

Dec. 23, 1941.

R. E. MATHES

2,267,120

LIMITING DEVICE

Original Filed March 18, 1939

Fig. 1

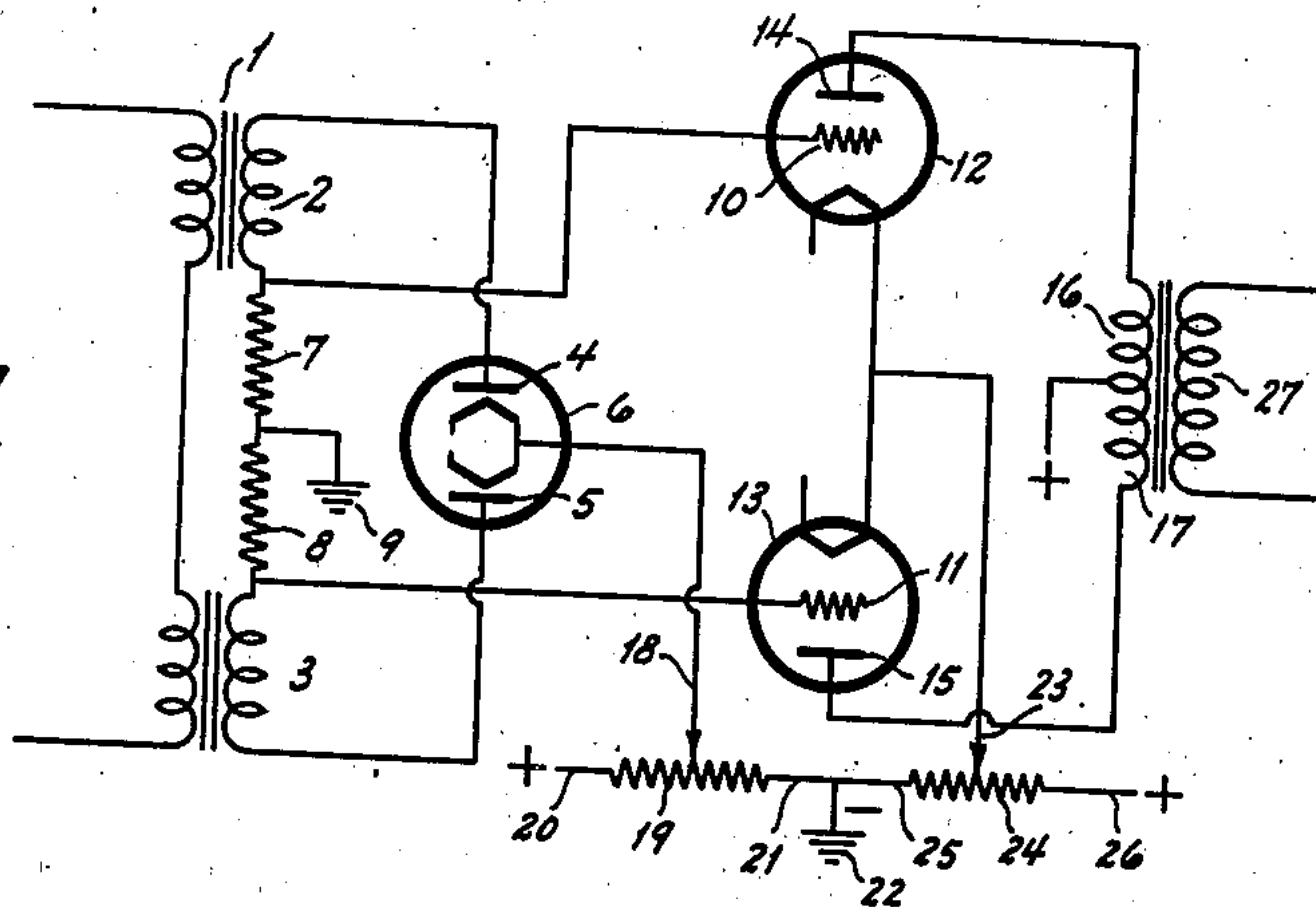
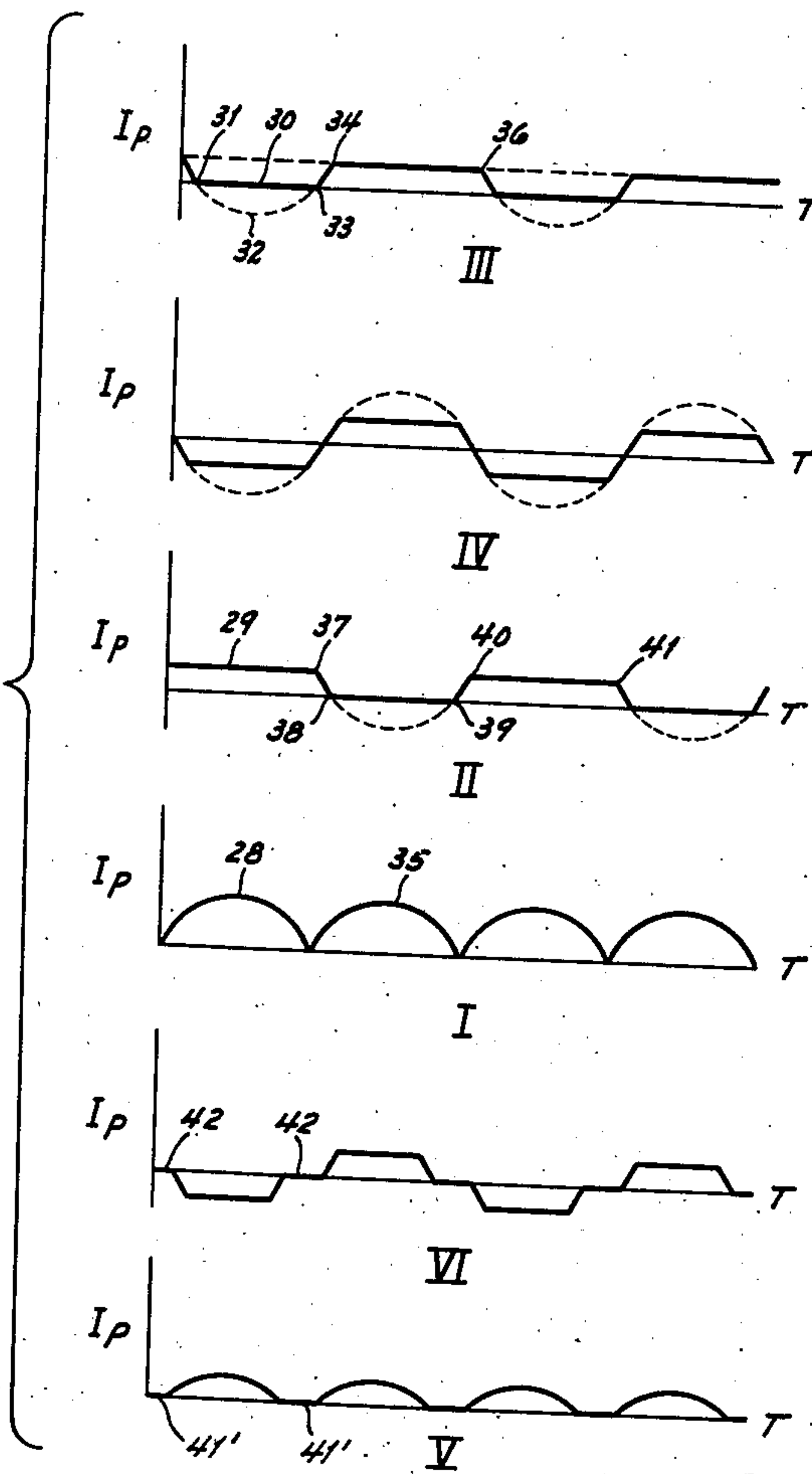


Fig. 2



INVENTOR.
RICHARD E. MATHES
BY
H. B. Snow
ATTORNEY.

UNITED STATES PATENT OFFICE

2,267,120

LIMITING DEVICE

Richard E. Mathes, Westfield, N. J., assignor to
Radio Corporation of America, a corporation of
Delaware

Original application March 18, 1939, Serial No.
262,664. Divided and this application May 11,
1940, Serial No. 334,523

2 Claims. (Cl. 178-44)

This invention relates to limiting devices and is a division of my application filed March 18, 1939, Serial No. 262,664.

It is an object of the invention to provide an improved limiter for both the positive and the negative halves of an alternating wave.

Another object is to provide a limiter that symmetrically limits the positive and negative halves of an alternating wave.

Another object is to provide a push-pull limiter using negative bias cut-off on both halves of the wave.

Another object is to provide a full wave rectifier in combination with a bias cut-off limiter to eliminate all limiting that would be caused by flow of grid current.

Other objects will appear in the following description with reference to the drawing in which:

Fig. 1 is a circuit diagram of the improved limiter.

Fig. 2 is a series of graphs illustrating the action of the limiter and the associated rectifier.

In prior art constructions it is usual to rely on the blocking of a tube by a negative grid bias for limiting the negative half wave and on electron saturation or grid energy consumption for limiting the positive half wave. The negative and positive parts of the wave passed through such prior art limiters are dissimilar and give rise to harmonics which in many cases are objectionable. I overcome this by the limiter in Fig. 1.

In Fig. 1 the current to be limited is fed into transformer 1 having two secondary coils 2, 3 connected to the anodes 4 and 5 of the double rectifier 6, which, of course, can be two separate rectifiers, if desired. The two coils 2, 3 are connected together by resistances 7 and 8. The conductor joining these two resistances is grounded at 9. The ungrounded ends of resistances 7, 8 are connected to grids 10, 11 of vacuum tubes 12, 13, respectively, in push-pull. The anodes 14 and 15 of these tubes are also connected in push-pull by transformer primaries 16, 17.

The cathodes of the double rectifier 6 are connected by adjustable contact 18 to resistance 19, one terminal 20 of which is connected to positive potential and the other terminal 21 of which is grounded at 22. The cathodes of vacuum tubes 12, 13 are connected by adjustable contact 23 with resistance 24, one terminal 25 being connected to ground and the other terminal 26 being connected to a positive source of potential.

The output of transformer primaries 16, 17

passes into any desired device, indicated generally as a coil 27.

The operation of my invention is as follows:

Let it be supposed that the upper end of coil 2 as shown in the drawing is for the instant made positive by the incoming signal or other alternating wave. This means that the lower end of coil 3 is negative. It also means that the lower end of coil 2 is negative in respect to the upper end and that the upper end of coil 3 is positive in respect to the lower end of that coil.

With the assumption made, current will flow from the upper end of coil 2 to plate 4 of the rectifier to the cathode, ground 22, ground 9 and resistance 7 to the grid 10. It will first be assumed that the adjustable tap 18 is connected to the ground wire 21 with the resistance 19 all out.

This will make grid 10 negative by the amount of the drop in load resistance 7. The shape of the wave passing through rectifier 6 is indicated for the purposes of illustration by 28 of graph I in Fig. 2. No current from the lower coil 3 can pass through the rectifier 6 because the negative end is connected to the anode 5. Therefore no signal potential will be applied to grid 11 of tube 13. For the half wave of the signal under discussion the plate current I_p of tube 13 will be a steady current, as indicated at 29 of graph II in Fig. 2. During this same half cycle the current I_p through the plate circuit of tube 12 is decreased by the negative potential applied to it by resistance 7, and therefore the graph of plate current in this tube is given by 30 of graph III. It will be seen that the current in this graph reaches the cut-off point at 31 and current flow through the tube ceases at this point. The dotted line 32 indicates the wave shape if there had been no cut-off of the current by the negative grid potential.

When the negative potential on grid 10 decreases to the point corresponding to point 33 of the plate current curve, current starts to flow in the plate circuit of tube 12 and increases until it reaches its maximum value at 34, at which point the other half wave of the signal reverses the polarity in coils 2 and 3. For this half cycle the current through the rectifier 6 will be shown at 35, which, of course, is the same shape as the other half wave 28. No signal potential is applied to the grid of tube 12 at this time because of the reversal of polarity and its plate current will be given by the straight portion between points 34 and 36. At this time a negative potential is applied to the grid of tube 13 and from the beginning of the half cycle indicated at point

37 the negative potential increases and the plate current decreases until the cut-off point 38 is reached (graph II).

No current will then flow in the plate circuit of tube 13 until the negative potential on grid 11 decreases to the cut-off point indicated by 39. As the negative potential on grid 13 continues to decrease until the half cycle is ended, the plate current in this tube will increase till it reaches point 40. For the next half cycle the plate current through tube 13 will be given by the straight line between points 40 and 41.

Since the tubes 12 and 13 are arranged in push-pull fashion, it is obvious that graphs II and III will produce a combined output indicated by graph IV of Fig. 2. This curve also indicates in general the induced electromotive force in output coil 27.

In the beginning it was assumed that slider 18 was at ground potential. If we assume that it is adjusted to place a positive voltage on the cathodes of rectifier 6, no current can flow through the rectifiers until the signal voltage reaches a threshold value in excess of this counter voltage. The shape of the rectified current is then indicated generally by graph V of Fig. 2, where at the beginning and ending of each half wave no current flows, as indicated at 41'. This will be the shape of the rectified wave of negative potential applied alternately to tubes 12 and 13 instead of the shape given in graph I. It will be seen that the shape of the current flow or E. M. F., as the case may be, will be indicated in graph VI, which is similar to graph IV except that there are appreciable lengths of time when current does not flow in the output circuit, as indicated at 42. The cut-off value in the rectifier 6 and the push-pull limiter tubes 12, 13 can be varied singly or jointly within any desired limits by adjustment of the resistance taps 18 and 23.

It will be seen that in my improved limiter the signal or other alternating current entering at input 2, 3 will pass into the output 27 as an alternating current with the tops of the waves cut off symmetrically, thus producing symmetrical limiting.

The limiter of my invention may be associated with any type of input or output, as the invention is not limited to any particular use.

Having described my invention, what I claim is:

1. In a voltage limiter, a transformer having two secondary coils, a resistance connecting said coils, a rectifier connected across one of said secondary coils and part of said resistance, a rectifier connected across the other of said secondary coils and another part of said resistance, an amplifying tube having its control electrode and cathode connected respectively to negative and positive potential points in the first-mentioned part of said resistance, an amplifying tube having its control electrode and cathode connected respectively to negative and positive potential points in the other part of said resistance, a source of negative bias between the cathodes and grids of said amplifier tubes sufficient to bring the tubes to cut off at the predetermined limiting point, and means for connecting the anodes of said tubes in opposition.

2. In a voltage limiter, a transformer having two secondary coils, a resistance connecting said coils, a rectifier connected across one of said secondary coils and part of said resistance, a rectifier connected across the other of said secondary coils and another part of said resistance, an amplifying tube having its control electrode and cathode connected respectively to negative and positive potential points in the first mentioned part of said resistance, an amplifying tube having its control electrode and cathode connected respectively to negative and positive potential points in the other part of said resistance, a source of negative bias between the cathodes and grids of said amplifier tubes sufficient to bring the tubes to cut off at the predetermined limiting point, a threshold for said rectifiers comprising a source of counterelectromotive force in series therewith and means for connecting the anodes of said tubes in opposition.

RICHARD E. MATHES.