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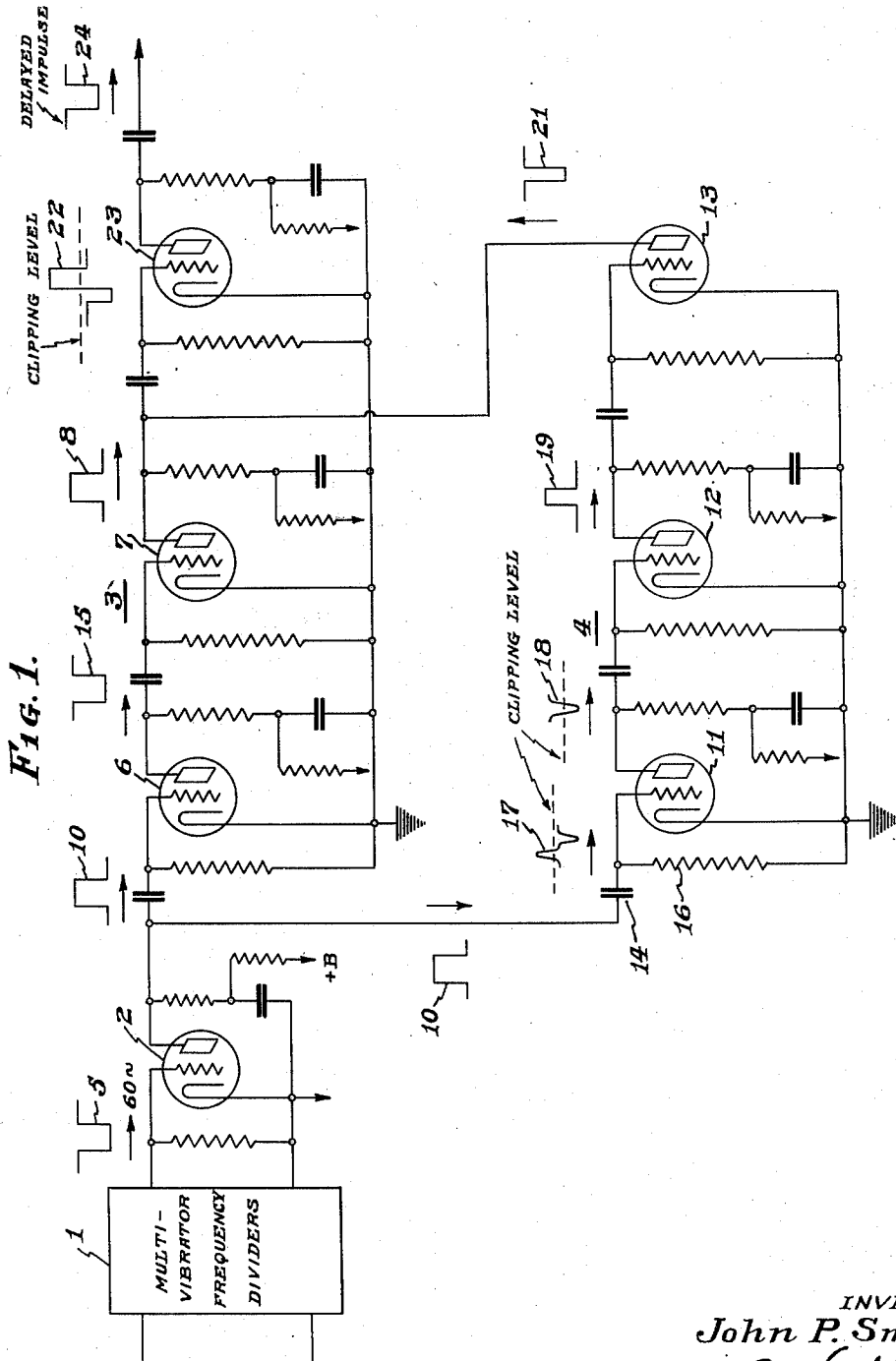
J. P. SMITH

2,118,626

METHOD AND APPARATUS FOR DELAYING ELECTRICAL IMPULSES

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2 Sheets-Sheet 1



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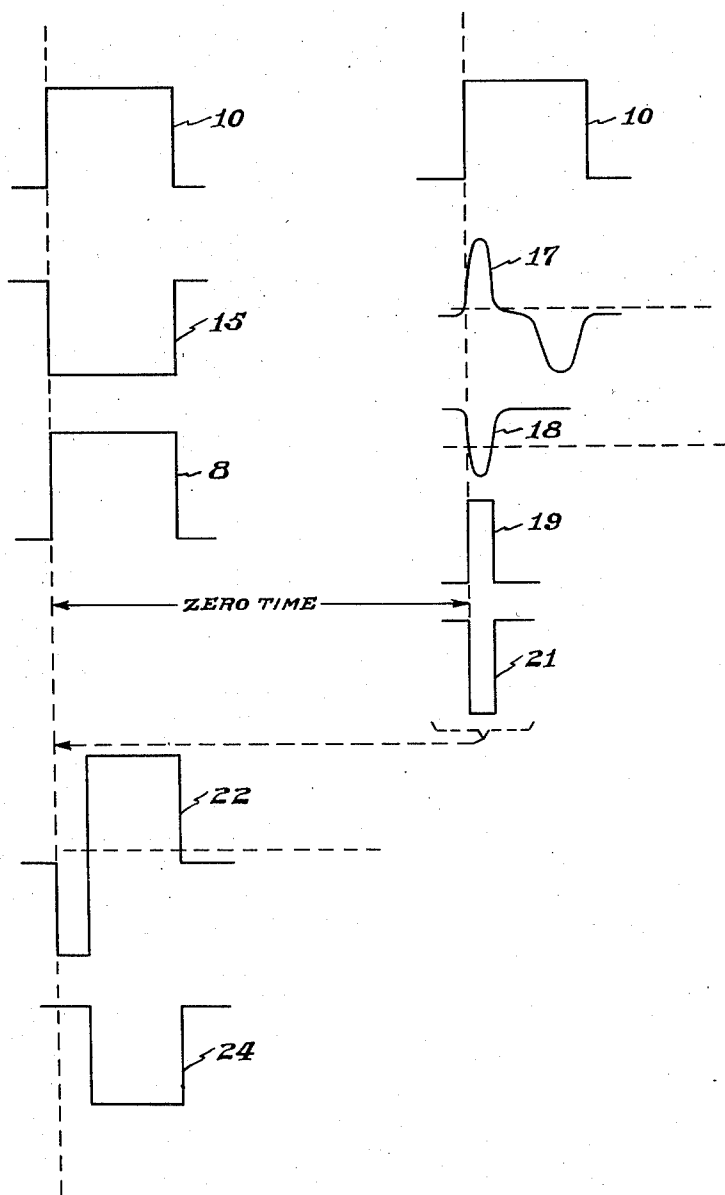
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Fig. 2.



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METHOD AND APPARATUS FOR DELAYING ELECTRICAL IMPULSES

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Application January 28, 1936, Serial No. 61,133

6 Claims. (Cl. 178-44)

My invention relates to television systems and particularly to a method of and means for delaying rectangular voltage impulses.

In my application, Serial No. 8,659, filed February 28, 1935, and assigned to the Radio Corporation of America, I have described an improved system for producing synchronizing impulses to be applied to the deflecting circuits of cathode ray tubes. In this system it is necessary to delay rectangular voltage impulses in order to have them occur in the proper time relation with respect to other voltage impulses. In the said application I described and claimed one method of delaying rectangular electrical impulses without resorting to the use of the usual delay networks comprising sections of inductance coils and capacitors.

An object of the present invention is to provide an improved method of and means for delaying rectangular electrical impulses without employing a delay network of the above-mentioned type.

A further object of my invention is to provide an improved method of and means for delaying a rectangular electrical impulse without impairing its wave form.

A still further object of my invention is to provide an improved method of and means for both narrowing and delaying a rectangular electrical impulse.

In practicing my invention a rectangular voltage impulse is produced by any suitable generator and supplied to two separate circuits or channels. In one of these channels the impulse is narrowed to a width which is equal to the amount of delay desired. The impulses appearing in the output circuits of the two channels are added in a common circuit, the impulse from one channel being of a polarity opposite to that of the impulse from the other channel. The resulting impulse is then passed through a clipping tube to remove the undesired part of the impulse whereby the desired delayed and narrowed impulse is obtained.

Other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying drawings, in which

Figure 1 is a circuit diagram of one embodiment of my invention, and

Fig. 2 is a group of curves which are referred to in explaining the invention.

Referring to Fig. 1, my invention is shown applied to a synchronizing impulse generator of the character described in my above-mentioned application. As indicated in Fig. 1, a 60 cycle ver-

tical synchronizing impulse 5 may be supplied from a source comprising a frequency divider, indicated at 1, which obtains comparatively high frequency impulses from a multivibrator or other electric discharge tube oscillator (not shown). The voltage impulse is supplied through an amplifier tube 2 to two signal channels 3 and 4; the channel 3 including two amplifier tubes 6 and 7 connected in cascade whereby the amplified impulse appears in the output circuit of the amplifier tube 7 with a positive polarity, as indicated at 8. The polarities of the impulses appearing in the plate circuits of tubes 2 and 6 are shown by the curves 10 and 15, respectively.

The channel 4 includes three amplifier tubes 11, 12 and 13 connected in cascade. The input circuit of the amplifier tube 11 includes a coupling condenser 14 having very small capacity and a grid resistor 16 of fairly low resistance whereby the condenser 14 and grid resistor 16 act as a differentiating circuit for narrowing the voltage impulse supplied thereto. The character of the signal applied to the grid of the tube 11 is indicated at 17.

The grid of the tube 11 is maintained at such a negative bias by means of the grid leak biasing provided by the condenser 14 and resistor 16 that the signal applied to this grid is clipped at the level indicated on the drawings. The resulting impulse which appears in the plate circuit of the tube 11 is indicated at 18. This impulse is clipped at the level indicated on the drawings by the amplifier tube 12, this tube also being suitably biased by means of grid leak biasing. The signal appearing in the output circuit of the tube 12 is a narrowed rectangular impulse, as indicated at 19. This impulse is passed through the third amplifier tube 13 to reverse its polarity as shown at 21.

It will be understood that by "clipping" a signal or impulse is meant removing an undesired portion thereof, as by so biasing a tube that only the more positive and desired portion of the signal can be passed therethrough, or as by saturating off the undesired portion in a vacuum tube driven beyond plate current saturation.

The plate circuit of the tube 13 is common to the plate circuit of the tube 7 in the channel 3 whereby the narrowed negative impulse 21 is added to the wide positive impulse 8 to produce a signal of the character indicated at 22.

The signal 22 is then clipped at the level indicated on the drawings by the last tube 23 in the channel 3 and the resulting delayed and narrowed impulse 24 appears in the plate circuit of 55

this tube. In the circuit illustrated, the grid of the tube 23 is maintained at the desired negative bias by means of grid leak biasing. It will be understood that the grids of the several clipping tubes may be negatively biased in any other suitable way, as by means of self-bias resistors or biasing batteries.

The manner in which the rectangular impulse is delayed may be better understood by referring to the curves in Fig. 2. In Figs. 1 and 2, like curves are indicated by the same reference numerals. It will be apparent that since the narrowed impulse 21 starts at the same time as the wider impulse 8, the amount of delay depends entirely upon the width of the narrowed impulse. This is made clear by the curve 22. If more delay is desired, the narrow impulse 21 from the channel 4 is made somewhat wider.

In the event that it is desired to narrow the impulse still further after the desired delay has been determined, the input circuit of the amplifier tube 6 in the first channel may be designed to act as a differentiating network to narrow the impulse a desired amount, as described in connection with the channel 4. In that case, the tubes 6 and 7 will be adjusted to clip the impulse supplied thereto in the same manner as the amplifier tubes 11 and 12 in the channel 4.

From the foregoing description it will be apparent that by employing my invention a rectangular voltage wave may be delayed any amount up to the width of the impulse itself, without distorting the wave-shape of the impulse. In other words, if a rectangular impulse is put into the circuit, the output of the circuit is also a rectangular impulse, and not an impulse having sloping sides and rounded corners.

It will be understood that in the claims the expressions "last occurring portion of said wave", "narrowed wave", "composite wave having a delayed wave portion", and similar expressions have reference to the appearance of the wave on a cathode ray tube oscillograph. On such an oscillograph, the wave appears at various points in the circuit as illustrated in Fig. 2 where the abscissa for each curve is a time axis. Obviously, a wave of short duration looks "narrow" and may be described as a narrow wave. The portion of a wave which actually is traced last on the viewing screen by the cathode ray is the "last occurring portion" as compared with the portion of the wave traced earlier. Likewise, the last traced portion of a composite wave such as shown by curve 22 is referred to as a "delayed wave portion".

Various modifications may be made in my invention without departing from the spirit and scope thereof and I desire, therefore, that only

such limitations shall be imposed thereon as are necessitated by the prior art and are set forth in the appended claims.

I claim as my invention:

1. Apparatus for delaying an electrical wave, said apparatus comprising means for removing the last occurring portion of said wave to produce a narrowed wave, and means for adding said first wave and said narrowed wave in polarity opposition whereby a composite wave having a delayed wave portion is produced.

2. Apparatus according to claim 1 characterized in that means is provided for separating said delayed portion from the remainder of said composite wave.

3. In combination, means for producing a rectangular electrical impulse, means for producing a second rectangular electrical impulse which is narrower than said first impulse and which starts at the same time as said first impulse, means for adding said two impulses in polarity opposition whereby a resulting signal having a delayed portion is produced, and means for supplying only the delayed portion of the resulting signal to an output circuit.

4. A circuit for delaying a comparatively wide rectangular electrical impulse, said circuit comprising a channel which includes means for narrowing said impulse while keeping its starting time unchanged, means for passing said wide impulse through a second channel, means for adding the outputs of said channels in polarity opposition, and means for clipping off the portion of the resulting signal which represents said narrowed impulse and supplying the remaining portion of said resulting signal to an output circuit.

5. The method of delaying an electrical wave which comprises removing the last occurring portion of said wave to produce a narrowed wave, combining said first wave and said narrowed wave in polarity opposition whereby a composite wave having a delayed wave portion is produced, and clipping off the undesired portion of said composite wave.

6. The method of delaying a rectangular electrical impulse which comprises passing said impulse through two channels, narrowing said impulse in one of said channels, said narrowing being done by eliminating the last occurring portion of said impulse whereby the starting time of the impulse is not changed, adding the outputs of said two channels in reverse polarity relation, and clipping off that portion of the resulting impulse which represents said narrowed impulse whereby the remaining portion is a delayed rectangular impulse.

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