RCA MANUFACTURING COMPANY, INC.
A RADIO CORPORATION OF AMERICA SUBSIDIARY
Harrison, New Jersey

RCA RADIOTRON
DIVISION

APPLICATION NOTE No. 18
July 27, 1933
Reprinted June 26, 1936.

APPLICATION NOTE ON OPERATION CONDITIONS FOR THE TYPE 19 TUBE

The type 19 tube is a Class B Twin-Amplifier designed primarily for use in battery-operated receivers. With 135 volts on the plate the 19 is capable of approximately 2.5 watts output. Combining two high-mu triodes in one bulb, the 19 offers advantages in battery-operated receiver design such as economy in chassis space, high efficiency, good power output at relatively low plate voltages, and good quality. Used in connection with a permanent-magnet type of dynamic speaker, the 19 makes possible the design of battery receivers having performance capabilities approaching those of a-c sets.

In battery receivers, the plate-voltage and plate-current requirements of the output tube are of prime importance. Tubes which require high plate voltages necessitate the use of more battery units, while tubes with high plate-current drains mean frequent battery renewals. The efficiency of the output tube is therefore of first importance when the cost of operation of the set is considered. Class B output systems have inherently high efficiency. Careful design of a Class B output system will insure good quality. The type 19 tube, giving adequate power output with only 135 volts on the plates, merits the attention of set engineers, because of its high efficiency and relatively low plate-current drain.

In Table 1 and Table 2 are tabulated typical operating conditions for the 19. The combinations of Table 1 employ a type 30 tube as the driver. The combinations of Table 2 employ a 31 as a driver.

In arrangement 1 of Table 1, the 19 is operated with zero volts grid bias. The grids are returned to the negative side of the filament. Under these conditions, the power output is 1.68 watts with a total harmonic distortion of 7.1 percent at full output. Like many Class B types, the distortion curve of the 19 has a hump at some point below full output. The maximum distortion at this hump is shown in the column headed "Low Peak." In this case it is 6.7 percent.

Arrangement 2 is practically identical with arrangement 1 except that the grids of the 19 are returned to the positive side of the filament. Under these conditions the power output is increased to 1.74 watts, and the low-peak distortion is reduced to 3.5 percent. The zero-signal plate current is raised slightly over that in arrangement 1; the plate current at full output is also slightly increased. Listening tests reveal that the higher-order harmonics are reduced when the grids of the 19 are returned to the positive side of the filaments.

Arrangement 3 shows the effect of a negative-bias voltage on the grids of the 19. The power output is the same as that with arrangement 1. The relative amount of higher-order harmonics is also nearly the same as that for arrangement 1. However, the zero-signal plate current is reduced considerably. This reduction in initial plate current may be of considerable advantage in some designs.

Arrangement 4 shows the effect of an increased negative-bias voltage on the grids of the 19. The power output for the same amount of distortion is reduced from that obtained with arrangement 3. The relative amount of higher-order harmonics, as indicated by listening tests, is increased noticeably. The zero-signal plate current is reduced to a negligible amount.

Arrangements 1 and 2 of Table 2 show operating conditions for the 19 with a 31 driver. In the first arrangement, the grids of the 19 are returned to the negative side of the filament, while with arrangement 2, they are returned to the positive side of the filament. Although the power output is approximately the same for both arrangements, the relative amount of higher-order harmonics is appreciably less when the grids are returned to the positive side of the filament.

Fig. 1 shows the operation characteristics of the 19 with a type 30 driver. The solid curves show the operation of the output system with the grids returned to the positive side of the filament, while the dotted curves show the operation with the grids returned to the negative side of the filament. The curves of power output, plate current, and grid current are approximately the same for both arrangements, but it will be seen that a much smoother rise of percent total harmonic distortion is obtained when the grids are returned to the positive side of the filament.

Fig. 2 shows the operation characteristics of the 19 with a type 31 driver. The curves of Fig. 2 are presented in the same form as those of Fig. 1 so that a comparison of operation characteristics can be readily made

The power output obtainable from the 19 is considerably higher when the 31 is used as a driver. However, the 31 driver requires a much larger signal input for full output than does the 30 driver. The plate current of the 31 driver is also higher.

Fig. 3 shows the average plate characteristics of a single-triode unit of the 19.

On an attached sheet will be found specifications for a suitable input transformer for the 19. This transformer used with a 30 driver will give operation characteristics essentially the same as those shown in Fig. 1.

GENERAL COMMENTS ON CLASS B DESIGNS

As a word of caution regarding Class B output systems, listening tests sometimes show the quality of the output to be very poor, although the circuit apparently has been designed properly. In such cases, the trouble may be due to radio-frequency oscillation in the output tubes. This oscillation occurs only when an audio-frequency signal is applied to the grids. The result of these radio-frequency oscillations is an audible rasp in the output which easily can be mistaken for higher harmonics of the input signal. To determine if this rasping is due to oscillations, an a-c signal should be applied to the grids of the Class B output tubes, and the grid leads touched with a finger. If the rasping stops when the leads are touched, it is undoubtedly due to radio-frequency oscillations. A remedy for oscillation is effected by connecting small fixed condensers between each grid and cathode of the Class B stage. Tests have shown that 0.0005 µf. condensers are usually satisfactory. These condensers may not be required if a speaker-correction network of resistance and capacitance is employed between the plates and cathodes.

It may be desirable to employ a speaker-correction network between the plates of the output tube, in order to maintain a uniform load at all frequencies. For a 10,000-ohm plate-to-plate load on the Class B stage, a resistance of 11,500 ohms and a capacitance of 0.021 µf. should be connected in series between the two plates. For a 12,000-ohm load, the resistance should be 13,800 ohms and the capacitance 0.017 µf.; for a 6,000-ohm load, the resistance should be 7,000 ohms and the capacitance 0.035 µf.

A more effective, but also more expensive, way of applying the correction network is obtained by balancing the network to the center tap of the interstage transformer. The value of resistance between each plate and center tap is one-half that given above, while the value of each capacitance is twice that given above.

The primary inductance of the output transformer should be high enough to give good low-frequency response; yet, at the same time, it should be kept sufficiently low to obtain good high-frequency response. Close coupling and low leakage reactance are necessary for low distortion levels and good power output at high frequencies.

INPUT TRANSFORMER S-108*

Interstage transformer for one type 30 tube operating at plate volts = 135, grid volts = -9 and driving one type 19 tube operating at plate volts = 135, grid volts = 0 and ultilized as Class B Amplifier.

For both 30 and 19, plate-supply voltage = 135 volts.

Core:	Material -	Grade Audio B, Gauge #29, Alleghany Steel Co., or equivalent.
	Punching	EI-75
	Window	1.125" x 0.375"
	Tongue	0.75"
	Stack	0.75"
	Joint	Butt
	Net Section	3.25 sq. cm.
	Mean length mag. circuit	13.3 cm.
	Weight	0.60 lbs.
Winding:	Traverse and Margin	1/16" + 15/16" + 1/16"
	Form (inside dimensions)	25/32" x 25/32" x length 1-1/16"
Primary:	Turns	5000 #40 enamelled
	Location	over insulated secondary
	Turns per layer	240
	Layers	21
	Insulation between layers	0.001" paper
	Insulation over winding	0.012" "
	Mean length of turn	5.3"
	Resistance at 25°C	2500 ohms
Secondary:	Turns	4400 #38 enamelled, tap at 2200 turns
	Location	next to core
	Turns per layer	185
	Layers	24
	Insulation between layers	0.001" paper
	Insulation under winding	0.045" "
	Insulation over winding	0.020" "
	Mean length of turn	4.0"
	Resistance at 25° C	980 ohms total

Efficiency approximately 70% at full load

Inductance of primary at 4 volts, 60 cycles, and 3 ma. d.c. is 50 henries

* Our design identification number.

TABLE I

CLASS B COMBINATIONS USING ONE TYPE 19

DRIVER-CLASS A-ONE TYPE 30: PLATE VOLTS = 135, GRID VOLTS = -9, PLATE MA. = 3

Arrangement	Input Transformer	Output Stage								
	Voltage Ratio Pri. to 1/2 Sec.	Plate Volts	Grid Volts	Total Av. Plate Ma.		Plate-to-Plate Load (Ohms)	Output Watts	Total Distortion %		Grid Return Connected To
				No Signal	Full Output			Low Peak	Full Output	
1	2.66	135	0	10.0	23.5	12000	1.68	6.7	7.1	- Filament
2	2.66	135	0	15.0	28.0	10000	1.74	3.5	7.5	+ Filament
3	1.83	135	-3	2.6	22.5	12000	1.68	6.3	7.5	- Filament
4	1.61	135	-6	0.4	20.0	12000	1.39	16.0	7.5	- Filament

TABLE 2

CLASS B COMBINATIONS USING ONE TYPE 19

DRIVER-CLASS A-ONE TYPE 31: PLATE VOLTS = 135, GRID VOLTS = -22.5, PLATE MA. = 8

Arrangement	Input Transformer	Output Stage								
	Voltage Ratio Pri. to 1/2 Sec.	Plate Volts	Grid Volts	Total Av. Plate Ma.		Plate-to-Plate Load (Ohms)	Output Watts	Total Distortion %		Grid Return Connected To
				No Signal	Full Output			Low Peak	Full Output	
1	1.53	135	0	10.0	40.0	6000	2.59	8.7	7.5	- Filament
2	1.72	135	0	15.0	40.0	6000	2.52	3.9	7.5	+ Filament

Cunningham Radiotron

RCA-19

OPERATION CHARACTERISTICS

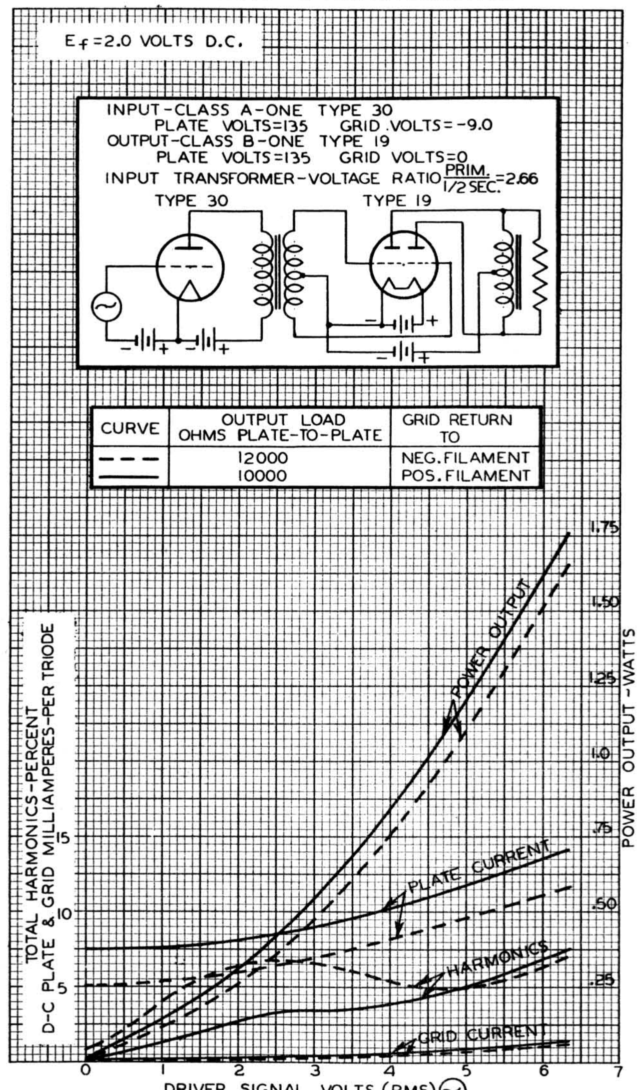

FIG. 1

JULY 17, 1933 | RCA RADIOTRON DIVISION | 92S-5354

RCA MANUFACTURING COMPANY, INC.

Cunningham Radiotron

RCA-19

OPERATION CHARACTERISTICS

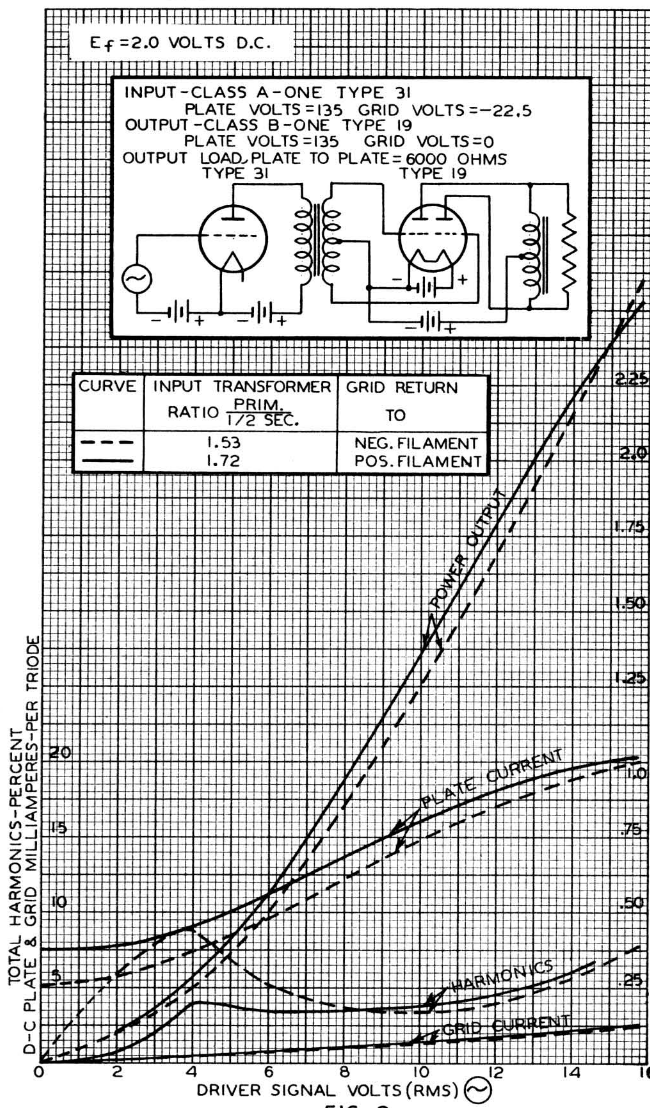

FIG. 2

JULY 17, 1933 | RCA RADIOTRON DIVISION | 92S-5355

RCA MANUFACTURING COMPANY, INC.

RCA Cunningham Radiotron RADIO TUBES

RCA-19

AVERAGE PLATE CHARACTERISTICS
EACH TRIODE UNIT

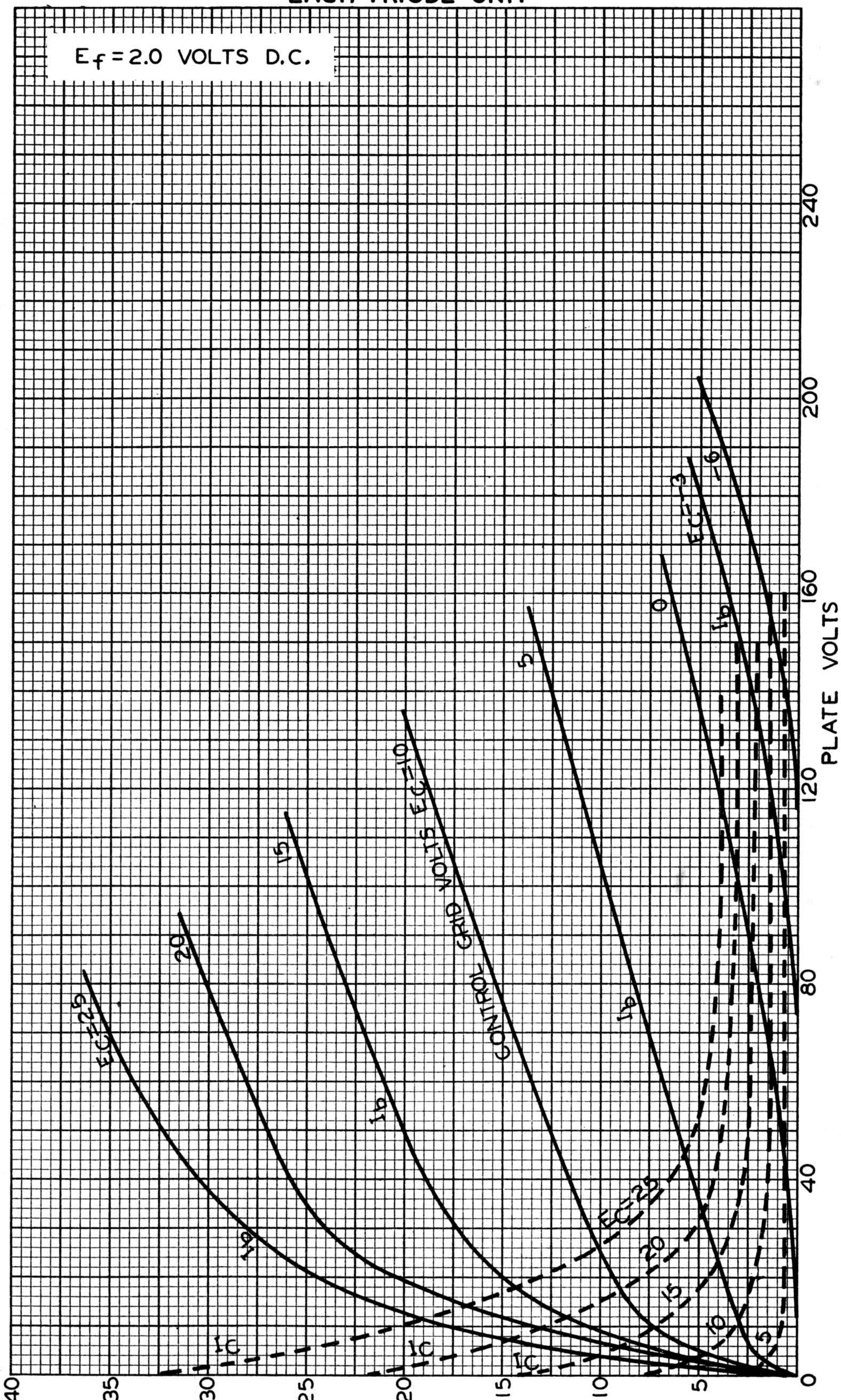

FIG. 3