July 14, 1959 M. FARBER 2,895,019

SINGLE-TUBE AMPLIFIER WITH TRANSFORMER OUTPUT

Filed Feb. 26, 1954

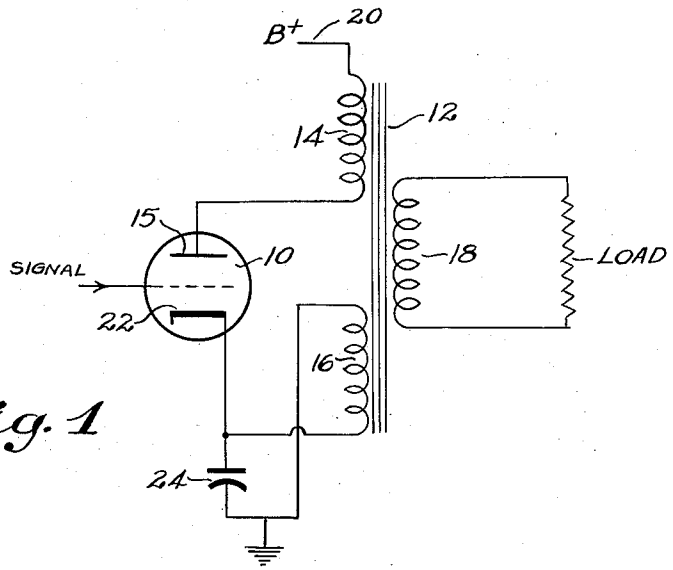


Fig. 1

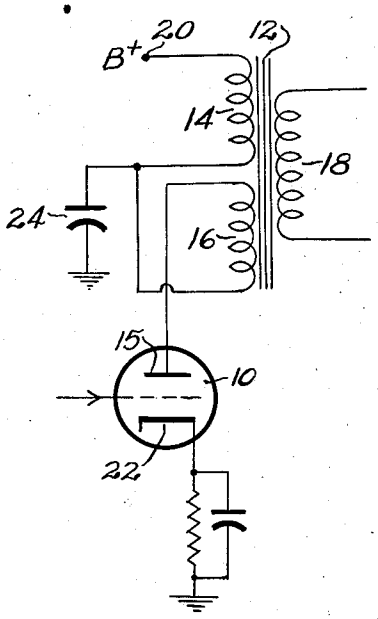


Fig. 2

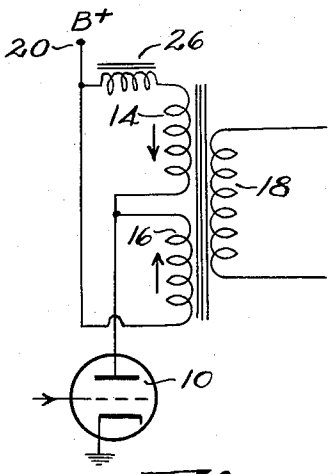


Fig. 3

INVENTOR:
MONROE FARBER,

BY Homer R. Montague
ATTORNEY

United States Patent Office 2,895,019 Patented July 14, 1959

2,895,019

SINGLE-TUBE AMPLIFIER WITH TRANSFORMER OUTPUT

Monroe Farber, Jericho, N.Y., assignor to Fairchild Camera and Instrument Corporation, a corporation of Delaware

Application February 26, 1954, Serial No. 412,807

7 Claims. (Cl. 179—171)

This invention pertains to amplifiers, and particularly to improvements in vacuum tube amplifiers whose final stage includes a single vacuum tube feeding an output transformer.

It is sometimes desirable to place a transformer in the output position of a single-tube (single-ended) amplifier in order to isolate the output voltage from the space current supply or other circuits of said tube. However, if such a transformer is merely connected with its primary winding in series with the space path of the tube, the tube's direct current will flow through the primary winding (in addition to the alternating component of space current resulting from the signal voltage being amplified), and will tend to saturate the iron circuit of the transformer with direct current flux. This distinguishes the single-ended transformer output amplifier from the conventional push-pull arrangement, for in the latter, as is well known, the direct currents through the two tubes tend to magnetize the core in opposite directions, and the resulting fluxes neutralize one another and do not tend to saturate the magnetic circuit.

The present invention provides a convenient solution to the problem of obtaining transformer-isolated output from a single ended amplifier, and thereby permits a transformer to be employed which is much smaller in size than would be the case if the saturation effect were not eliminated.

Generally speaking, the invention accomplishes the above result by utilizing a transformer which has two substantially identical primary windings. The space path of the single tube is caused to pass through these two windings in series, but one of the windings is provided with a suitable by-pass condenser so that the alternating component of the space current enters only one of said windings. By poling the windings properly, the result is obtained that the direct current component (which flows in both windings) is self-neutralizing so far as the magnetic circuit of the transformer is concerned, and saturation is not produced. The single winding through which flows the alternating component of space current induces a secondary voltage in the usual manner.

In an alternative form, the primary windings may be identical and connected in parallel, with the direct component only blocked from one winding as by a choke or filter.

The invention is more particularly described hereinafter in connection with certain preferred embodiments, and shown in the accompanying drawings, in which:

Fig. 1 is a schematic diagram of the connection of an amplifier stage having one tube to a transformer, in accordance with one form of the invention.

Fig. 2 is a similar diagram of a modified form which the circuit may take, and

Fig. 3 is a similar view of still another modification.

Referring now to Fig. 1 of the drawings, there is shown a single tube amplifier stage which may, of course, be the final stage of a more elaborate amplifier. The vacuum tube 10 of this stage is shown as a triode, although other types of multi-electrode tubes may also be employed. The input signal to triode 10 is applied to the control grid in the usual way, and the output is derived from a transformer 12. Specifically, the transformer 12 is provided with similar primary windings 14 and 17, and at least one secondary or output winding 18. Transformers of this type are well known for various purposes, and indeed a conventional push-pull output transformer may be used so long as the paired windings are separable; that is, do not have a common terminal which cannot be disconnected.

The anode or plate supply voltage for tube 10 is indicated at 20, and is connected through one primary winding 14 to the anode 15 of the tube. The space path of the tube is completed, in the embodiment of Fig. 1, by a connection from the tube cathode 22 to ground through the other primary winding 16, the latter being connected so that direct current which flows through winding 14 to generate a flux in one direction in the core of the transformer will, in passing through winding 16, generate a flux in the opposite direction in the core. The return path from ground to the negative side of the anode supply is not indicated, it being understood that the negative plate supply terminal is also grounded. The ground symbol herein is merely a convenient symbol for a low resistance common return circuit, which may or may not be connected to the chassis of the apparatus.

A by-pass capacitor 24 is connected in parallel with winding 16 (it may equally well be connected across the other winding 14, so long as only one of the two is bypassed thereby), and has a value such as will permit the alternating component of the tube space current to pass directly through such capacitor, with little or none passing through winding 16. Hence, and since the alternating component of space current can only enter winding 14, the flux produced thereby in the magnetic circuit will not be neutralized, and a corresponding voltage will be developed in the secondary winding 18.

Obviously, the same principle can be carried out in other ways. Thus, as shown in Fig. 2, it is not necessary that the primary windings be connected to plate and cathode of the tube 10 respectively. In Fig. 2, both primaries are in series with the plate electrode and the space current supply, and again, one is reversed in polarity. In this case, the by-pass capacitor 24 shunts both the winding 14 and the plate voltage supply, but it effectively ensures that the alternating current component flows through winding 16 only. Equally well, both primary windings could be connected between the cathode and ground in a series connection.

The resistor 26 and capacitor 28 of Fig. 2 represent merely a conventional bias supply circuit for tube 10, and do not affect the operation of the circuit as a whole, from the standpoint of preventing saturation of the transformer magnetic circuit.

Since the operation depends upon allowing the direct current component to flow in both windings, poled to neutralize their effects so far as flux is concerned, and allowing the alternating current component to flow in only one winding, a parallel connection of the transformer primaries can also be used. As shown in Fig. 3, for example, in which like reference numerals designate parts already described, the windings 14 are paralleled in the anode voltage supply path of the tube, and alternating currents are blocked from winding 14 only as by a choke 26 connected in series with this winding only. A more complex filter may be substituted for the choke 30 where desired, so long as it is successful in preventing the alternating current components from reaching winding 14.

The invention enables a smaller transformer to be used in applications requiring an isolated single tube amplifier stage, and does not require any special or unusual components. The operation of the system is unaffected by resistance which may be shunted across both of the primary windings or either of them, except that in the latter case windings **14** and **16** would, in general, no longer be identical.

While the invention has been disclosed in connection with three simple and preferred embodiments chosen for illustration, it is to be understood that other arrangements may be devised which fall within the spirit of the invention as defined in the appended claims.

I claim:

1. A single-ended amplifier comprising an amplifier tube having at least an anode, a cathode and a control grid, a source of space current connected between said anode and said cathode, an output transformer having a ferro-magnetic core and two matched primary windings both connected in the space current path through said tube and respectively poled so that the fluxes induced therein because of direct current flow in said transformer are in opposing directions whereby saturation of said core is prevented, and means for preventing alternating current components in said path from entering one only of said windings.

2. A single-tube output stage for an amplifier, comprising an electron tube having at least a cathode, an anode and a grid, a signal input circuit connected between said grid and said cathode, a source of space current connected in a series circuit with said anode and cathode, an output coupling transformer having a ferro-magnetic core and a pair of primary windings connected in said series circuit and poled for producing opposing fluxes in said core from the passage of direct current through said pair of windings, and means for blocking the flow of amplified signal-produced currents from only one of said windings.

3. A single-tube output stage for an amplifier, in accordance with claim 2, in which one winding of said pair is connected between said source and said anode, and the other winding is connected between said cathode and said source.

4. A single-tube output stage for an amplifier, in accordance with claim 2, in which both windings of said pair are connected in series adjacency between said source and said anode.

5. A single-tube output stage for an amplifier, in accordance with claim 2, in which said windings are connected in series with one another, and said blocking means comprises a by-pass capacitor shunting only one winding of said pair.

6. A single-tube output stage for an amplifier, in accordance with claim 2, in which said windings are connected in parallel with one another, and said blocking means comprises a choke coil in series with only one of said windings.

7. A single-tube output stage for an amplifier comprising a triode electron tube having a cathode, an anode and a grid, a signal input circuit connected between said grid and said cathode, a source of space current connected in a series circuit with said anode and cathode, an output coupling transformer having a ferro-magnetic core, a first primary winding on said core connected in said series circuit whereby the entire space current of said tube passes through said first winding, a second primary winding on said core connected in said series circuit, means for preventing the flow through said second primary winding of the amplified signal-produced portion of the space current of said tube, said first and second primary windings being oppositely wound so as to produce opposing cancelling fluxes in said transformer core upon the passage through said windings of the direct current portion of the space current of said tube.

References Cited in the file of this patent

UNITED STATES PATENTS

1,429,634	Robinson et al.	Sept. 19, 1922
1,751,081	Gollos	Mar. 18, 1930
1,808,726	Donle	June 2, 1931
2,595,443	Becker	May 6, 1952
2,595,444	Becker	May 6, 1952
2,688,694	Evertsz	Sept. 7, 1954