3BZ6
Alternate Use Suggestion

The 3BZ6 (& 6BZ6, etc.) was popular as an AGC (automatic gain controlled) I.F. amplifier in television receivers. The amplitude-modulated RF signal amplified by the Pentode in a TV set is up to 6MHz wide and in the 41-46MHz range, so there is no shortage of performance.

Use as an audio voltage amplifier and especially as a compressor or soft limiter suggests itself. A compressor or soft limiter is, after all, an automatic gain controlled amplifier stage.

The following comments refer to the Tung-Sol 3BZ6 data sheet dated September 1, 1959, available from frank.pocnet.net

Please refer to the class-A amplifier conditions showing 200V on the plate, 150V on the screen grid, and cathode bias supplied by a180 Ohm resistor. This equates to 2.5V of bias at the cathode (-2.5V relative grid bias) with 11mA through the plate and 2.6mA through the screen. The gm (transconductance) is 6100 micromhos under these conditions. Calculations show a plate dissipation of 2.2W (rating is 2.5W) and a screen dissipation of 0.39W (rating is 0.5W).

The above set of conditions uses the same plate and screen voltages as some of the other charts in the data sheet.

gm, for those who do not know, refers to the relationship between the magnitude of the grid voltage signal and the plate current signal, and therefore it is intimately related to the gain of the amplifier stage. A tube like the 3BZ6 has curves that show a large change in gm for a small change in DC grid bias.

Please refer to the chart for grid bias vs. Transconductance (gm) and plate resistance (rp). Under the stated class A conditions, with -2.5V bias on the grid, the gm is 6100 um (micromhos) and that the plate resistance is 550K Ohm. This is the high gain operating condition.

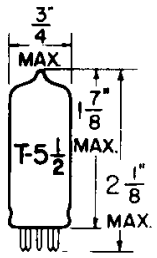
In a compressor, an AGC signal drives the grid-to-cathode bias more negative when a certain output level is reached. This reduces the transconductance and therefore the gain of the AGC Amplifier (3BZ6). If the bias is increased from -2.5 to -7V, the gm decreases to a tenth, or 600 um.
The bias can be increased to -20V, for a gm of just 60 um, which is just a hundredth of the normal 6100 value. The plate current will be very low, around 0.3mA, but the tube will still amplify the signal as long as neither the bias nor the negative peaks of the grid signal are so great as to cut the plate current off. A range of 1:100 looks like a lot of fun for the tube experimenter.

Generating the AGC voltage is typically accomplished by a very simple rectifier and DC level circuit which is driven by a lower impedance stage farther along so as not to load down the 3BZ6 plate circuit. There are many compressor/limiter circuits on the web that illustrate AGC generation and use. In audio circuits, AGC is sometimes called AVC (automatic volume control).

TUNG-SOL

PENTODE

MINIATURE TYPE

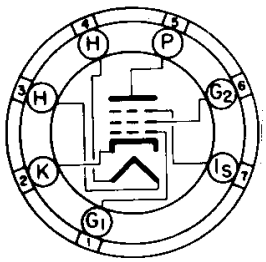


GLASS BULB

COATED UNIPOTENTIAL CATHODE

HEATER
3.15 VOLTS 0.6 AMP.
AC OR DC

ANY MOUNTING POSITION



BOTTOM VIEW
MINIATURE BUTTON
7 PIN BASE
7CM

THE 3BZ6 IS A HIGH TRANSCONDUCTANCE, SEMI-REMOTE CUT-OFF, PENTODE AMPLIFIER. IT IS DESIGNED FOR SERVICE AS AN AUTOMATIC GAIN CONTROLLED IF AMPLIFIER IN 600 MA. SERIES HEATER OPERATED TELEVISION RECEIVERS. THERMAL CHARACTERISTICS OF THE HEATER ARE CONTROLLED SUCH THAT HEATER VOLTAGE SURGES DURING THE WARM-UP CYCLE ARE MINIMIZED PROVIDED IT IS USED WITH OTHER TYPES WHICH ARE SIMILARLY CONTROLLED. WITH THE EXCEPTION OF HEATER RATINGS, ITS CHARACTERISTICS ARE IDENTICAL TO THE 6BZ6.

DIRECT INTERELECTRODE CAPACITANCES

	WITH SHIELD[A]	WITHOUT SHIELD	
GRID TO PLATE: G_1 TO P (MAX.)	0.015	0.02	μμf
INPUT: G_1 TO (H+K+G_2+G_3+IS)	7.5	7.5	μμf
OUTPUT: P TO (H+K+G_2+G_3+IS)	2.8	1.8	μμf

[A] EXTERNAL SHIELD #316 CONNECTED TO CATHODE AT SOCKET.

RATINGS[B]

INTERPRETED ACCORDING TO DESIGN MAXIMUM SYSTEM

HEATER VOLTAGE	3.15	VOLTS
MAXIMUM HEATER CATHODE VOLTAGE:		
HEATER NEGATIVE WITH RESPECT TO CATHODE[C] ←		
TOTAL DC AND PEAK	300	VOLTS
HEATER POSITIVE WITH RESPECT TO CATHODE		
DC	100	VOLTS
TOTAL DC AND PEAK	200	VOLTS
MAXIMUM PLATE VOLTAGE	300	VOLTS
MAXIMUM GRID #2 VOLTAGE	SEE RATING CURVE	
MAXIMUM PLATE DISSIPATION	2.5	WATTS
MAXIMUM GRID #2 DISSIPATION	0.5	WATT
MAXIMUM GRID #2 SUPPLY VOLTAGE	300	VOLTS
MAXIMUM GRID #1 CIRCUIT RESISTANCE:		
FIXED BIAS OPERATION	0.25	MEGOHM
SELF BIAS OPERATION	1.0	MEGOHM
HEATER WARM-UP TIME (APPROX.)*	11.0	SECOND

*HEATER WARM-UP TIME IS DEFINED AS THE TIME REQUIRED FOR THE VOLTAGE ACROSS THE HEATER TO REACH 80% OF ITS RATED VOLTAGE AFTER APPLYING 4 TIMES RATED HEATER VOLTAGE TO A CIRCUIT CONSISTING OF THE TUBE HEATER IN SERIES WITH A RESISTANCE OF VALUE 3 TIMES THE NOMINAL HEATER OPERATING RESISTANCE.

→ INDICATES A CHANGE.

CONTINUED ON FOLLOWING PAGE

TUNG-SOL

CONTINUED FROM PRECEDING PAGE

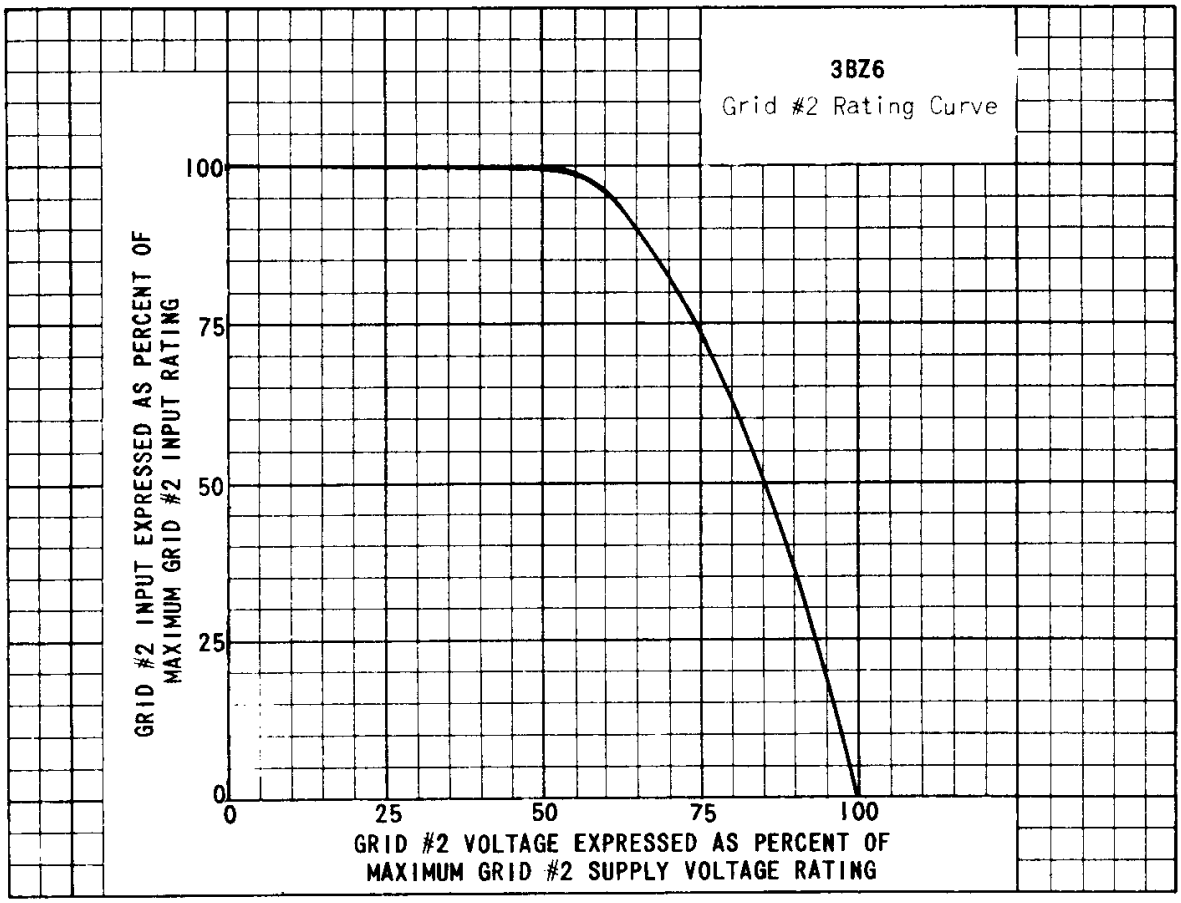
TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

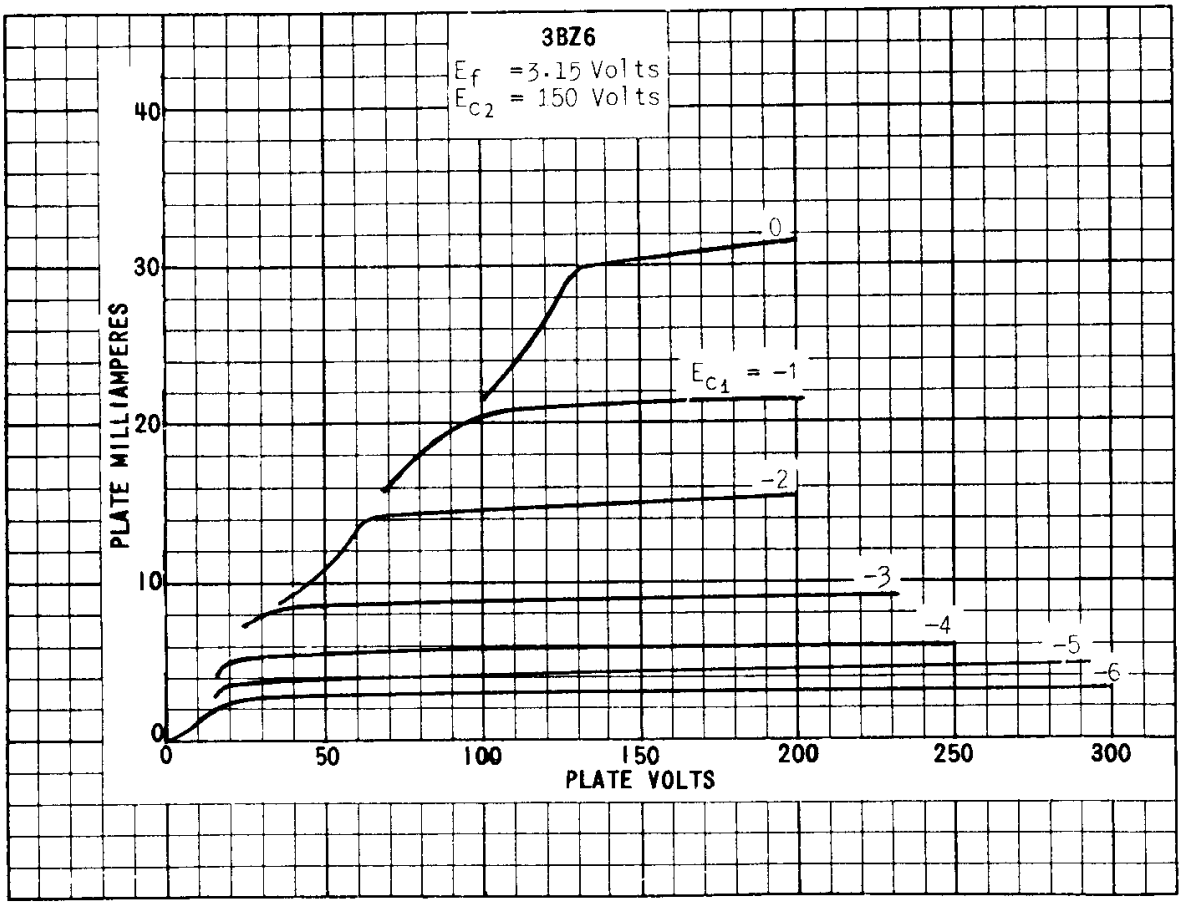
CLASS A_1 AMPLIFIER

HEATER VOLTAGE		3.15	VOLTS
HEATER CURRENT		0.6	AMP.
PLATE VOLTAGE		200	VOLTS
GRID #2 VOLTAGE		150	VOLTS
GRID #3 VOLTAGE	PIN #7 CONNECTED TO PIN #2 AT SOCKET		
CATHODE BIAS RESISTOR		180	OHMS
PLATE RESISTANCE (APPROX.)		0.6	MEGOHM
TRANSCONDUCTANCE		6 100	μMHOS
PLATE CURRENT		11	MA.
GRID #2 CURRENT		2.6	MA.
GRID #1 VOLTAGE (APPROX.) FOR G_m = 50 μMHOS		−23	VOLTS

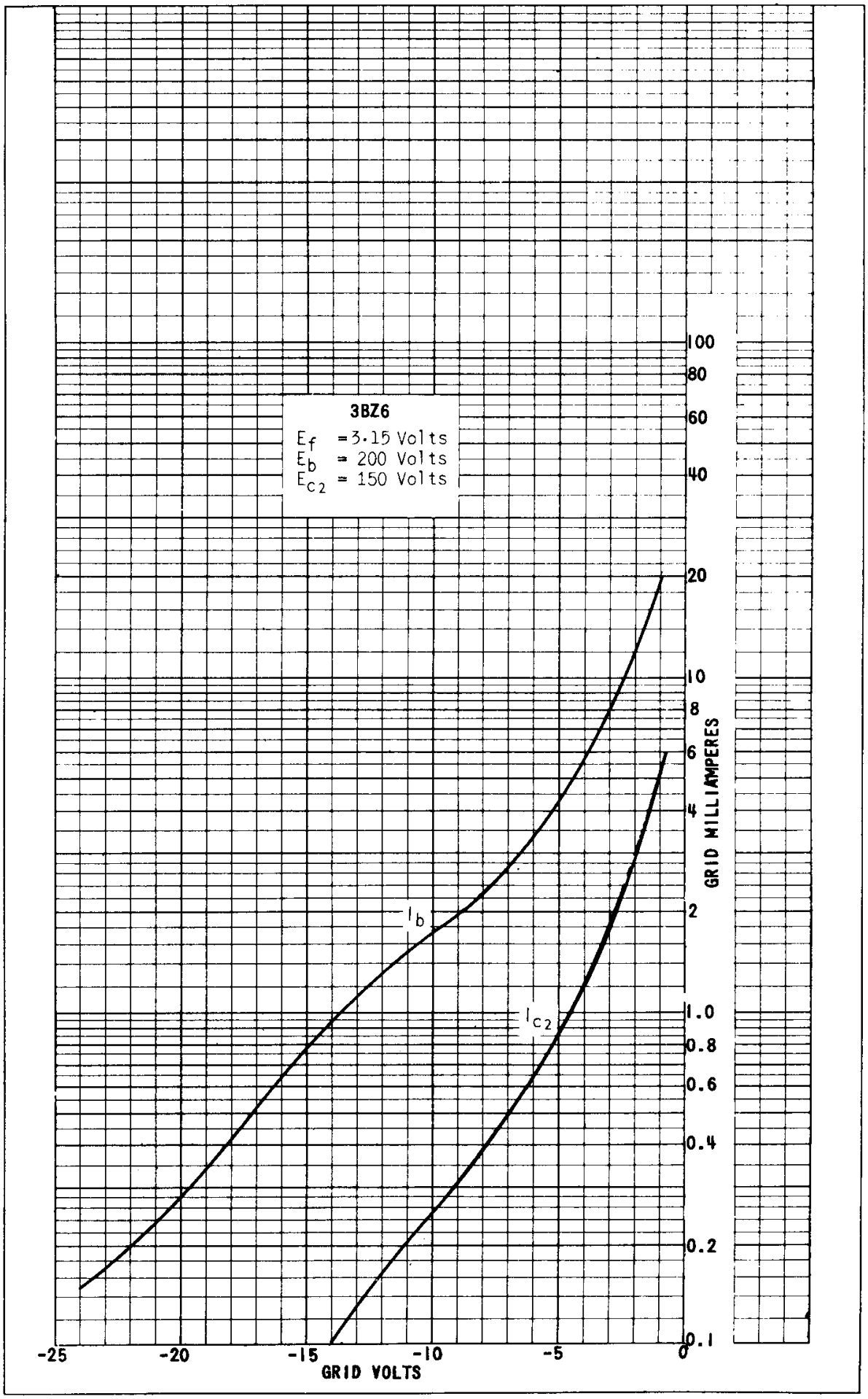
[B] DESIGN MAXIMUM RATINGS ARE THE LIMITING VALUES EXPRESSED WITH RESPECT TO BOGIE TUBES AT WHICH SATISFACTORY TUBE LIFE CAN BE EXPECTED TO OCCUR IN THE TYPES OF SERVICE FOR WHICH THE TUBE IS RATED. THEREFORE, THE EQUIPMENT DESIGNER MUST ESTABLISH THE CIRCUIT DESIGN SO THAT INITIALLY AND THROUGHOUT EQUIPMENT LIFE NO DESIGN MAXIMUM VALUE IS EXCEEDED WITH A BOGIE TUBE UNDER THE WORST PROBABLE OPERATING CONDITIONS WITH RESPECT TO SUPPLY-VOLTAGE VARIATION, EQUIPMENT COMPONENT VARIATION, EQUIPMENT CONTROL ADJUSTMENT, LOAD VARIATION, AND ENVIRONMENTAL CONDITIONS.

[C] THE DC COMPONENT MUST NOT EXCEED 200 VOLTS.


3BZ6
Grid #2 Rating Curve
GRID #2 INPUT EXPRESSED AS PERCENT OF MAXIMUM GRID #2 INPUT RATING
100
75
50
25
0
0
25
50
75
100
GRID #2 VOLTAGE EXPRESSED AS PERCENT OF MAXIMUM GRID #2 SUPPLY VOLTAGE RATING


3BZ6
E_f = 3.15 Volts
E_{c2} = 150 Volts
PLATE MILLIAMPERES
40
30
20
10
0
0
50
100
150
200
250
300
PLATE VOLTS
0
E_{c1} = -1
-2
-3
-4
-5
-6

3BZ6



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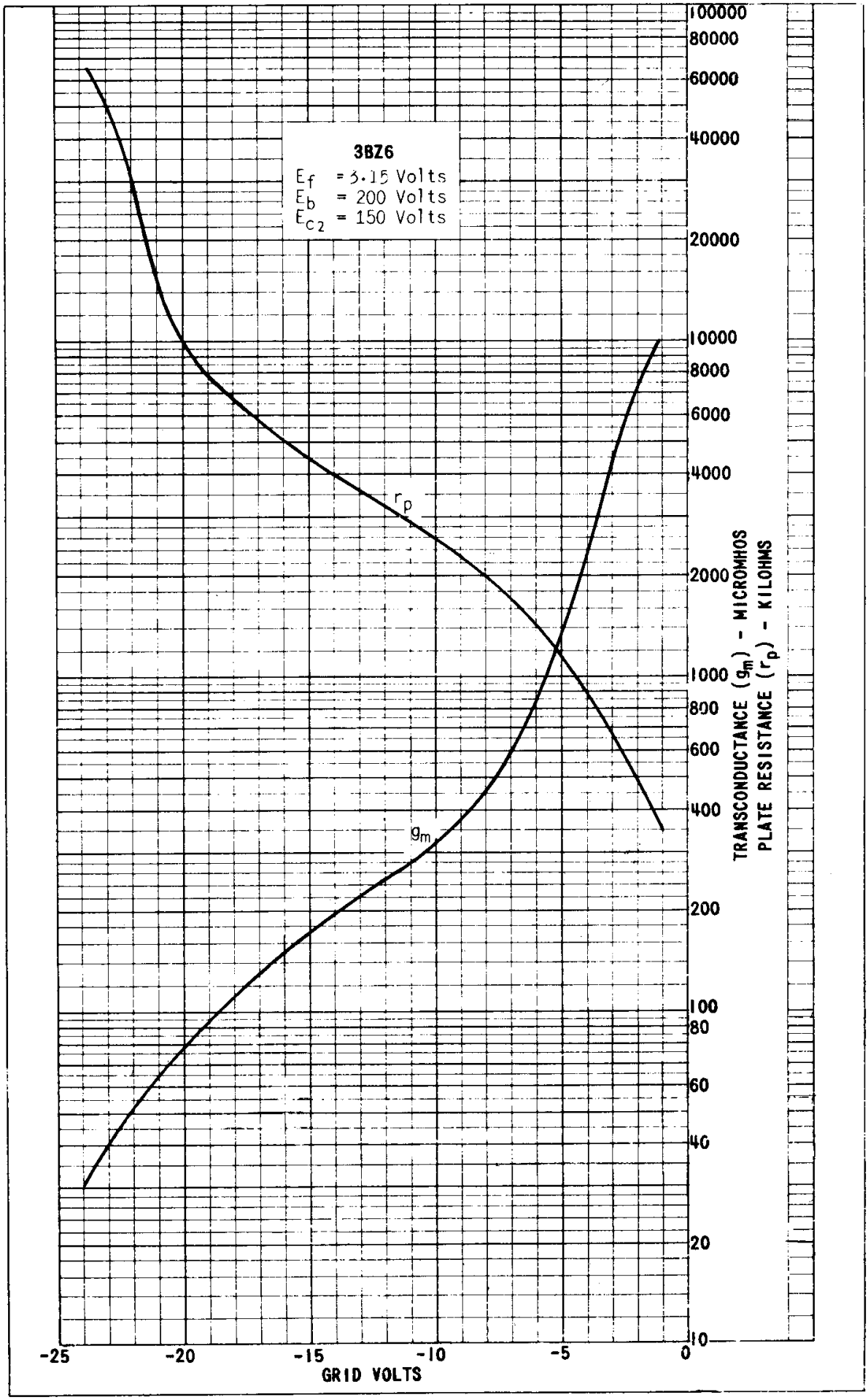

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