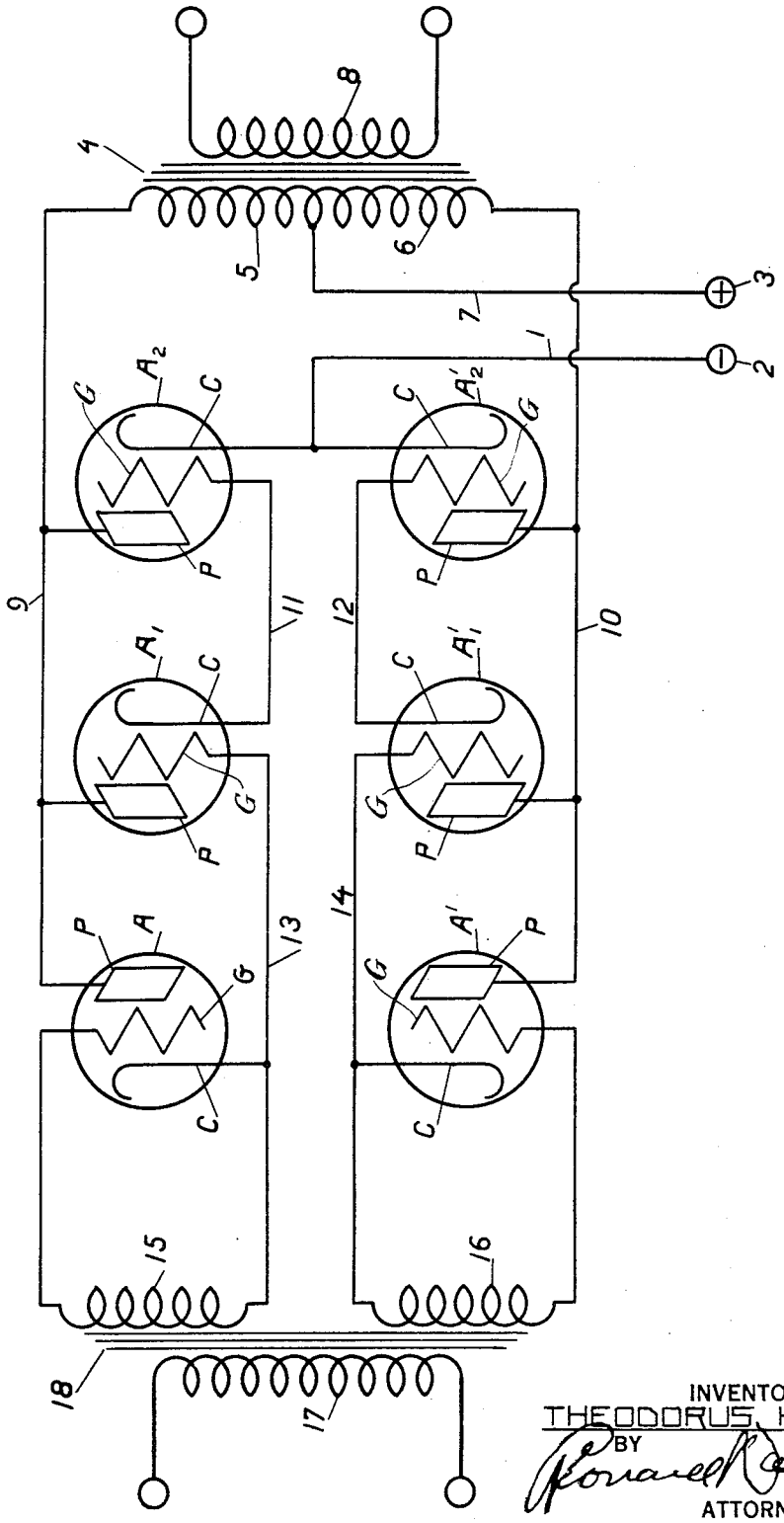
Feb. 27, 1934. T. H. NAKKEN 1,949,217

HARMONIC NEUTRALIZING AMPLIFIER

Filed June 12, 1929




INVENTOR
THEODORUS H. NAKKEN
BY
ATTORNEY

Patented Feb. 27, 1934 1,949,217

# UNITED STATES PATENT OFFICE

1,949,217

## HARMONIC NEUTRALIZING AMPLIFIER

Theodorus H. Nakken, Brooklyn, N. Y., assignor to Nakken Patents Corporation, a corporation of Delaware

Application June 12, 1929. Serial No. 370,296

2 Claims. (Cl. 179—171)

This invention relates to amplifiers for feeble periodic signal variations such as the electric variations from phonograph pickup, sound-on-film pickup, radio receiver and the like.

The object of the invention is to effect large amplification in an efficient manner by means of simple apparatus and with a minimizing of amplitude distortion.

In carrying out the general object of the invention I make possible the utilization of direct cascade coupling between triode amplifiers by combining two similar series of triode amplifiers connected with an electromagnetic differential mechanism at the output end and with means for dividing the initial signal impulse between said two series at the input ends thereof.

The above and further objects of the invention will be pointed out more in detail in the following claims which are directed to an illustrative embodiment of the invention described in the following specification in connection with the accompanying drawing solely for purposes of illustration and not limitation.

In the drawing, the single figure is a diagram illustrating my invention.

I combine two series of triode amplifiers, one the series A, $A_1$ and $A_2$ and the other the series A', $A'_1$ and $A'_2$. The last triodes of the series $A_2$ and $A'_2$ are preferably of the power type capable of delivering a large plate current. All of the triodes are shown of the heater cathode type. It is an essential of the invention that the cathodes of all of the triodes of the series, except those of the last stage, have potential floating cathodes. This is a quality of triodes in which the cathode is excited by heat from an independent disconnected heater. Although I have shown the triodes of the last stage of the two series of the same character, it is not essential to the invention that the cathodes of the triodes $A_2$ and $A'_2$ be potential floating as they are both conductively connected by lead 1 to the negative terminal 2 of a suitable source of direct current potential 3. An important element in my invention is an electromagnetic differential device 4 shown in the form of a transformer having a primary coil made up of two similar parts 5 and 6 with a center tap 7 leading to the positive terminal of the source 3. A single secondary 8 is magnetically linked with the coils 5 and 6 and is responsive to the differential effect of these two coils, the terminals of which are respectively connected by conductors 9 and 10 with the plates P of all the triodes of each series of triode amplifiers.

The grid of the last triode of each series is connected by a conductive connection with the cathode of the next preceding triode. Connections 11 and 12 serve this purpose between triodes $A_1$ and $A_2$ and $A'_1$ and $A'_2$ respectively, while conductors 13 and 14 serve the same purpose for the triodes A and $A_1$ and A' and $A'_1$ respectively.

An input coil 15 is shown directly connected at its terminals to the grid G and the cathode C of the first triode A of one series and a second similar input coil 16 is symmetrically connected to the grid and the cathode of triode A'. The periodic electric signal to be amplified is led to a primary coil 17 which is magnetically linked to the coils 15 and 16 as by core 18. Care should be taken in the winding of coils 15 and 16 to minimize mutual coupling therebetween, both capacity coupling and magnetic coupling, so that the virtual potential or electrostatic potential of each of the coils 15 and 16 may float as freely as possible relatively to each other. The direction of the winding of the coils 15 and 16 is such that coil 15 tends to make grid G of triode A more positive relatively to its cathode C and the coil 16 tends to make grid G of triode A' more negative relatively to its cathode C and vice versa.

*Operation*

For condition of no signal reception and with all cathodes excited into condition of electron emission, a condition of differential balance between the two combined plate circuits of the two series is present. One circuit traced in the direction of electron flow is from negative lead 2 to the cathodes C of $A_2$ and $A'_2$. Thence, placing the path through one series, a part of the electron stream flows to plate P of triode $A_2$ and thence through coil 5 to the positive terminal of the source, but a part flows to the positive grid G of this triode over conductor 11 to the cathode of triode $A_1$ and thence branches part to its plate P back to the positive terminal of the source through coil 5 and part to the positive grid G of triode $A_1$ over conductor 13 to cathode C of triode A, thence to the plate of triode A and back through coil 5 to the positive terminal of the source. A similar symmetrical circuit with similar and symmetrical branches may be traced in an obvious manner for the triode series A', $A'_1$, $A'_2$ which is, of course, limited to the coil 6. Thus for this condition, the magnetizing effect of the two plate circuits differentially combined is zero.

When the coil 15 is tending to make grid G of triode A more positive and coil 16 is tending

to make grid G of triode A' more negative both relatively to their respective cathodes, the following changed condition takes place. The controlling effect of grid G of triode A causes an increase in the flow of electrons to the plate of this triode from its cathode C. The only source for these electrons is the grid G of the succeeding triode $A_1$. The effect of drawing electrons from this grid is to make it electrostatically more positive or less negative which in turn effects an increase of electron flow from its cathode C to its plate P. The only source from which cathode C of triode $A_1$ can draw electrons is the grid G of the last triode $A_2$ of the series which, becoming more positive, increases the electron flow from its cathode C to its plate P. Thus there is an increased electron flow or an increasing electron flow through coil 5. In a similar manner for the series A', $A'_1$, $A'_2$, the more negative or less positive condition for grid G of triode A' effects an opposite condition for this series of triode. Electrons at a lower rate flow from cathode C to plate P of triode A'. Electrons are drawn out of grid G of triode $A'_1$ at a lower rate with the effect that this grid becomes more negative and from its controlling effect upon the electron stream, reduces the rate of electron flow from its cathode to its plate. Likewise the cathode C of triode $A'_1$ draws electrons at a lower rate over conductor 12 from grid G of triode $A'_2$ to effect by its control a lessening of the rate of electron flow from its cathode to its plate. Therefore, a tendency to decrease for the current through the coil 6 takes place. The electromagnetic linkage between coils 5, 6 and 8 imparts to coil 8 the combination of the increase of flow through coil 5 and the decrease in flow through coil 6. For the next half of the wave of the periodic disturbance in coil 17, the reverse of this functioning takes place but in both cases there is imparted to the output coil 8 a half wave of similar form regardless of any dissimilarity in form between the simultaneous variations of periodic energy variation in coils 5 and 6.

What I claim and desire to secure by United States Letters Patent is:

1. A full wave amplifier assemblage for amplifying periodic signal variations comprising two symmetrical series of three or more direct connected triode amplifiers; a separate input coil for each said series and operatively connected to the grid and the cathode of the first triode amplifier of said series; an electromagnetic differential coil responsive to both said series; and a single source of plate circuit potential connected between the midpoint of said electromagnetic differential coil and the two cathodes of the last triode amplifiers of said two symmetrical series.

2. An amplifier assemblage for minimizing amplitude distortion comprising two triode amplifier series, each comprising an equal number plurality of triode amplifiers, the electrodes of all said triode amplifiers except the cathodes of the last triodes of the series being free from conductive and capacity coupling with relation to the rest of said system and therefore free to float in potential in response to signal control; an input coil for each series having terminal connection with the grid and the cathode of the first triode of said series; a cathode of each triode having a conductive connection with the grid of the succeeding triode of said series; an electromagnetic plate circuit differential means; a conductive connection connecting all the plates of each series respectively to said differential means, a source of direct current potential; and connections connecting said source with the cathodes of the last triode of said two series and with said differential device.

THEODORUS H. NAKKEN.