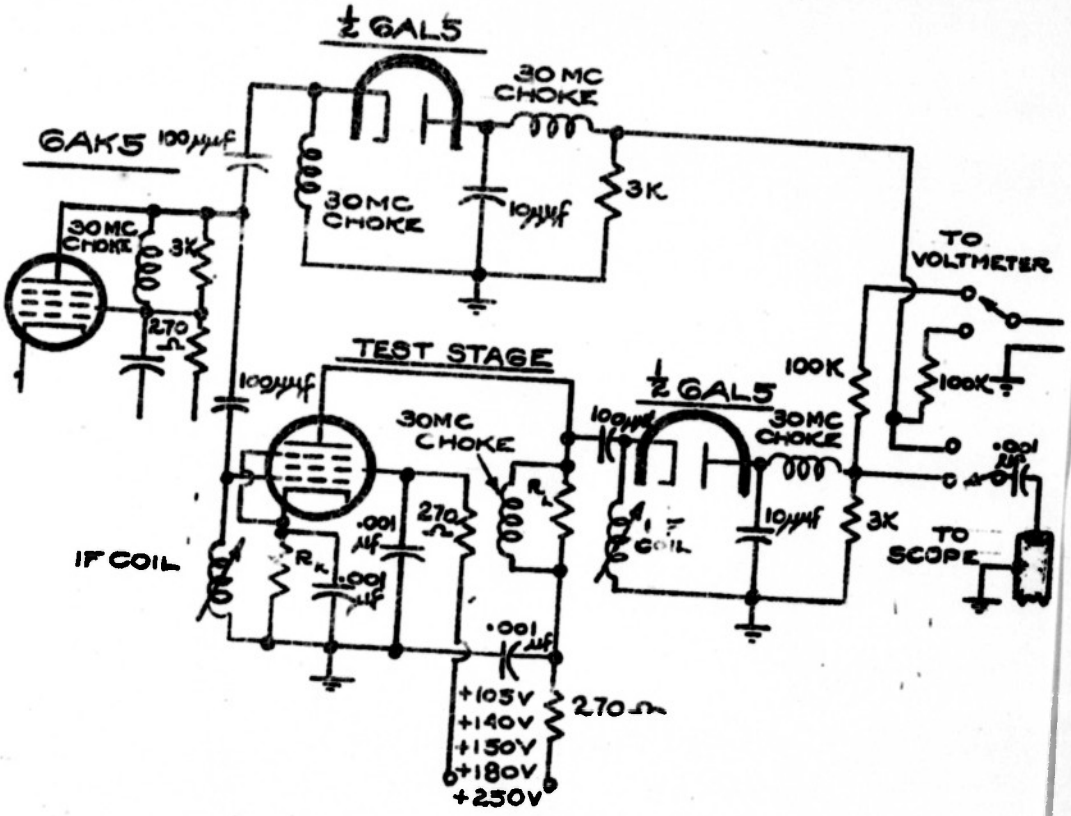
CIRCUIT OF MIXING PAD

FIG. 2



TYPICAL DRIVER STAGE

FIG. 3



TEST STAGE AND DETECTORS

FIG. 4

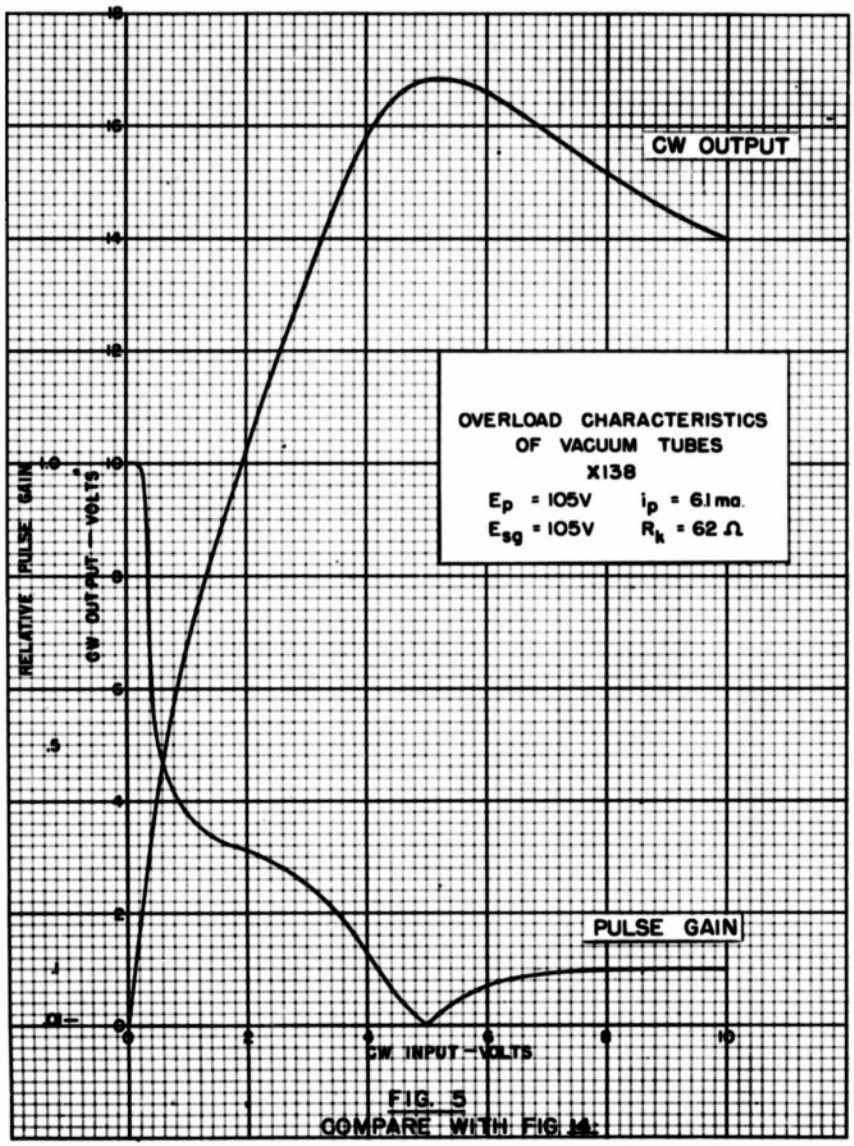


FIG. 5
COMPARE WITH FIG. 14.

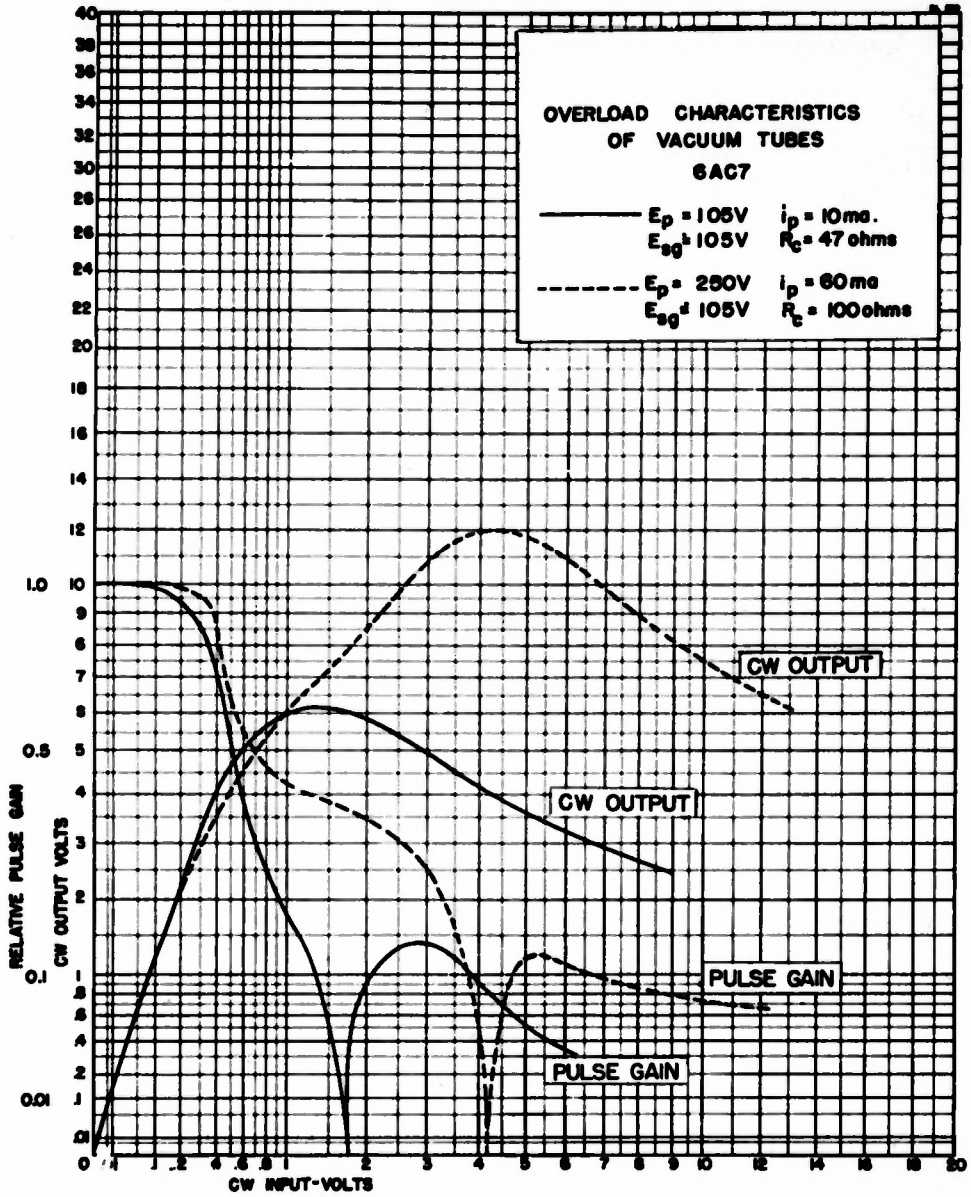

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
6AC7
E_p = 105V i_p = 10ma.
E_{sg} = 105V R_c = 47 ohms
E_p = 250V i_p = 60ma
E_{sg} = 105V R_c = 100 ohms
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT VOLTS
CW INPUT-VOLTS

FIG. 6

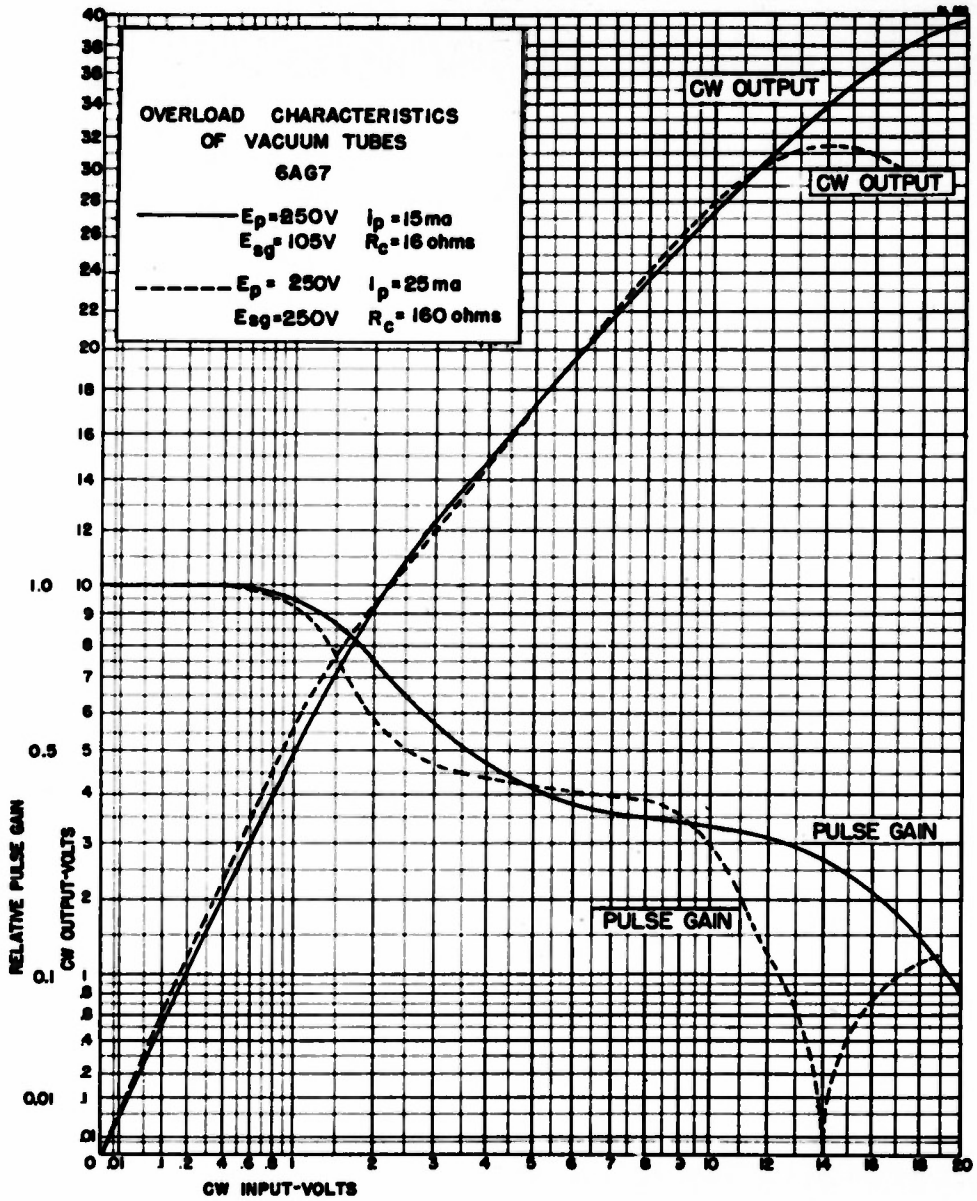

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
6AG7
Ep=250V Ip=15ma
Esg=105V Rc=16 ohms
Ep= 250V Ip=25ma
Esg=250V Rc=160 ohms
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
CW INPUT-VOLTS

FIG. 7

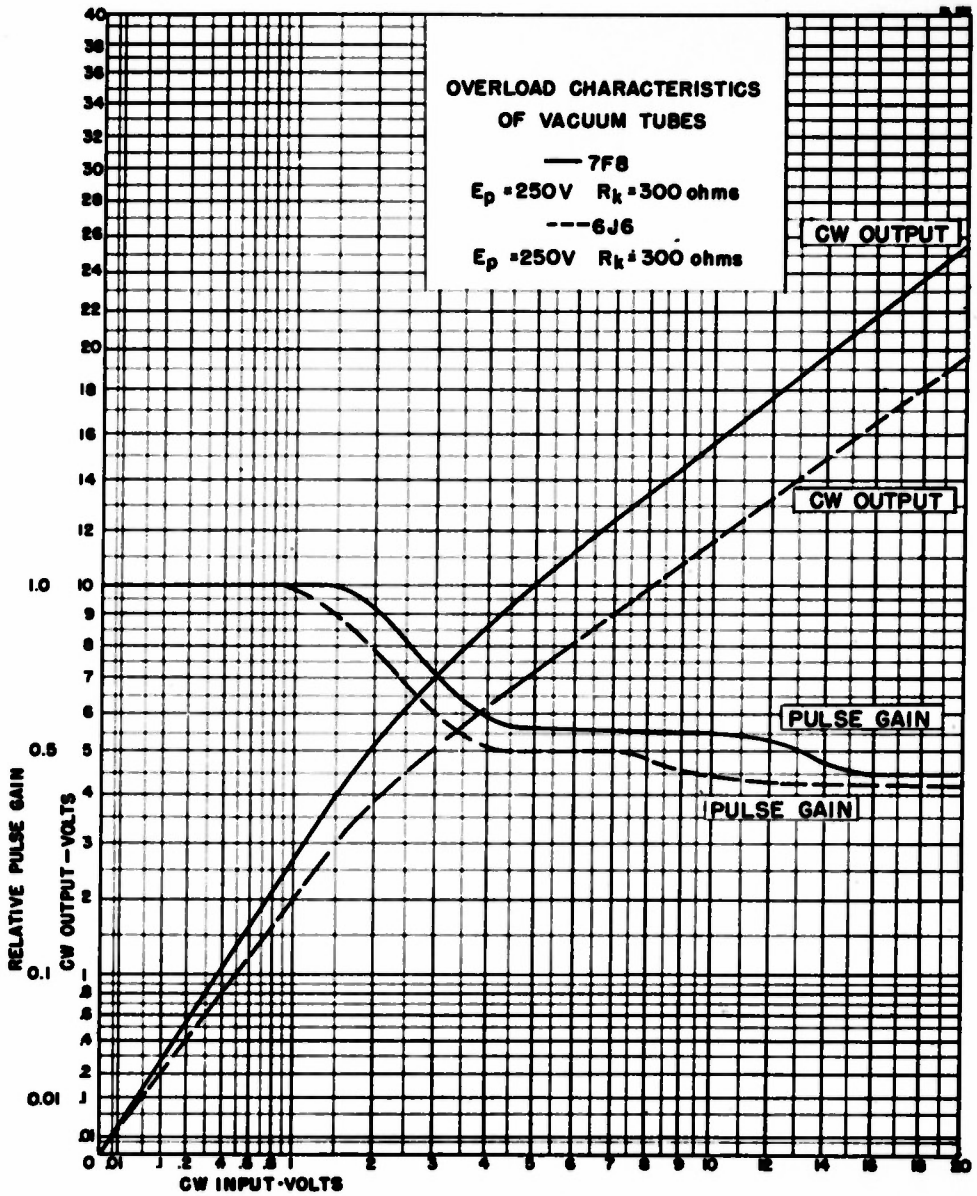

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
— 7F8
Ep = 250V Rk = 300 ohms
---6J6
Ep = 250V Rk = 300 ohms
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
CW INPUT-VOLTS

FIG. 8

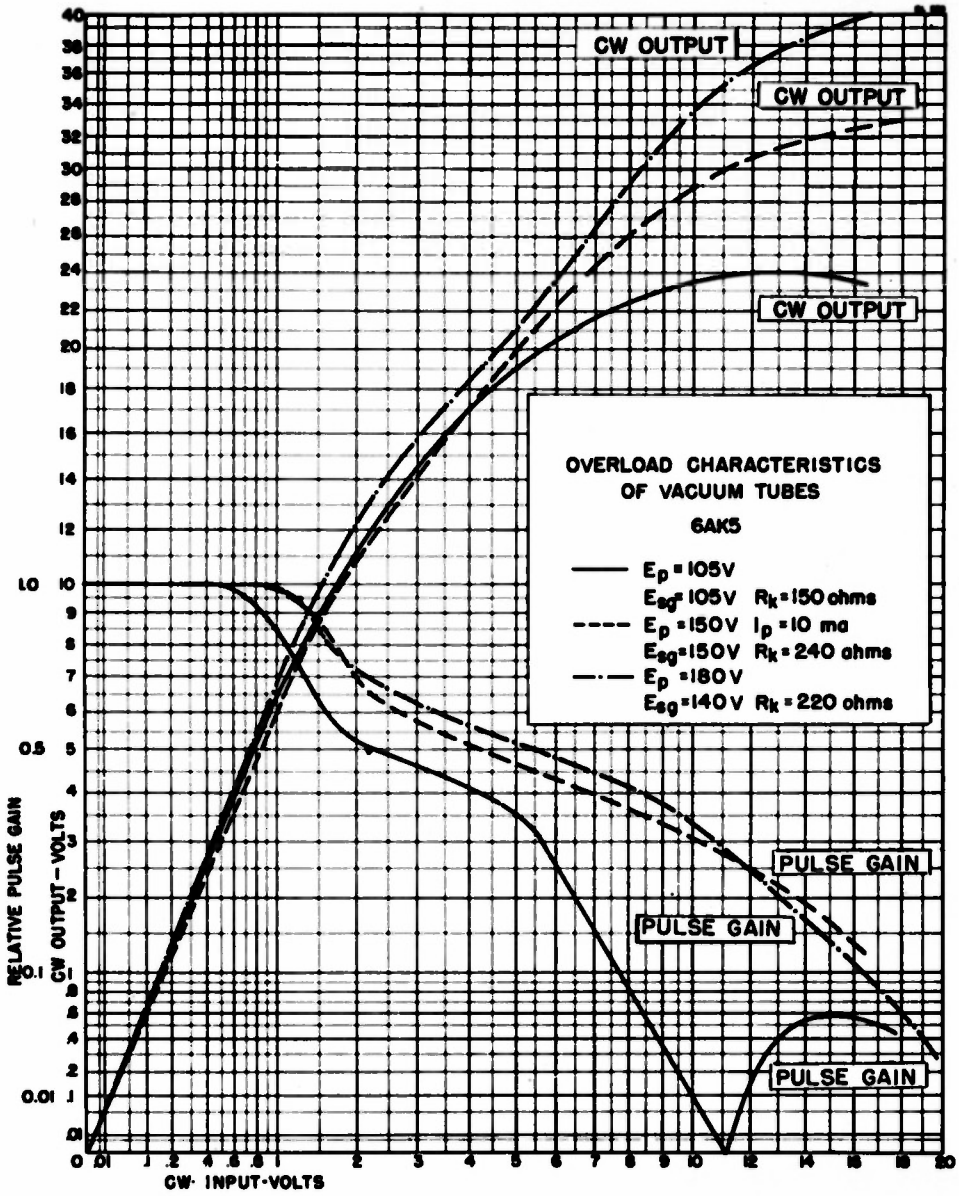

CW OUTPUT
CW OUTPUT
CW OUTPUT
OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
6AK5
Ep = 105V
Esg = 105V Rk = 150 ohms
Ep = 150V Ip = 10 ma
Esg = 150V Rk = 240 ohms
Ep = 180V
Esg = 140V Rk = 220 ohms
PULSE GAIN
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT - VOLTS
CW- INPUT-VOLTS

FIG. 9

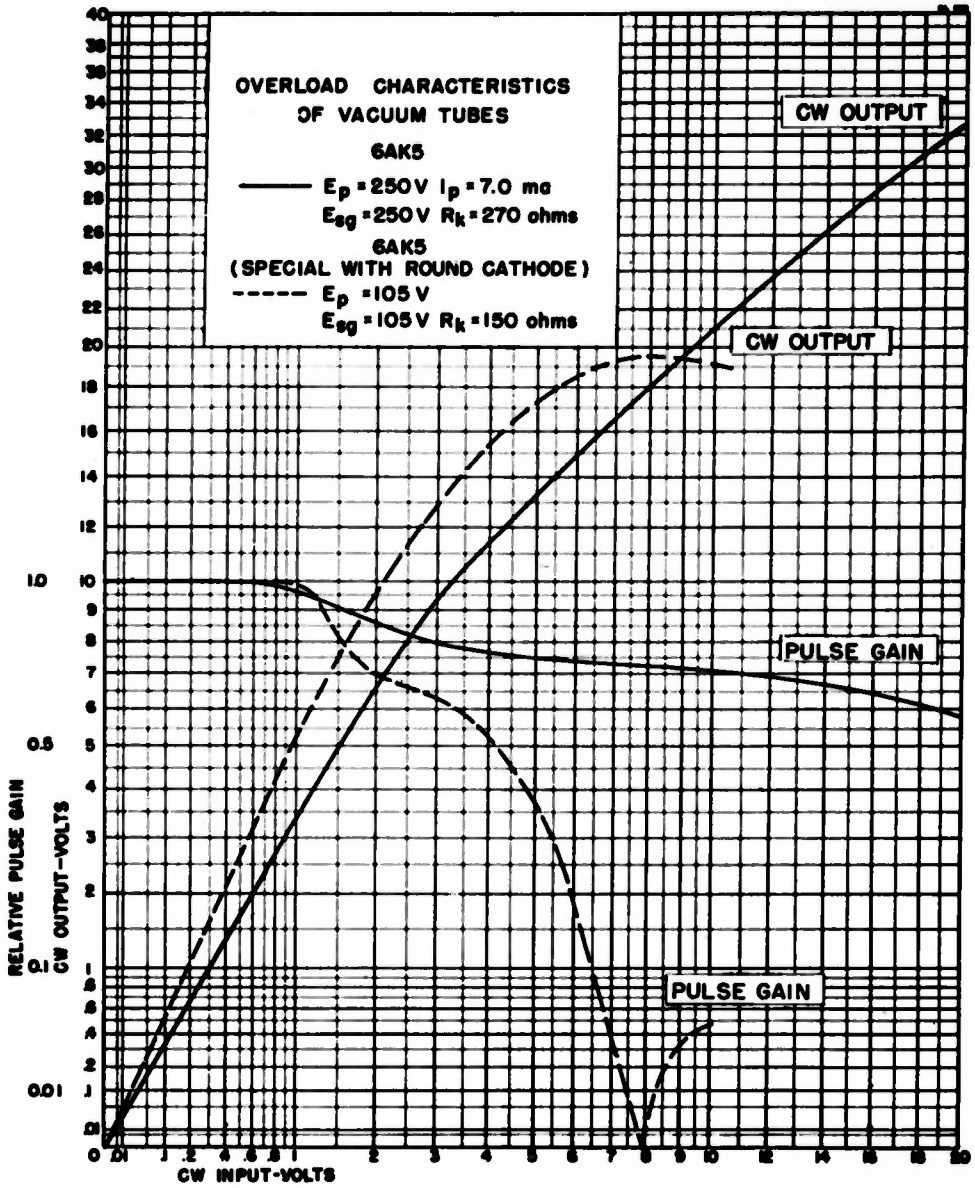

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
6AK5
E_p = 250 V I_p = 7.0 ma
E_{sg} = 250 V R_k = 270 ohms
6AK5
(SPECIAL WITH ROUND CATHODE)
E_p = 105 V
E_{sg} = 105 V R_k = 150 ohms
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
CW INPUT-VOLTS

FIG. 10

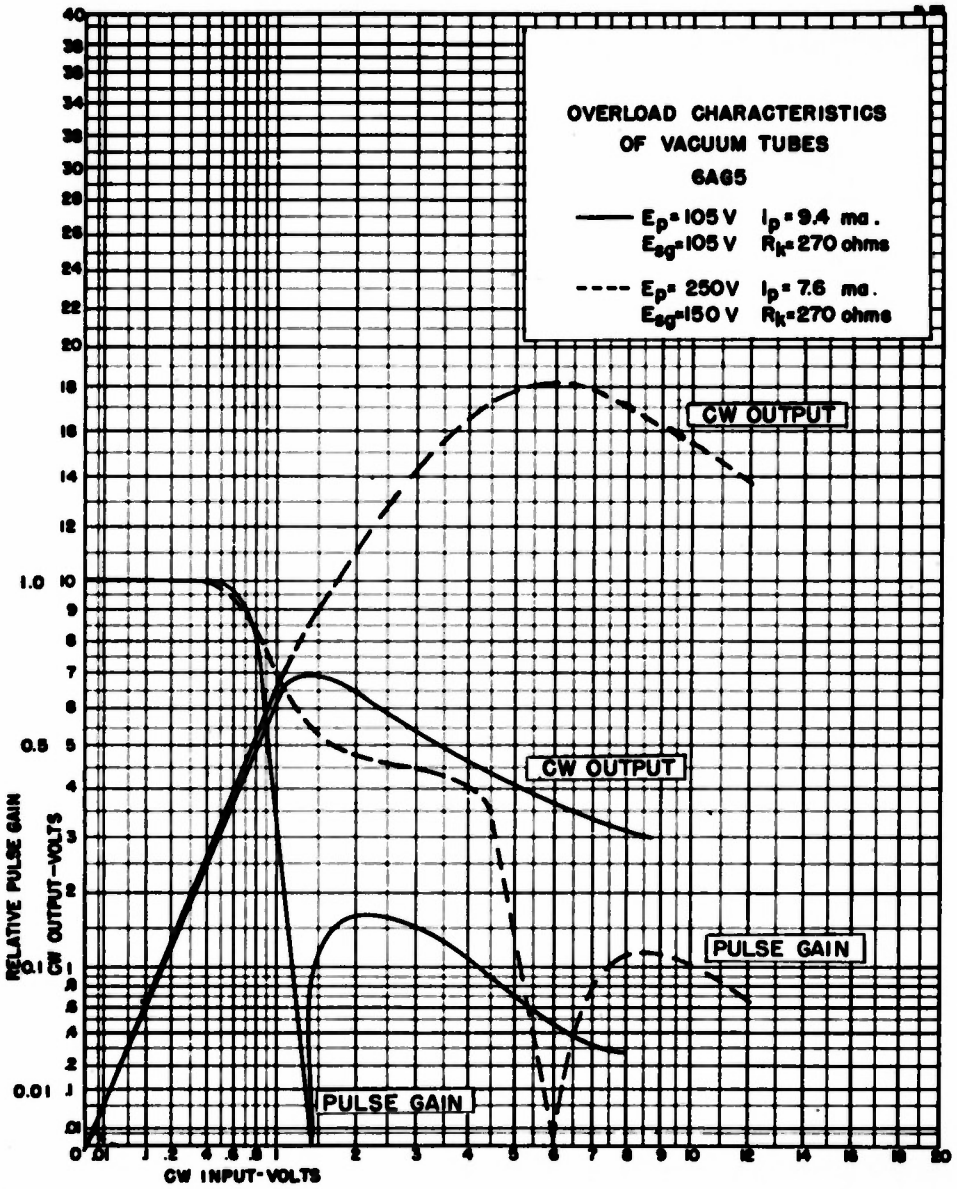

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
6AG5
E_p = 105 V I_p = 9.4 ma.
E_{sg} = 105 V R_k = 270 ohms
E_p = 250V I_p = 7.6 ma.
E_{sg} = 150 V R_k = 270 ohms
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT—VOLTS
CW INPUT-VOLTS

FIG. 11

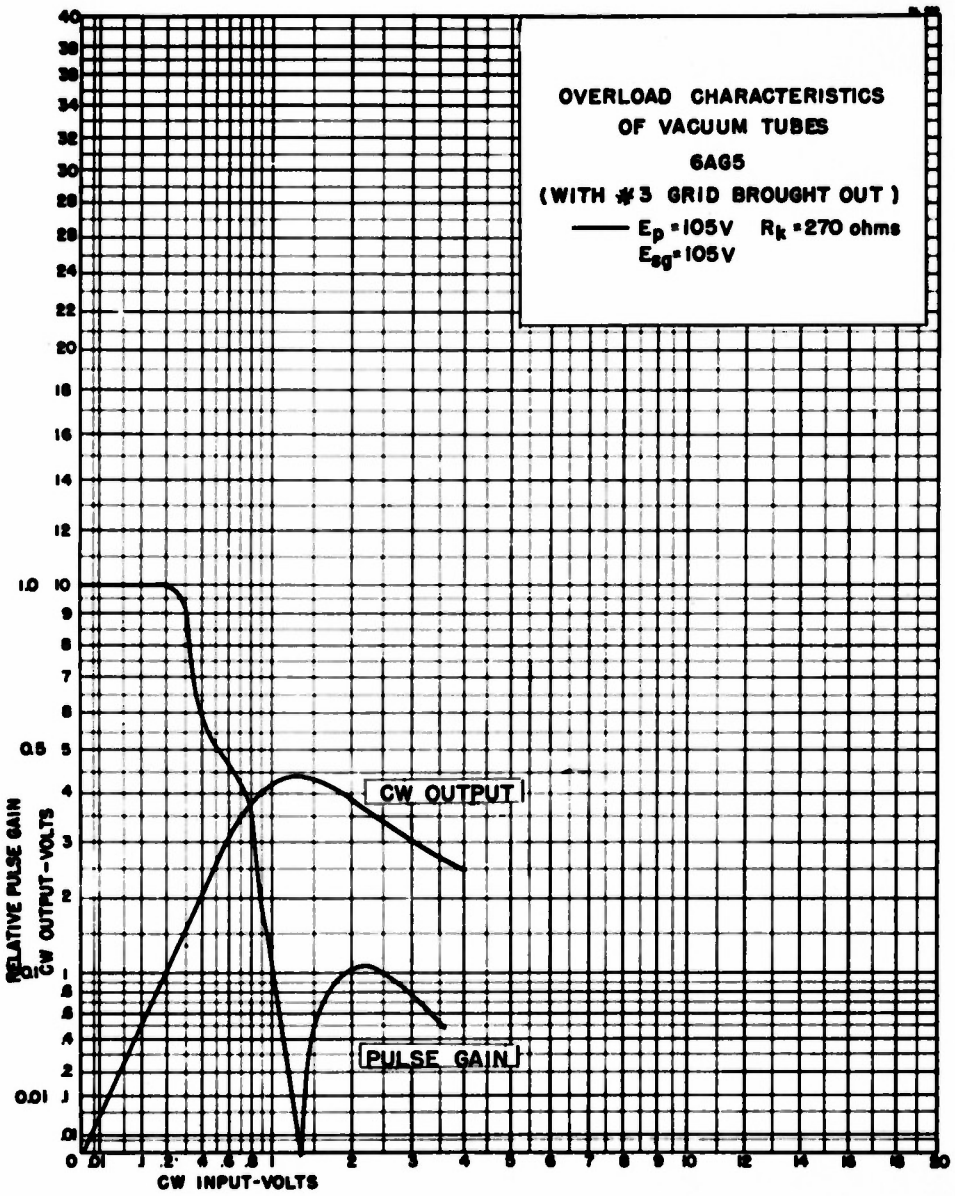

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
6AG5
(WITH #3 GRID BROUGHT OUT)
E_p = 105V R_k = 270 ohms
E_{sg} = 105V
CW OUTPUT
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
CW INPUT-VOLTS

FIG. 12

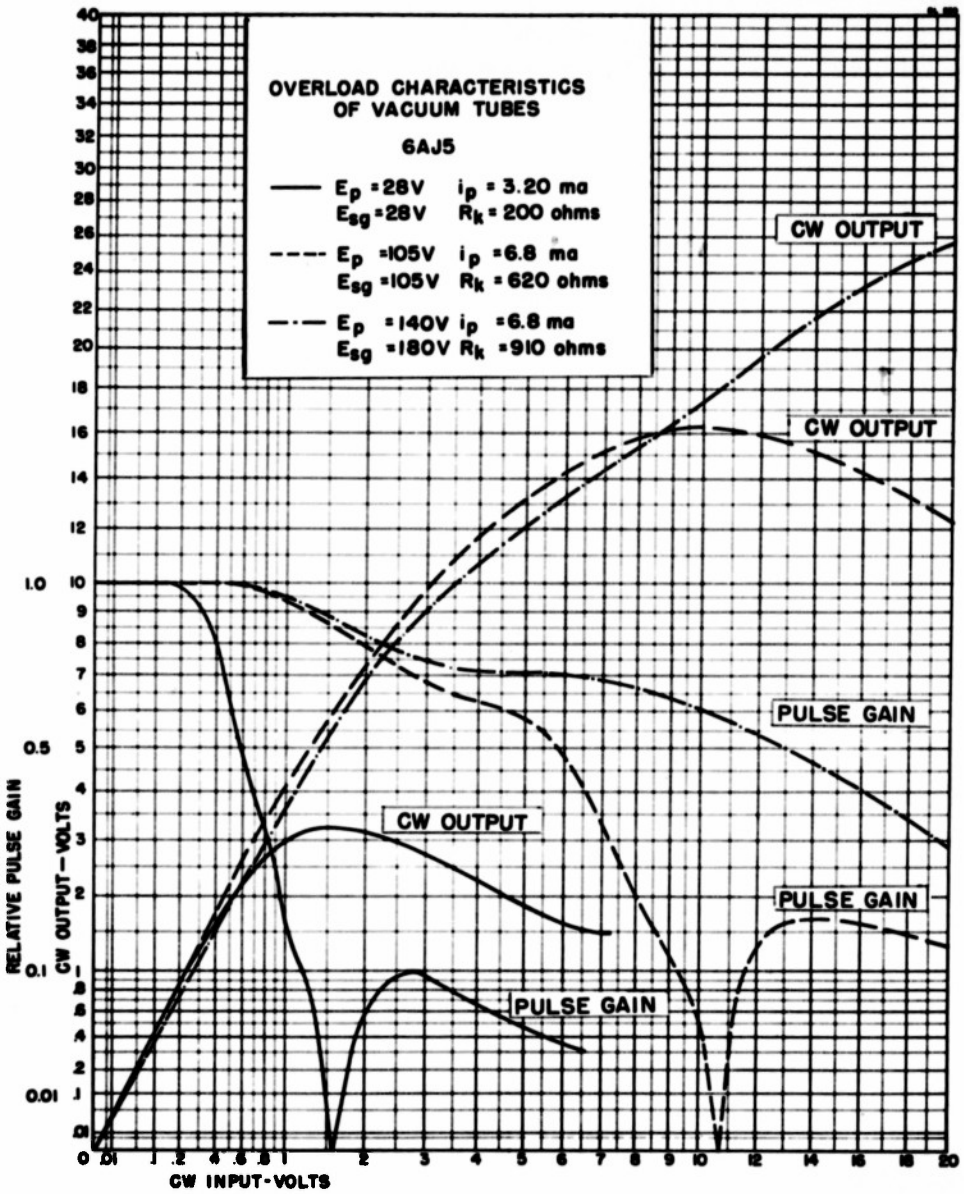

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
6AJ5
Ep =28V ip = 3.20 ma
Esg =28V Rk = 200 ohms
Ep =105V ip =6.8 ma
Esg =105V Rk = 620 ohms
Ep =140V ip =6.8 ma
Esg =180V Rk =910 ohms
CW OUTPUT
CW OUTPUT
PULSE GAIN
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT—VOLTS
CW INPUT-VOLTS

FIG. 13

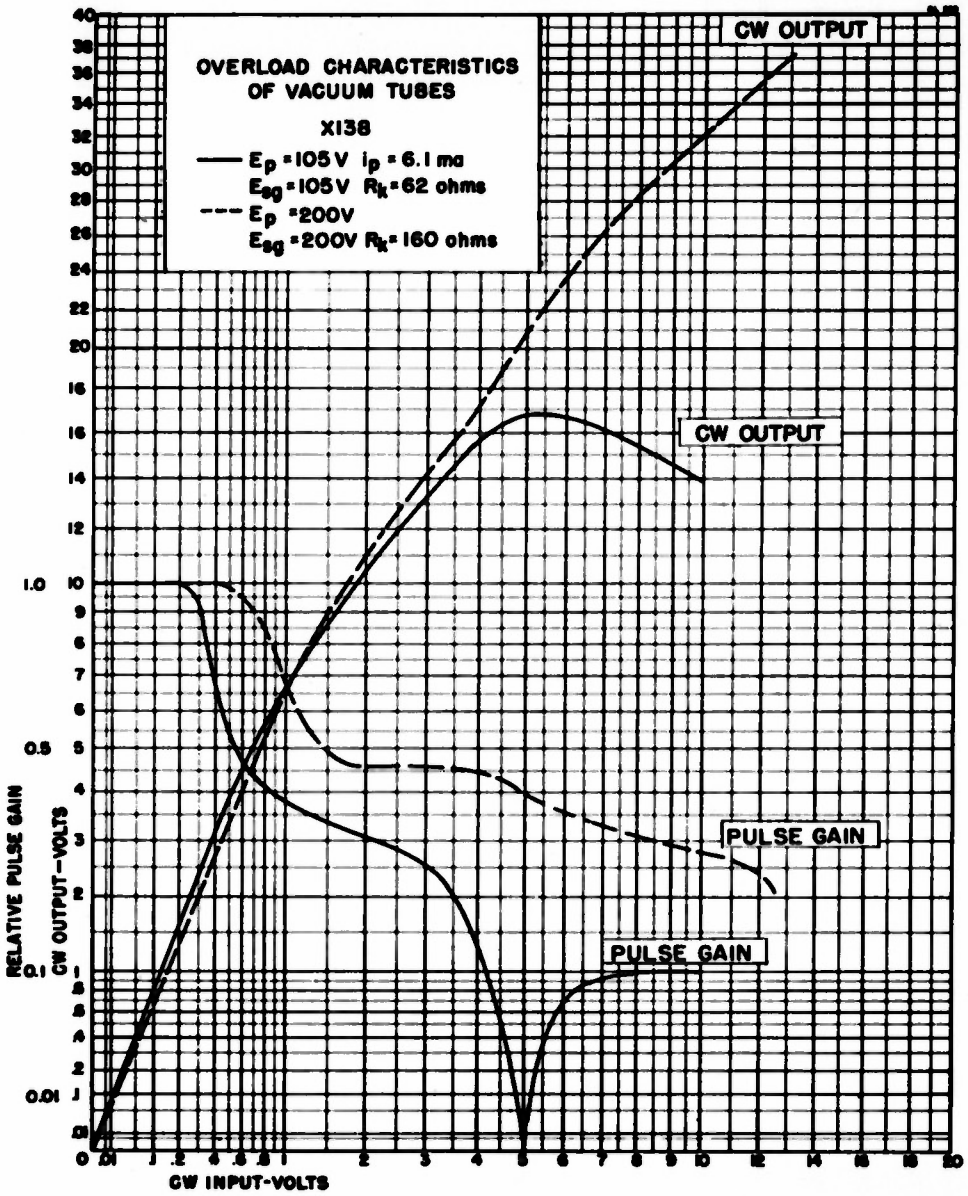

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
X138
Ep = 105 V ip = 6.1 ma
Esg = 105 V Rk = 62 ohms
Ep = 200V
Esg = 200V Rk = 160 ohms
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
CW INPUT-VOLTS

FIG. 14

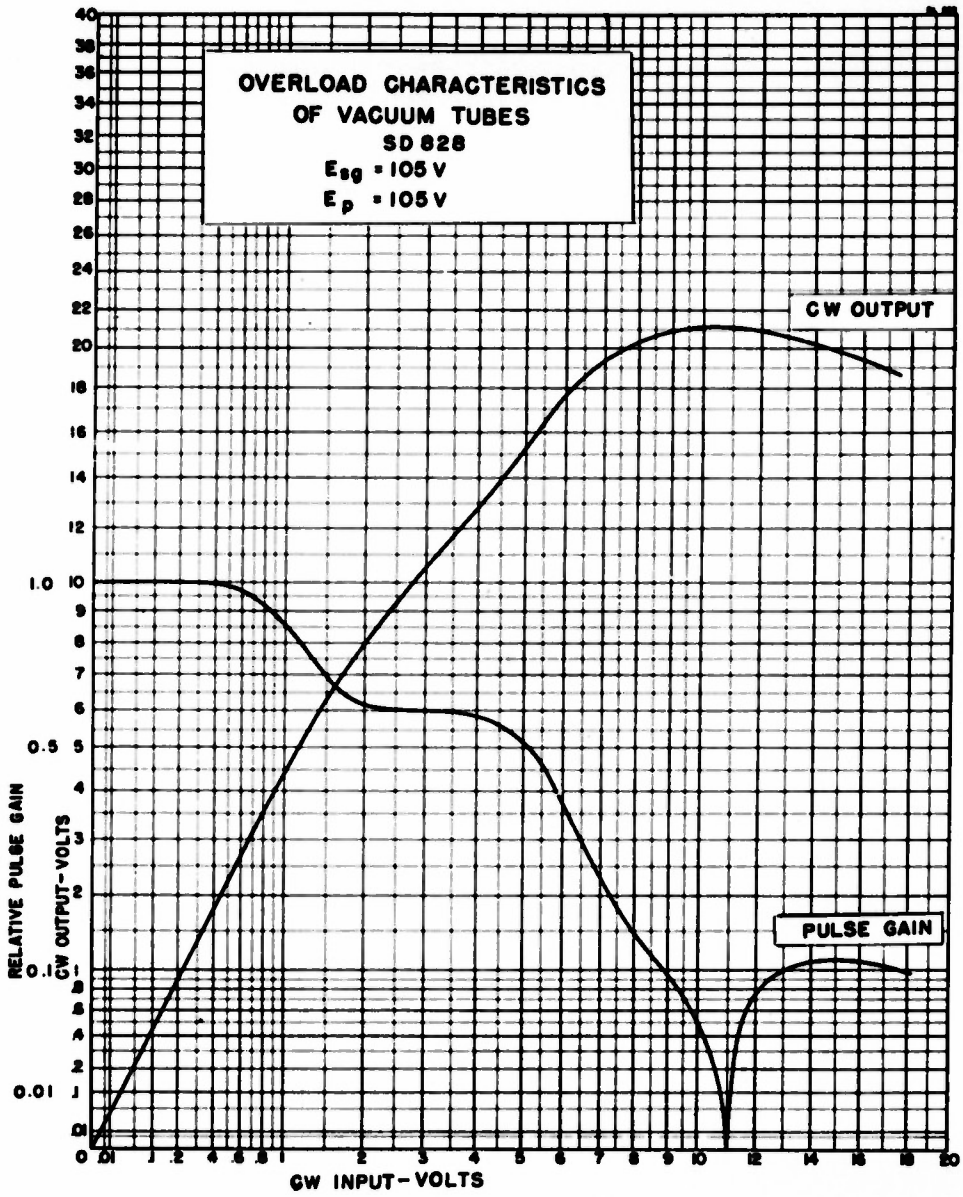

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
SD 828
E_{sg} = 105 V
E_p = 105 V
CW OUTPUT
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
CW INPUT-VOLTS

FIG. 15

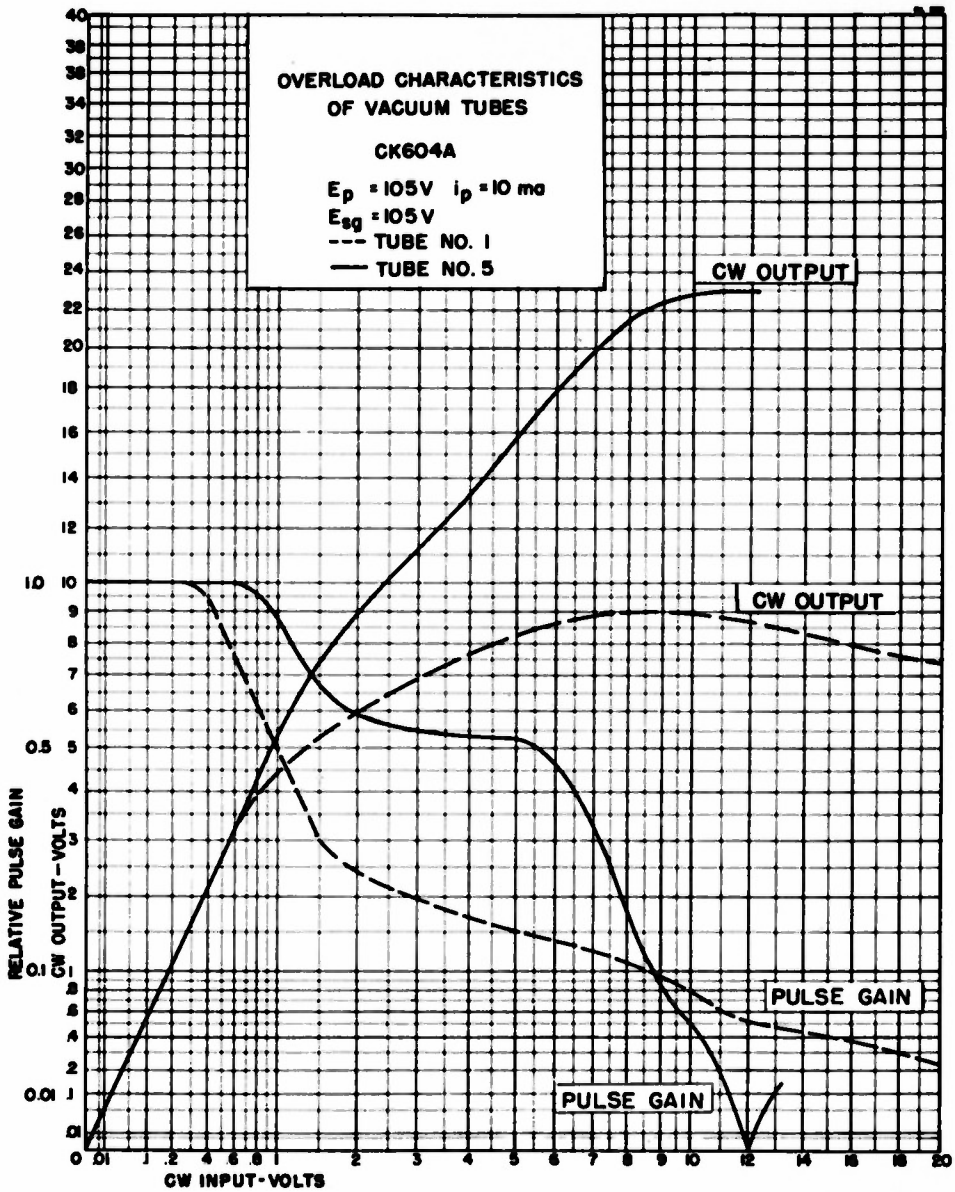

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
CK604A
E_p = 105V i_p = 10 ma
E_{sg} = 105 V
--- TUBE NO. 1
— TUBE NO. 5
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
CW INPUT-VOLTS

FIG. 16

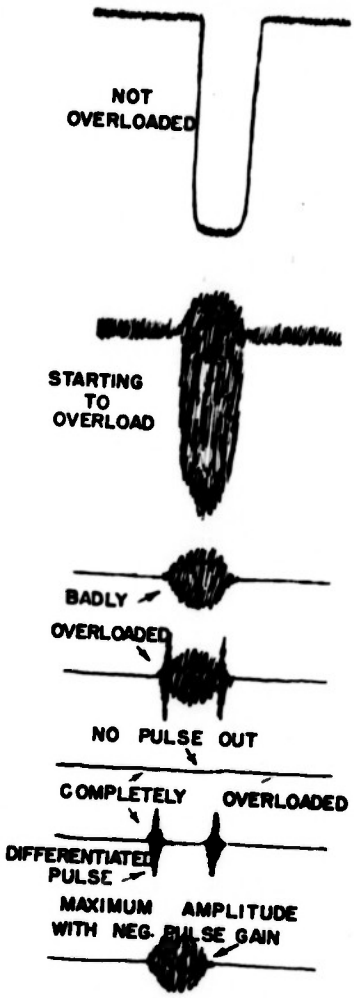

NOT
OVERLOADED
STARTING
TO
OVERLOAD
BADLY
OVERLOADED
NO PULSE OUT
COMPLETELY
OVERLOADED
DIFFERENTIATED
PULSE
MAXIMUM AMPLITUDE
WITH NEG. PULSE GAIN

FIG. 17

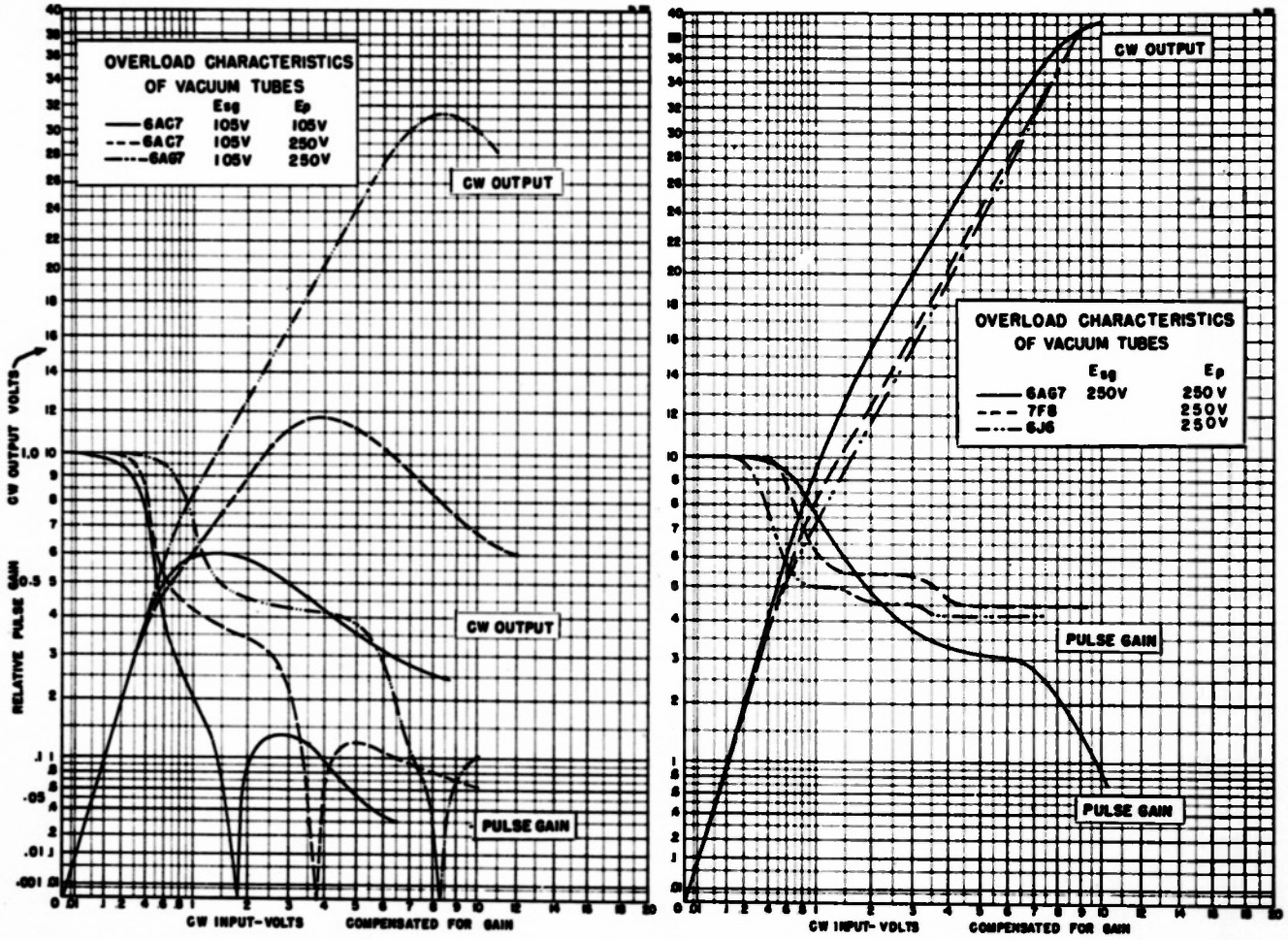

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
Esg Ep
6AC7 105V 105V
6AC7 105V 250V
6AG7 105V 250V
CW OUTPUT
CW OUTPUT
PULSE GAIN
CW OUTPUT VOLTS
RELATIVE PULSE GAIN
CW INPUT-VOLTS COMPENSATED FOR GAIN
CW OUTPUT
OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
Esg Ep
6AG7 250V 250V
7F8 250V
6J6 250V
PULSE GAIN
PULSE GAIN
CW INPUT-VOLTS COMPENSATED FOR GAIN

FIG. 18

1092

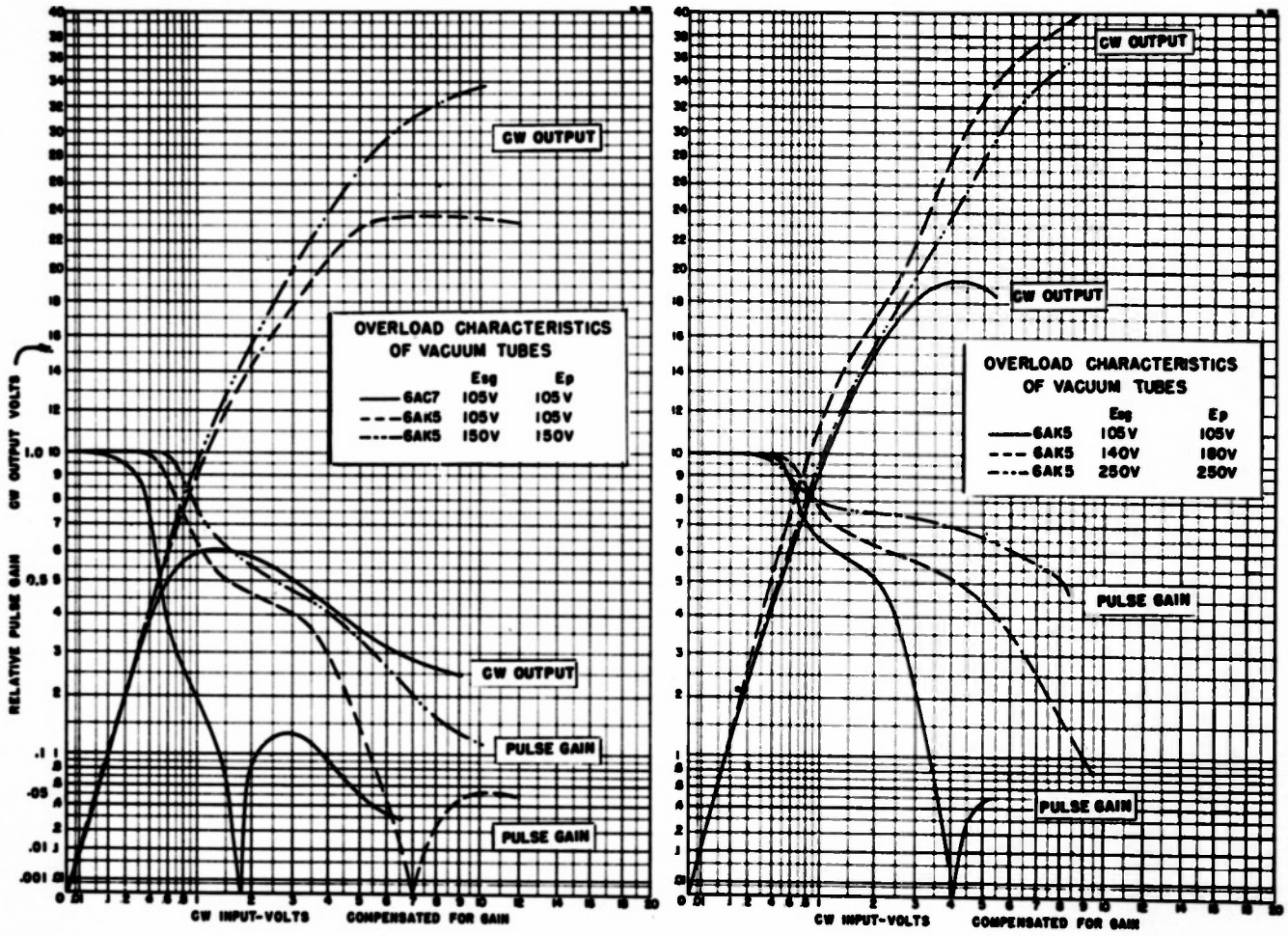
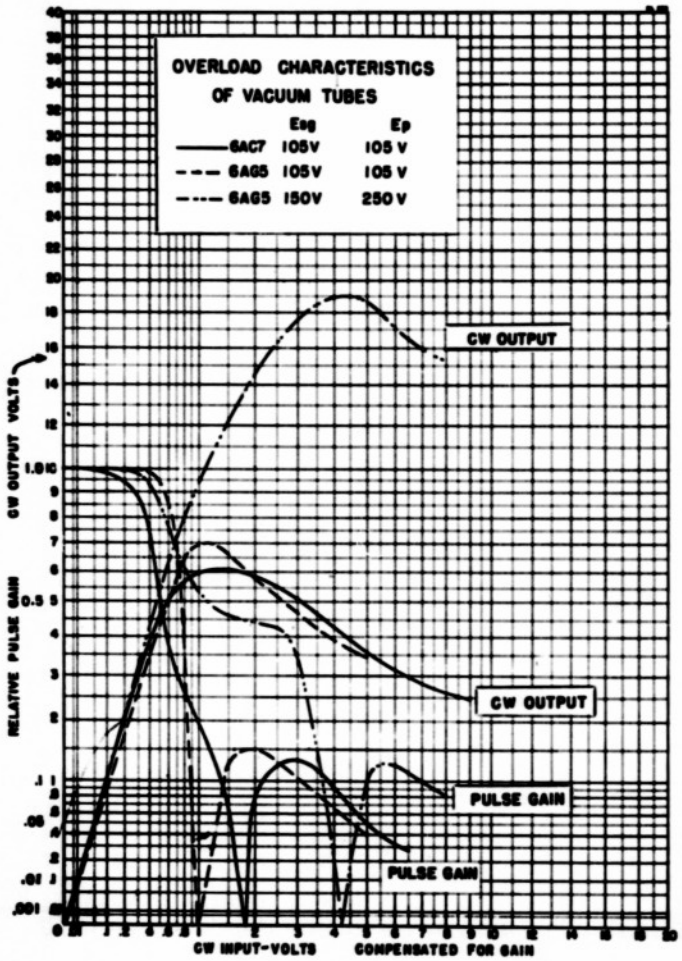

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
Esg Ep
6AC7 105V 105V
6AK5 105V 105V
6AK5 150V 150V
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
RELATIVE PULSE GAIN CW OUTPUT VOLTS
CW INPUT-VOLTS COMPENSATED FOR GAIN
OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
Esg Ep
6AK5 105V 105V
6AK5 140V 180V
6AK5 250V 250V
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
CW INPUT-VOLTS COMPENSATED FOR GAIN

FIG. 19

1032


OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
Esg Ep
6AC7 105V 105 V
6AG5 105V 105 V
6AG5 150V 250 V
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
CW OUTPUT VOLTS
RELATIVE PULSE GAIN
CW INPUT-VOLTS
COMPENSATED FOR GAIN

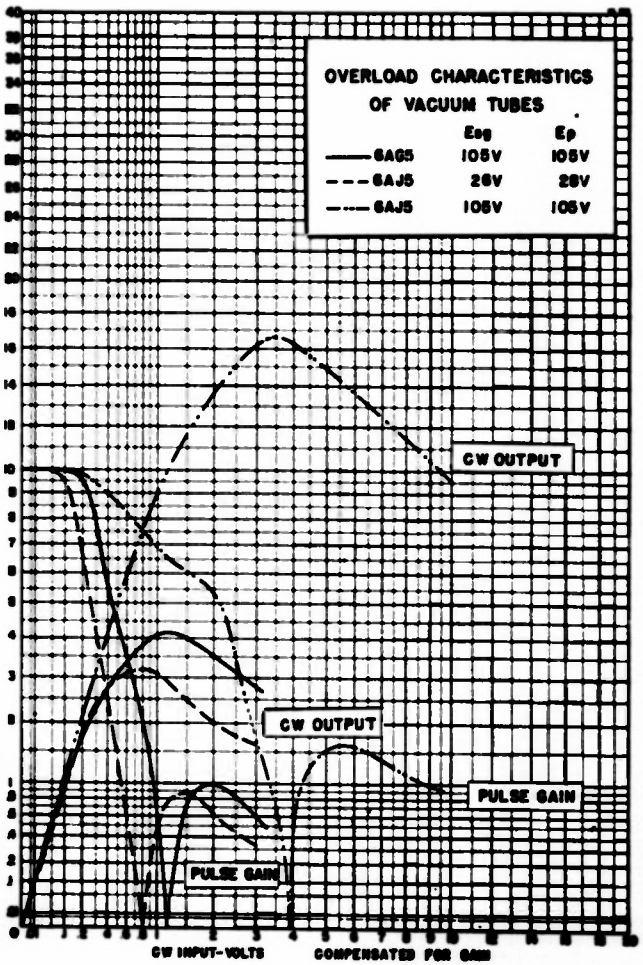
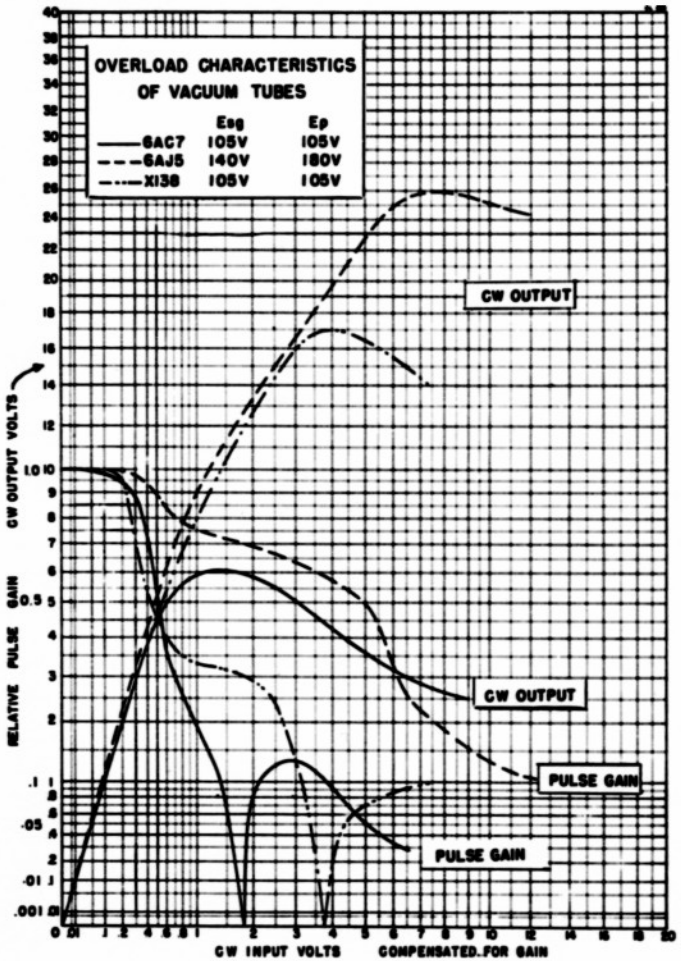

OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
Esg Ep
6AG5 105V 105V
6AJ5 26V 26V
6AJ5 105V 105V
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
CW INPUT-VOLTS
COMPENSATED FOR GAIN

FIG. 20

1032


OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
Esg Ep
6AC7 105V 105V
6AJ5 140V 180V
X138 105V 105V
CW OUTPUT
CW OUTPUT
PULSE GAIN
PULSE GAIN
CW OUTPUT VOLTS
RELATIVE PULSE GAIN
CW INPUT VOLTS COMPENSATED FOR GAIN

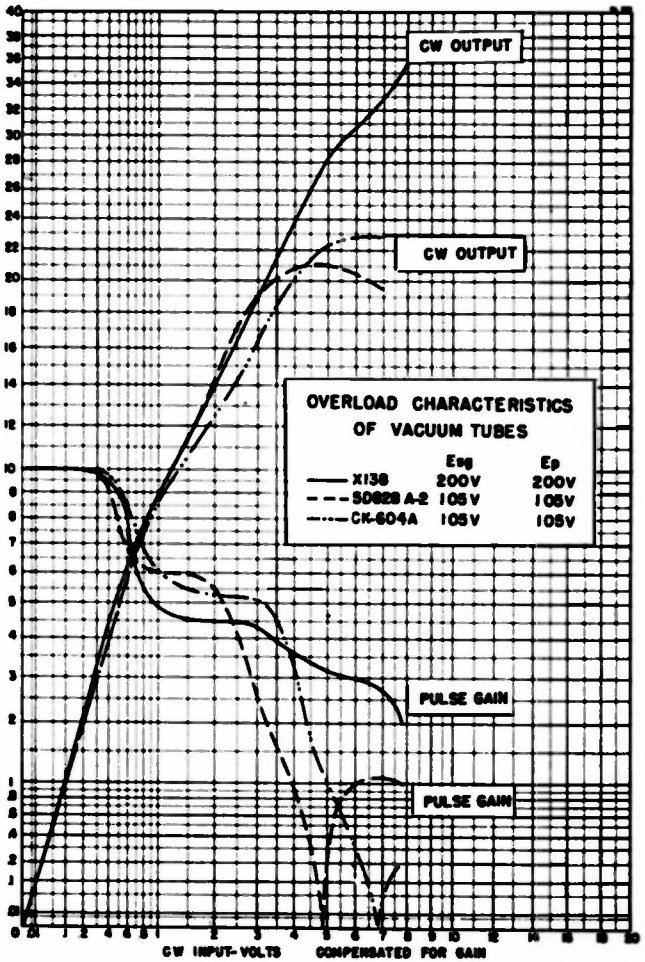

CW OUTPUT
CW OUTPUT
OVERLOAD CHARACTERISTICS
OF VACUUM TUBES
Esg Ep
X138 200V 200V
50829 A-2 105V 105V
CK-604A 105V 105V
PULSE GAIN
PULSE GAIN
CW INPUT-VOLTS COMPENSATED FOR GAIN

FIG. 21

1032

6AK5 Special
With Round Cathode
$E_p = 105$ v.
$E_{sg} = 105$ v.

CW input r.m.s. volts	Pulse input divisions	CW output r.m.s. volts	Pulse output divisions	Pulse Gain	Rel. Pulse Gain
		Tube # S1			
.19	2.2	.19	20	5.2	1.0
.30	3.8	1.05	20	5.2	1.0
.40	3.8	1.70	20	5.2	1.0
.50	3.8	2.46	20	5.2	1.0
.60	3.8	3.30	20	5.2	1.0
.70	3.8	3.90	20	5.2	1.0
.80	3.8	4.20	20	5.2	1.0
.90	3.8	4.70	20	5.2	1.0
1.00	3.8	5.20	20	5.2	1.0
1.50	3.8	7.50	16	4.2	.80
2.00	3.8	9.50	13.5	3.6	.70
3.00	3.8	12.50	12.5	3.3	.64
4.00	3.8	15.00	10.6	2.8	.54
5.00	3.8	17.30	8.0	2.1	.40
5.50	3.8	18.00	4.7	1.2	.24
6.00	3.8	18.60	3.0	.8	.15
7.20	3.8	19.00	0	0	0
8.00	3.8	18.90	.5	.13	.025
9.00	3.8	18.80	.8	.21	.04
10.00	3.8	18.50	1.0	.26	.05
		Tube # S10			
.19	2	.15	20	5.3	1.0
.30	3	1.17	20	5.3	1.0
.40	3.8	1.90	20	5.3	1.0
.50	3.8	2.55	20	5.3	1.0
.60	3.8	3.15	20	5.3	1.0
.70	3.8	3.80	20	5.3	1.0
.80	3.8	4.25	20	5.3	1.0
.90	3.8	4.85	19	5.0	.94
1.00	3.8	5.30	18	4.7	.89
1.50	3.8	7.60	13	3.4	.64
2.00	3.8	9.20	11	2.9	.54
3.00	3.8	11.60	10	2.6	.49
4.00	3.8	14.20	9	2.4	.45
5.00	3.8	16.50	7	1.9	.35
6.00	3.8	18.10	5	1.3	125
7.00	3.8	19.20	2	.52	.098
8.00	3.8	19.60	1	.26	.049
9.00	3.8	19.70	0	0	0
10.00	3.8	19.50	1	.26	.049
11.00	3.8	19.20	1	.26	.049

FIG. 22

6AK5
Data Cont.

CW input r.m.s. volts	Pulse input divisions	CW output r.m.s. volts	Pulse output divisions	Pulse Gain	Rel. Pulse Gain
		Tube # S12			
.19	2.0	.14	20	5.1	1.0
.30	3.5	1.16	20	5.1	1.0
.40	3.9	1.85	20	5.1	1.0
.50	3.9	2.55	20	5.1	1.0
.60	3.9	3.00	20	5.1	1.0
.70	3.9	3.55	20	5.1	1.0
.80	3.9	4.20	20	5.1	1.0
.90	3.9	4.70	20	5.1	1.0
1.00	3.9	5.10	20	5.1	1.0
1.50	3.9	7.60	17	4.3	.84
2.00	3.9	9.80	14	3.6	.70
3.00	3.9	12.60	13	3.3	.64
4.00	3.9	15.20	11	2.8	.54
5.00	3.9	17.60	8	2.1	.42
6.00	3.9	19.10	3.5	.87	.17
7.00	3.9	19.70	1.5	.38	.074
8.00	3.9	19.90	0	0	0
9.00	3.9	19.60	.8	.22	.044
10.00	3.9	19.50	1.0	.28	.054
11.00	3.9	19.00	1.0	.28	.054

Calculation of CW input scale using normalized

Gain Ratio of $\frac{5.2 + 5.3 + 5.1}{3 \times 10} = .52$

CW input r.m.s. volts	CW input corrected for gain	Average CW output r.m.s.v.	Ave. Rel. Pulse Gain		
0	0	0	1		
.8	.41	4.3	1		
1.0	.51	5.1	.97		
1.5	.76	7.5	.75		
2.0	1.02	9.5	.65		
3.0	1.53	12.5	.59		
4.0	2.04	14.8	.51		
5.0	2.55	17.0	.38		
6.0	3.06	18.5	.20		
7.0	3.57	19.2	.067		
8.0	4.10	19.7	0		
9.0	4.60	19.4	.035		
10.0	5.10	19.0	.050		
11.0	5.60	18.6	.050		

FIG. 22 CONT.

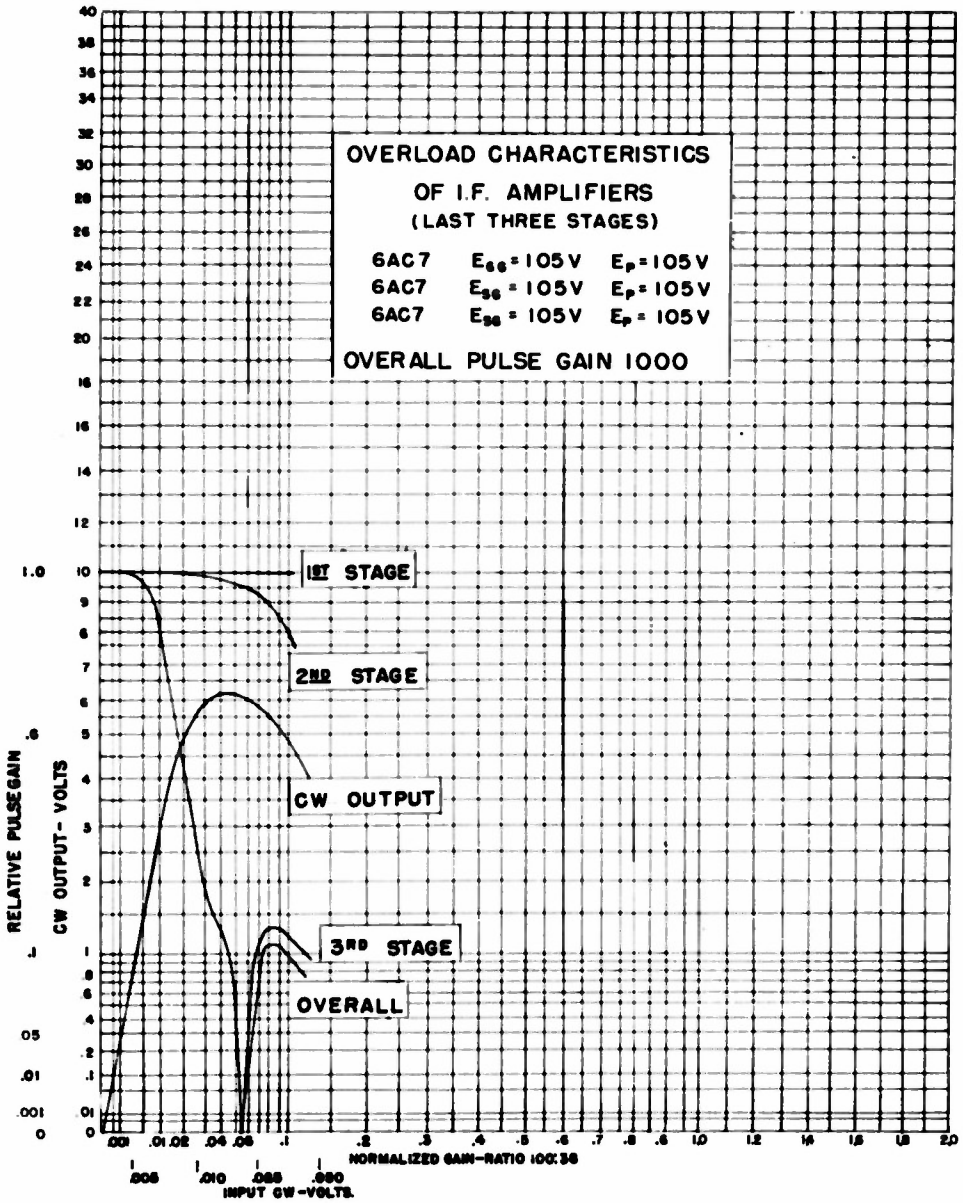

OVERLOAD CHARACTERISTICS
OF I.F. AMPLIFIERS
(LAST THREE STAGES)
6AC7 E_{66} = 105V E_p = 105V
6AC7 E_{36} = 105V E_p = 105V
6AC7 E_{36} = 105V E_p = 105V
OVERALL PULSE GAIN 1000
1ST STAGE
2ND STAGE
CW OUTPUT
3RD STAGE
OVERALL
RELATIVE PULSEGAIN
CW OUTPUT - VOLTS
NORMALIZED GAIN-RATIO 100:36
INPUT CW-VOLTS.

FIG. 23

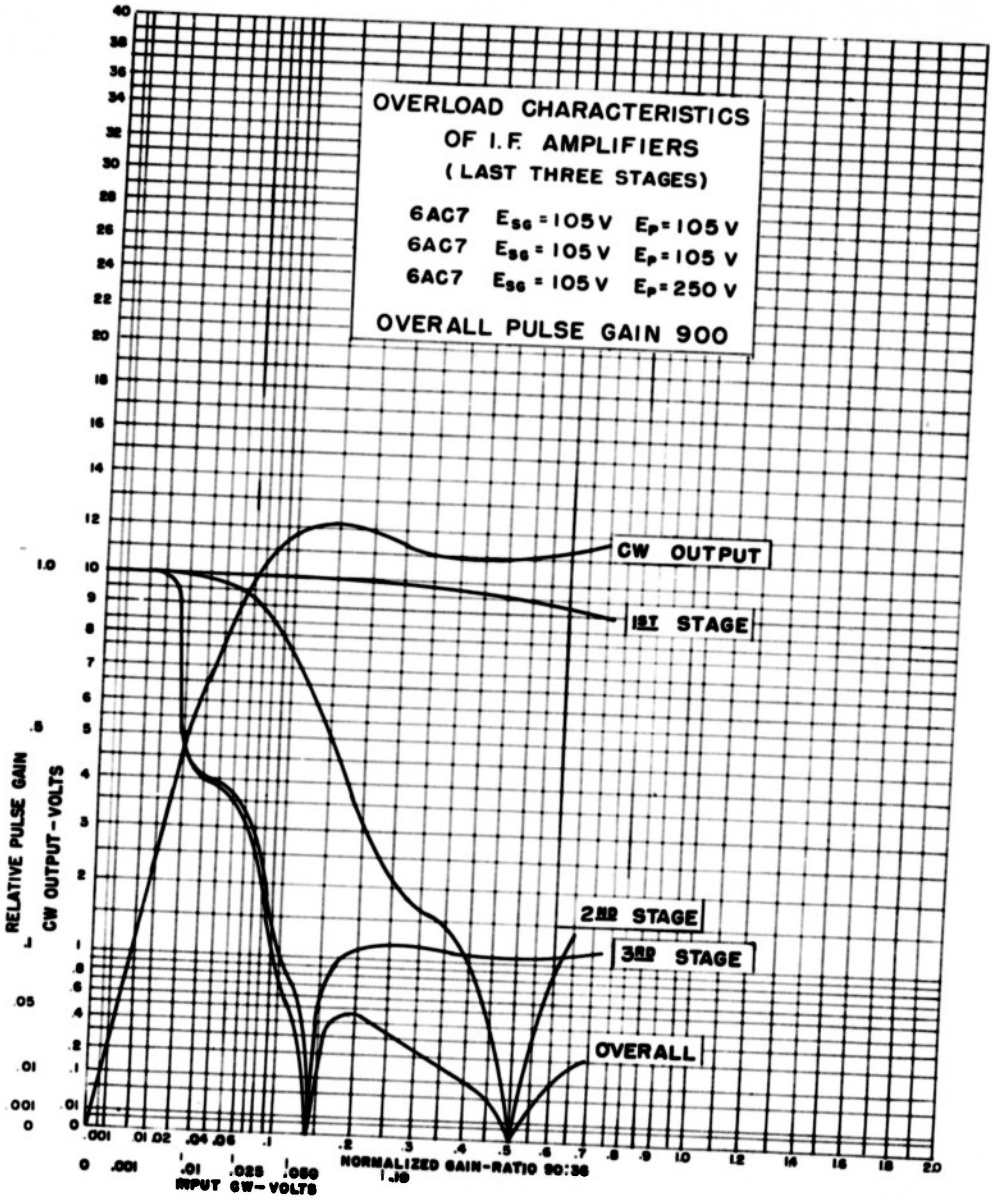

OVERLOAD CHARACTERISTICS
OF I.F. AMPLIFIERS
(LAST THREE STAGES)
6AC7 E_{sg} = 105 V E_p = 105 V
6AC7 E_{sg} = 105 V E_p = 105 V
6AC7 E_{sg} = 105 V E_p = 250 V
OVERALL PULSE GAIN 900
CW OUTPUT
1ST STAGE
2ND STAGE
3RD STAGE
OVERALL
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
INPUT CW-VOLTS
NORMALIZED GAIN-RATIO 90:36

FIG. 24

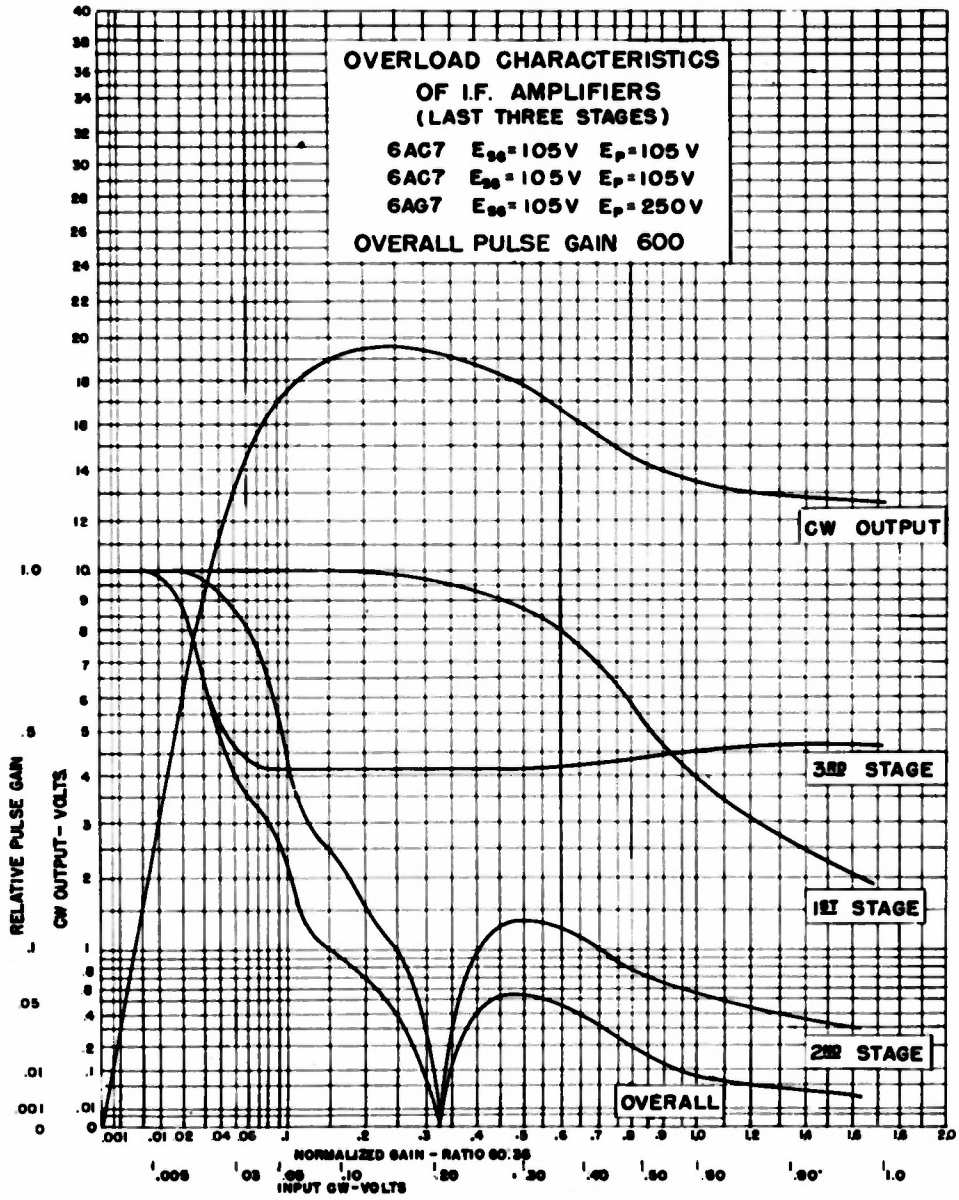

OVERLOAD CHARACTERISTICS
OF I.F. AMPLIFIERS
(LAST THREE STAGES)
6AC7 E_{SG}=105V E_P=105 V
6AC7 E_{SG}=105V E_P=105V
6AG7 E_{SG}=105V E_P=250V
OVERALL PULSE GAIN 600
CW OUTPUT
3RD STAGE
1ST STAGE
2ND STAGE
OVERALL
RELATIVE PULSE GAIN
CW OUTPUT - VOLTS
NORMALIZED GAIN - RATIO 60:36
INPUT CW-VOLTS

FIG. 25

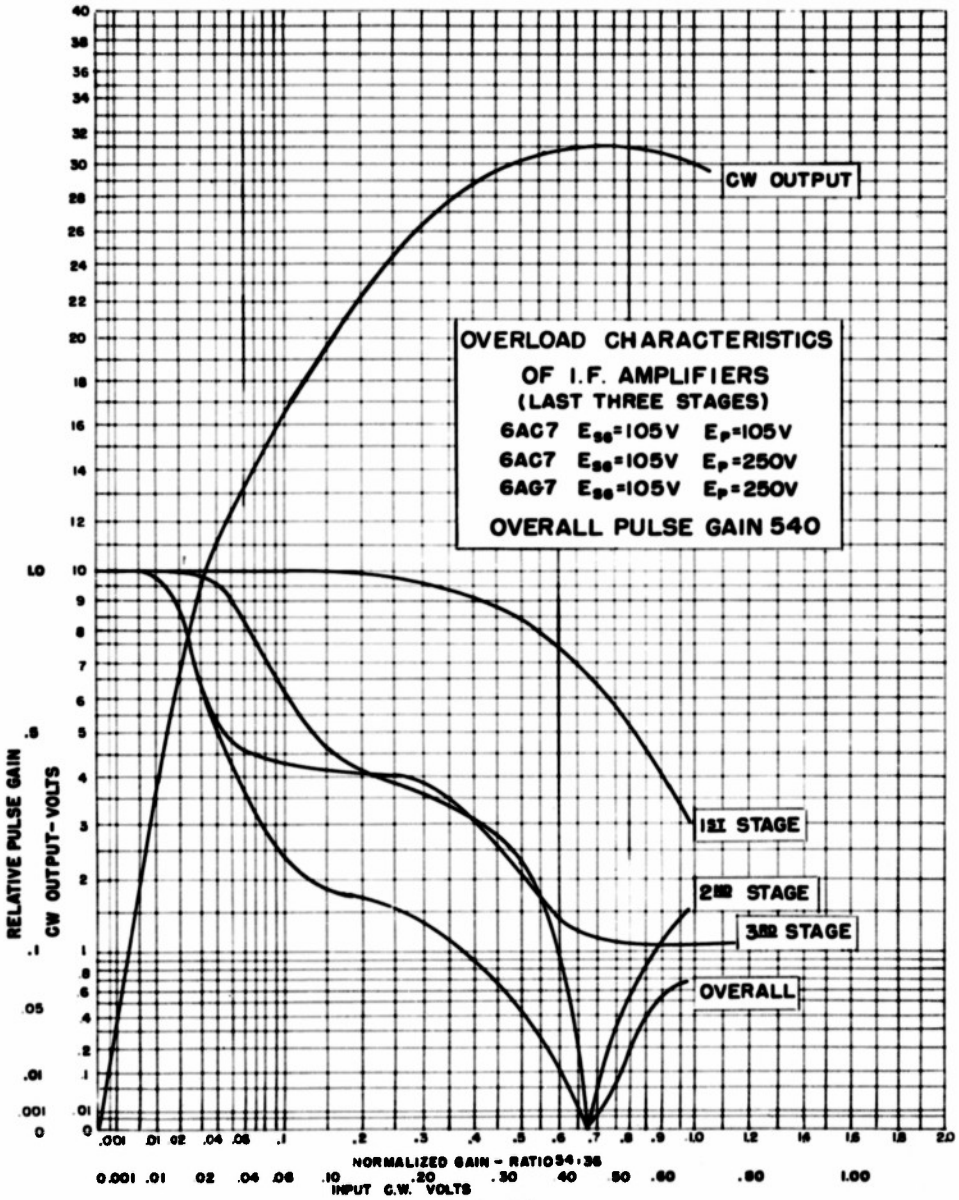

OVERLOAD CHARACTERISTICS
OF I.F. AMPLIFIERS
(LAST THREE STAGES)
6AC7 E_{SG}=105V E_P=105V
6AC7 E_{SG}=105V E_P=250V
6AG7 E_{SG}=105V E_P=250V
OVERALL PULSE GAIN 540
CW OUTPUT
1ST STAGE
2ND STAGE
3RD STAGE
OVERALL
RELATIVE PULSE GAIN
CW OUTPUT-VOLTS
NORMALIZED GAIN - RATIO 54:36
INPUT C.W. VOLTS

FIG. 26

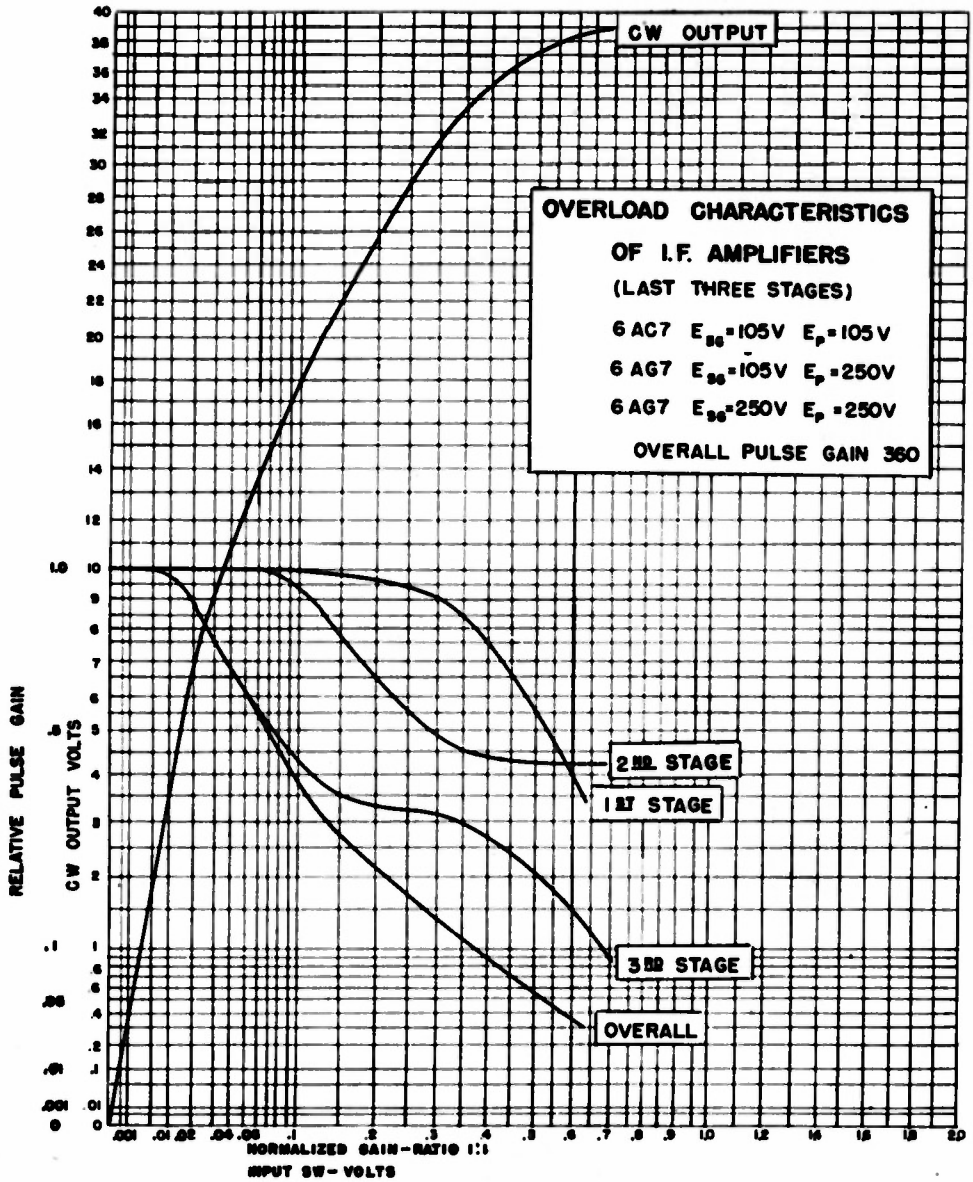

CW OUTPUT
OVERLOAD CHARACTERISTICS
OF I.F. AMPLIFIERS
(LAST THREE STAGES)
6 AC7 E96=105V Ep=105V
6 AG7 E96=105V Ep=250V
6 AG7 E96=250V Ep=250V
OVERALL PULSE GAIN 360
2ND STAGE
1ST STAGE
3RD STAGE
OVERALL
RELATIVE PULSE GAIN
CW OUTPUT VOLTS
NORMALIZED GAIN-RATIO 1:1
INPUT SW-VOLTS

FIG. 27

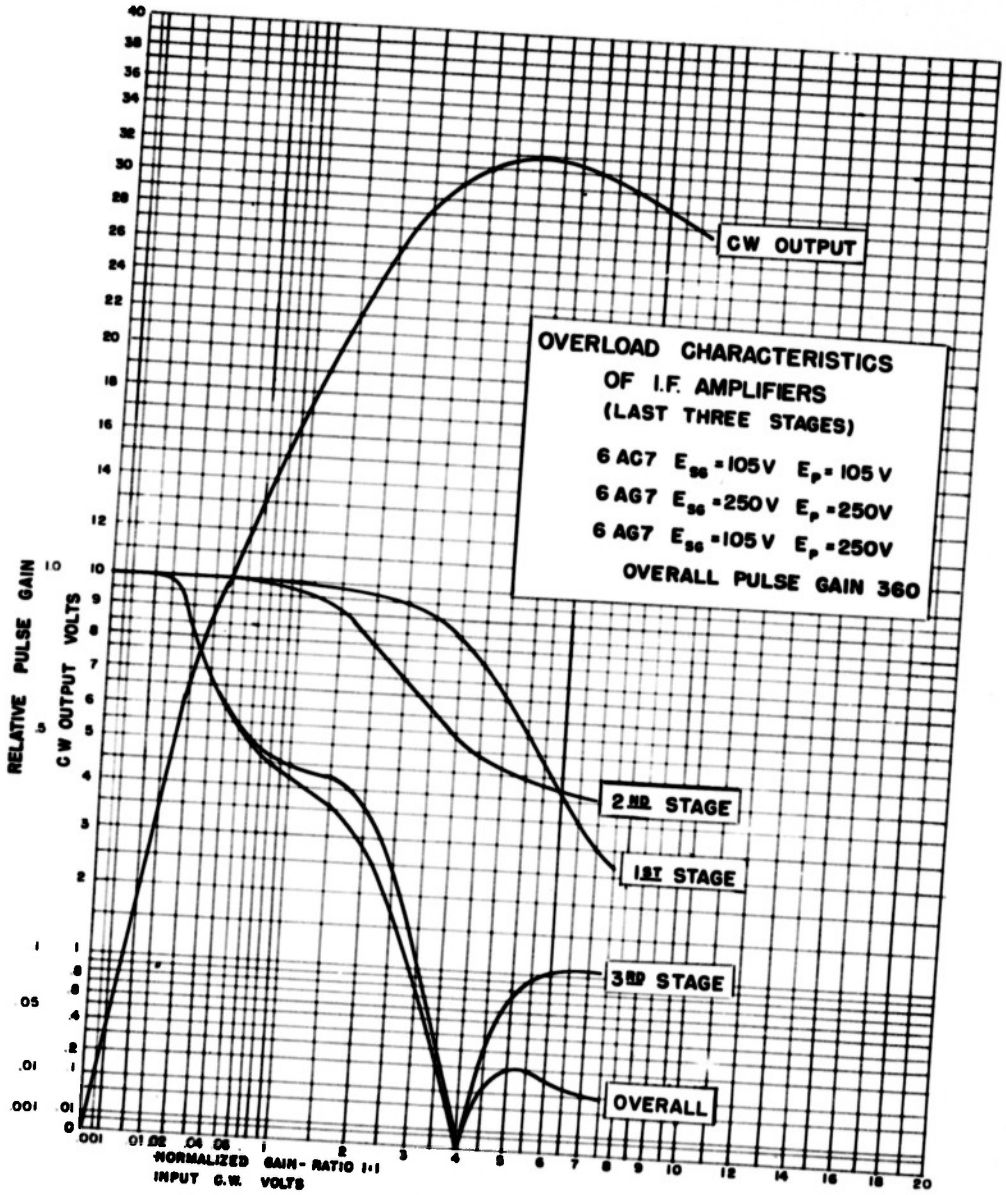

OVERLOAD CHARACTERISTICS
OF I.F. AMPLIFIERS
(LAST THREE STAGES)
6 AC7 E_{sg} = 105V E_p = 105 V
6 AG7 E_{sg} = 250V E_p = 250V
6 AG7 E_{sg} = 105 V E_p = 250V
OVERALL PULSE GAIN 360
CW OUTPUT
2ND STAGE
1ST STAGE
3RD STAGE
OVERALL
RELATIVE PULSE GAIN
&
CW OUTPUT VOLTS
NORMALIZED GAIN- RATIO 1:1
INPUT C.W. VOLTS

FIG. 28

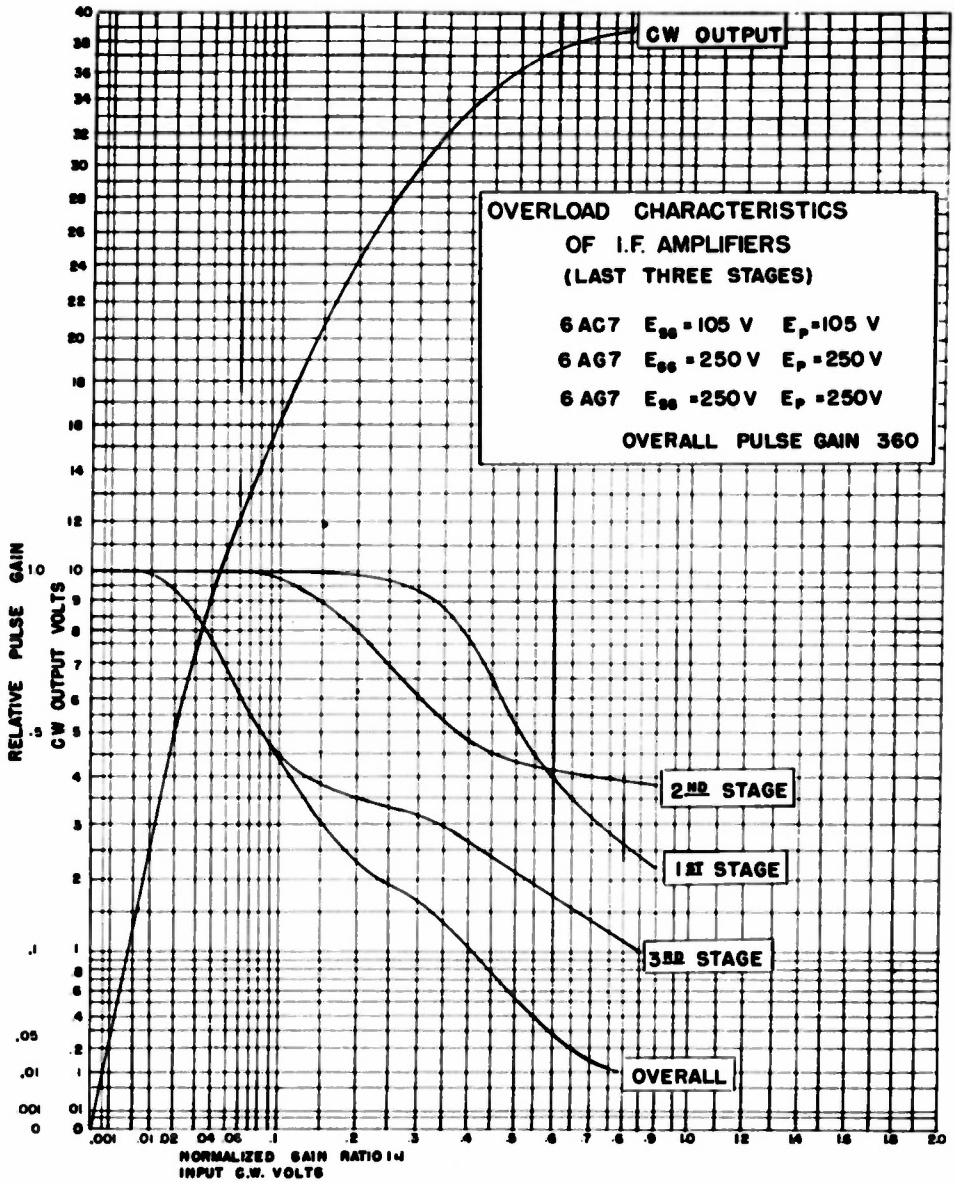
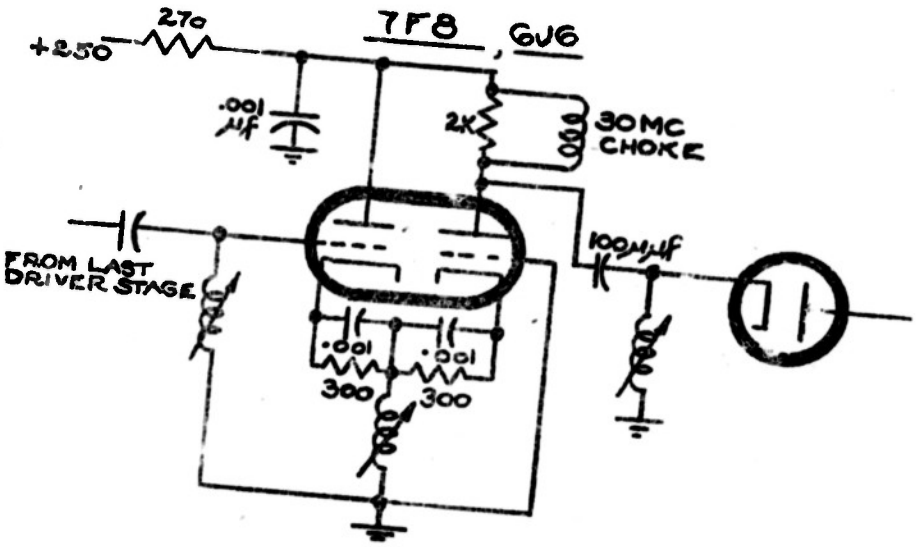
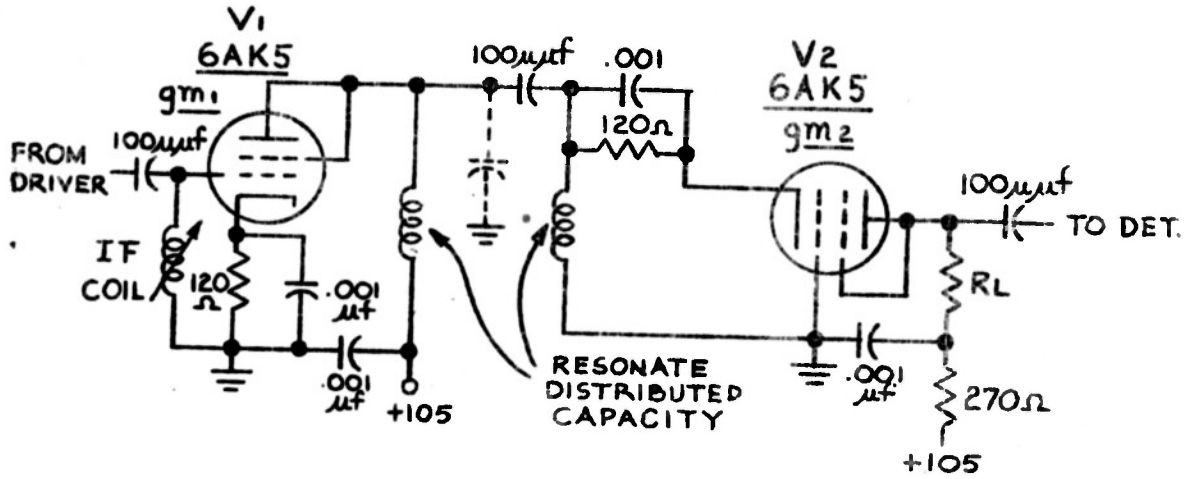

OVERLOAD CHARACTERISTICS
OF I.F. AMPLIFIERS
(LAST THREE STAGES)
6 AC7 E_{SG} = 105 V E_P = 105 V
6 AG7 E_{SG} = 250 V E_P = 250 V
6 AG7 E_{SG} = 250 V E_P = 250 V
OVERALL PULSE GAIN 360
CW OUTPUT
2ND STAGE
1ST STAGE
3RD STAGE
OVERALL
RELATIVE PULSE GAIN
CW OUTPUT VOLTS
NORMALIZED GAIN RATIO IN
INPUT C.W. VOLTS

FIG. 29



TRIODE COMBINATION NO. 1

FIG. 30



GAIN OF $V_1 = g_{m1} \times \frac{1}{g_{m2}} \cong 1$

GAIN OF $V_2 = g_{m2} \times R_L$

HOWEVER, WHEN V_1 IS A C.F. AS IN FIGURE 30

GAIN OF $V_1 = g_{m1} \left(\frac{1}{g_{m1} + g_{m2}}\right) \cong 1/2$

FIG. 31 TRIODE COMBINATION NO. 2

REEL – C

763

A.T.I.

20406

ATI - 20406

U

Dup of 6082

TSDIN FORM 80 (13 MAR 47)

Smith, S. A.
Ashbrook, F. M.

AUTHOR(S)

DIVISION: Electronics (3)
SECTION: Components (10)
CROSS REFERENCES: Amplifiers (10675)

ATI- 6082

ORIG. AGENCY NUMBER

R-1032

REVISION

AMER. TITLE: Intermediate frequency amplifier overload characteristics

FORG'N. TITLE:

P8/1

ORIGINATING AGENCY: Massachusetts Inst. of Technology, Radiation Lab., Cambridge

TRANSLATION:

COUNTRY	LANGUAGE	FORG'N.CLASS	U. S.CLASS.	DATE	PAGES	ILLUS.	FEATURES
U.S.	Eng.		Unclass.	Jan'46	40	33	tables, diagr, graph

ABSTRACT

Performance of IF amplifier tubes under conditions of jamming or interference is important in receiver design. Curves are given for analyzing overloading effects within an IF amplifier and comparing various IF tube types regarding overloading. Data for curves are made by measuring pulse gain of a test stage over a wide range of CW (jamming signal) input voltages. Test procedure and equipment are described in detail. Discussion of apparent cause of complete collapse of some tubes is included.

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