

Jan. 31, 1933.

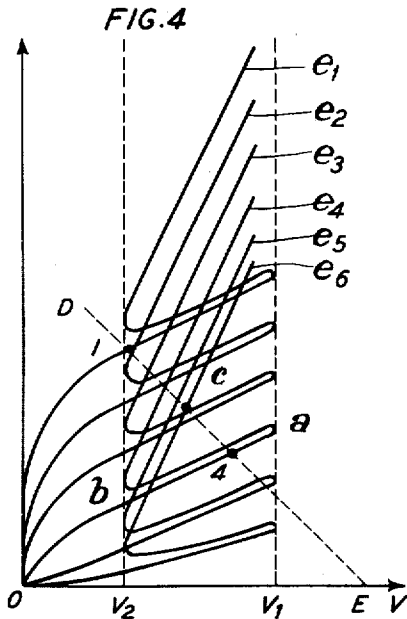
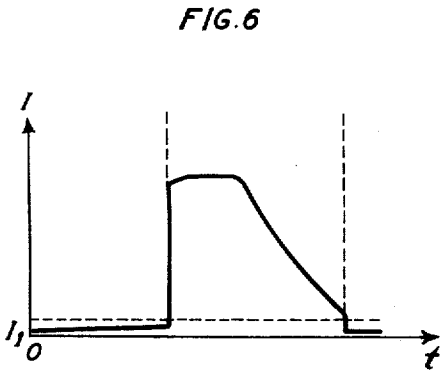
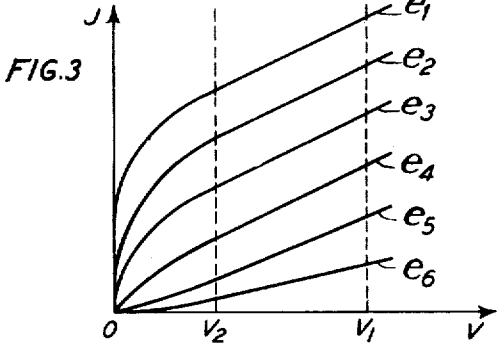
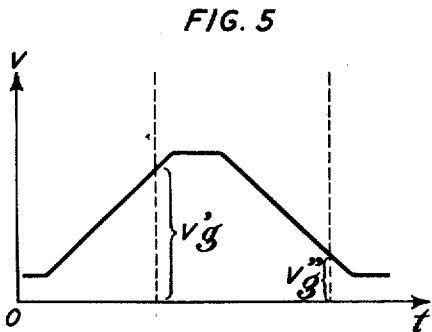
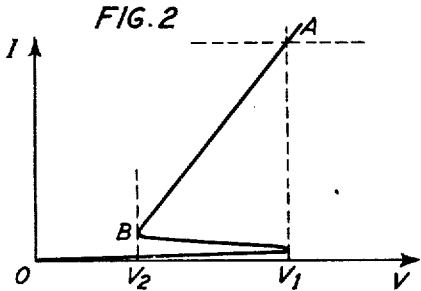
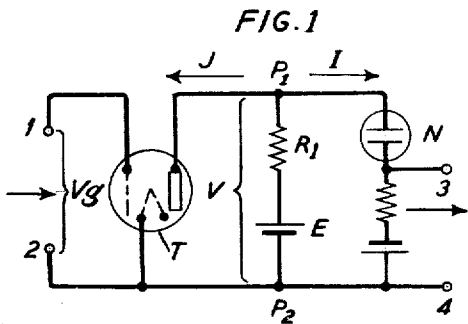
F. E. A. SMETS ET AL

1,895,774

SIGNAL SHAPING CIRCUIT

Filed Jan. 12, 1932

4 Sheets-Sheet 1



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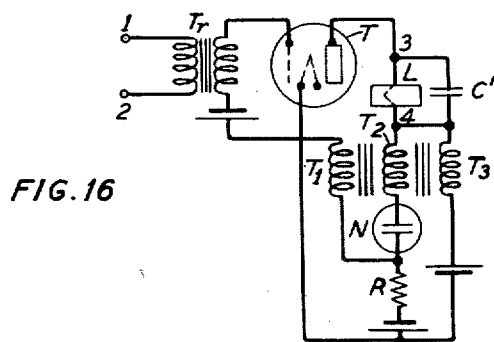
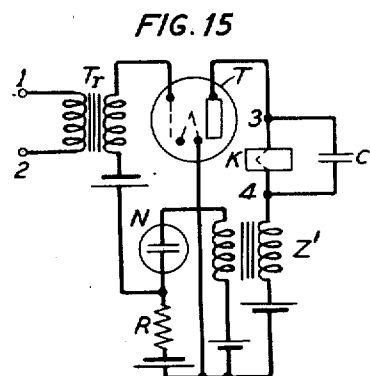
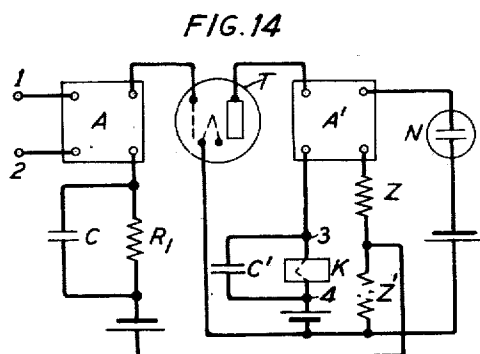
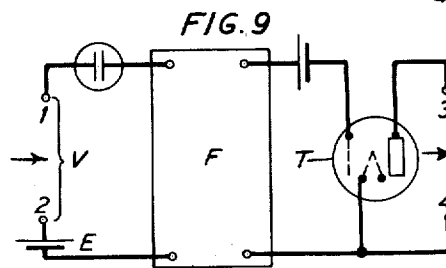
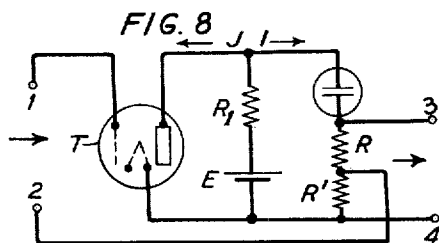
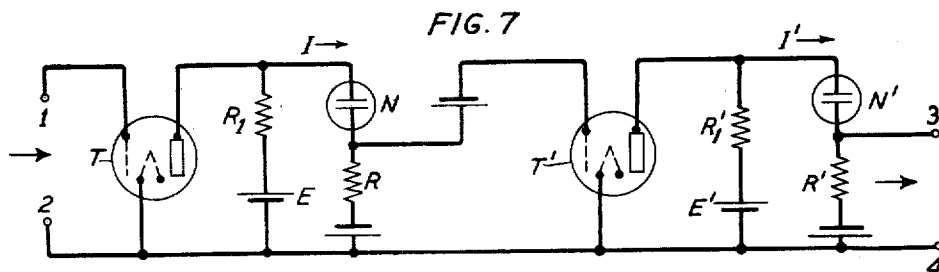
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SIGNAL SHAPING CIRCUIT

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4 Sheets-Sheet 2



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SIGNAL SHAPING CIRCUIT

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FIG. 10

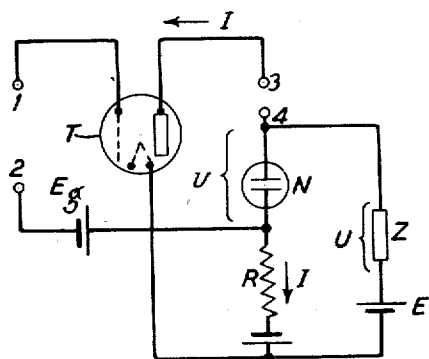


FIG. 12

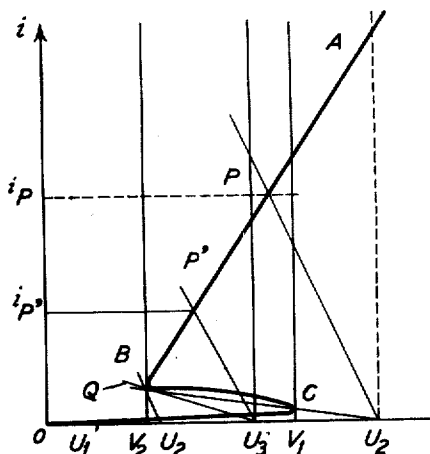


FIG. 13

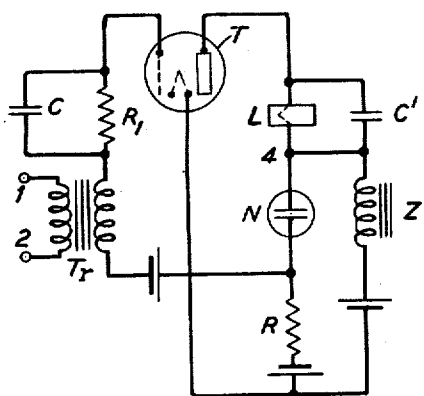
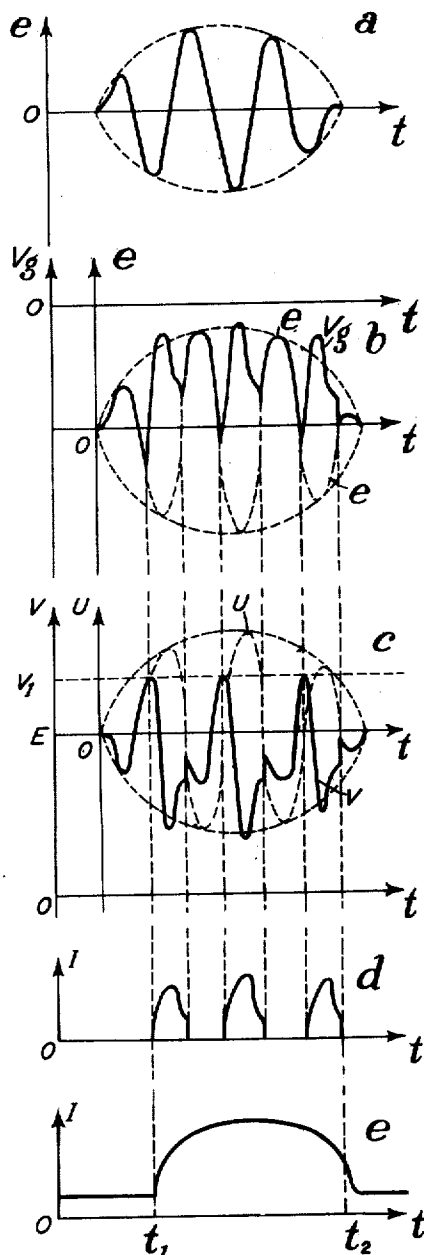


FIG. 11



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FIG. 17

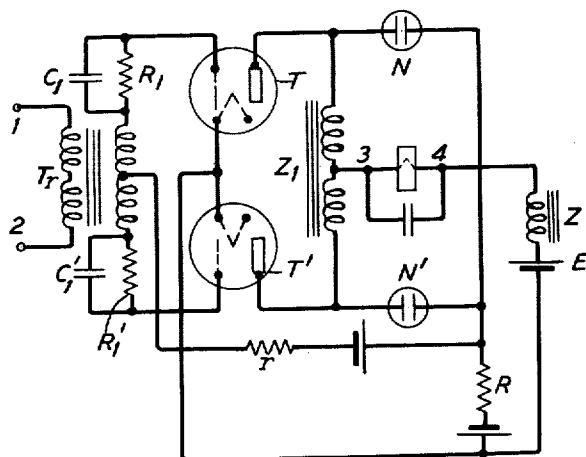


FIG. 18

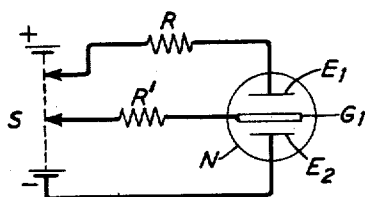
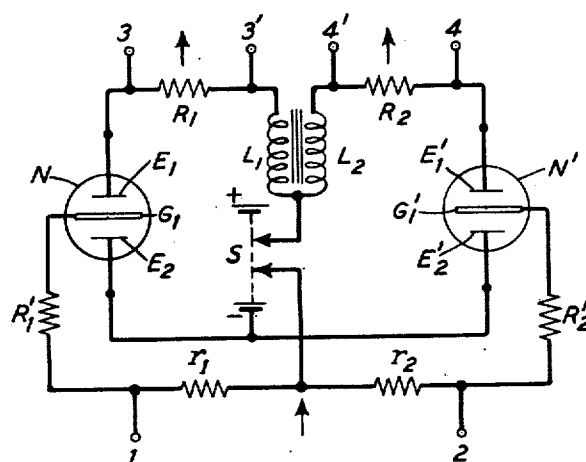


FIG. 19



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UNITED STATES PATENT OFFICE

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SIGNAL SHAPING CIRCUIT

Application filed January 12, 1932, Serial No. 586,164, and in France March 21, 1931.

The present invention relates to arrangements adapted to be inserted in electric transmission circuits, said arrangements being intended to modify or control in a predetermined manner the form of the electric impulses passing through such circuits.

It is well known that it is often necessary in the art of electric signaling to modify in a predetermined manner the form of the electric signals in one or more portions of the circuit which transmits said signals. Well known examples of the change of form which it may be necessary to cause the electric signals to undergo are supplied by the rectification or detection of oscillatory currents which may or may not be modulated.

A particular case where it is necessary to modify the form of the signals is presented in signaling systems such as telegraph systems, or systems for the transmission of image or order signals. In such systems the signals sent by the transmitting station have, as a rule, substantially a rectangular form, but the distortion which may be introduced by the transmission circuits transforms these rectangular signals into rounded signals, which may be a considerable disadvantage, because the receiving installations usually operate better with rectangular signals than the rounded signals.

In order to remedy this disadvantage it has been proposed, particularly for long submarine telegraph cables, to employ impedance networks adapted to attenuate or correct the distortion of the transmission system.

One object of the present invention is to provide arrangements which modify the form of the electric signals applied to them.

Another object of the invention is to provide arrangements of the type mentioned having selective properties either in amplitude or both in amplitude and frequency.

According to another object of the invention, arrangements of the type mentioned are adapted to be employed in a system for transmitting facsimile signals.

In order to attain the various objects of the invention, an arrangement is provided, according to one of the characteristics of the invention, comprising a luminescent dis-

charge tube in series with an impedance, adapted to be inserted in the signal transmission circuit, said arrangement being adapted to control the polarization of an apparatus such as an electron discharge tube, so as to modify in a predetermined manner the shape of the signals.

According to one of the characteristics of the invention an electric signal to be transmitted is applied to an arrangement for translating and modifying the shape of the signals, said arrangement comprising one or more luminescent discharge tubes, the arrangement being adjusted so that as soon as the level of the signals applied to the input thereof exceeds a certain limit, a signal of constant amplitude (and in any case independent of the amplitude of the input signal) is produced in the output circuit of said translator arrangement, this signal being kept at a constant amplitude as long as the input signal remains above another well defined level, but this output signal stops abruptly as soon as the input signal falls below said level.

One of the characteristics of the invention relates to a relay circuit adapted to transform the shape of the electric signals applied thereto, said circuit comprising one or more luminescent discharge tubes associated in series with an impedance and adapted to modify by function of the signals to be transmitted the polarization of one or more electron discharge tubes inserted in the path of the signals so as to modify the shape of said signals in a predetermined manner dependent upon the adjustment of the elements of said relay circuit.

Another characteristic of the invention consists in an arrangement to control automatically the polarization of an apparatus such as an electron discharge tube by function of the shape of the applied signals, the arrangement comprising one or more luminescent discharge tubes which are arranged and adjusted so that when the difference of potential (whether alternating, direct, or undulated) between the input terminals exceeds a predetermined value, the said arrangement behaves as a rectifier, while this property disappears when said difference of

potential falls below another predetermined value.

One characteristic of the invention consists in an arrangement for translating and modifying the form of the signals applied to it, said arrangement comprising one or more luminescent discharge tubes, the whole being adjusted so that a signal of any shape, but exceeding in amplitude a predetermined limit, applied to the input of the translating circuit may be transformed in the output circuit into rectangular signals of constant amplitude, the life of the output signals depending upon the shape of the wave and upon the amplitude of the input signals.

Another characteristic of the invention consists in an arrangement of the type indicated in which the thresholds of lighting and extinction of luminescent discharge tubes are employed to transform a signal of any shape into signals of rectangular shape.

In accordance with one characteristic of the invention one or more luminescent discharge tubes are placed in series with an impedance (for example, a resistance), the arrangement being adjusted so that under the influence of voltage variations applied to said arrangement the luminescent discharge tubes may be lighted and/or extinguished, the corresponding variation of the drop of potential in said impedance being employed to control the polarization, for example, an electric discharge tube.

In accordance with one characteristic of the present invention an arrangement of the type mentioned is associated with an impedance network which may be adapted to modify the shape of the signals, said network may be placed at the input or output of said arrangement. It is clear that such an impedance network may comprise frequency filters.

Another characteristic of the invention relates to arrangements transforming the shape of the signals in which means are provided to vary in a predetermining manner the ratio

$$\frac{\text{amplitude maximum signal of input.}}{\text{amplitude maximum signal of output.}}$$

Arrangements for modifying the shape of the signals of the types mentioned may, according to one of the characteristics of the invention, be employed to compensate the distortion of signals applied to the input terminals of such arrangements.

The luminescent discharge tubes employed in the arrangements mentioned above may be of any well known type and particularly tubes having more than two electrodes may be employed.

The invention will be better understood by referring to the following detailed description of arrangements incorporating characteristics of the invention. This description is based on the attached drawings in which:

Fig. 1 shows an arrangement for translating and modifying the shape of the electric signals;

Figs. 2, 3 and 4 are curves serving to explain the operation of the arrangement shown in Fig. 1;

Fig. 5 shows, by way of example, the shape of a signal applied to the input of the arrangement of Fig. 1, and

Fig. 6 shows the shape of the same signal employed by the arrangement of Fig. 1;

Fig. 7 shows an arrangement for modifying signals adapted to transform signals of any shape but exceeding a certain amplitude into signals of rectangular shape;

Fig. 8 shows a modification of the arrangement of Fig. 1 in which a return coupling is provided to increase sensitivity;

Fig. 9 shows an arrangement incorporating a frequency filter;

Fig. 10 shows a signal modifying arrangement adapted to operate as a detector;

Fig. 11 shows a series of curves employed to explain the operation of the arrangement shown in Fig. 10;

Fig. 12 is a curve showing the conditions of operation of a luminescent discharge tube;

Fig. 13 is an embodiment of the arrangement shown in Fig. 10;

Fig. 14 shows a modification of the arrangement shown in Fig. 10;

Figs. 15 and 16 are modifications of the detector circuit of Fig. 10, adapted to produce particular effects;

Fig. 17 is a detector arrangement comprising two thermionic discharge tubes symmetrically mounted;

Fig. 18 is a schematic diagram of a circuit comprising a luminescent three-electrode discharge tube; and

Fig. 19 represents a circuit modifying the shape of the signals comprising two luminescent three-electrode discharge tubes.

In the various figures similar elements are designated by the same references.

Fig. 1 represents an arrangement for modifying the shape of electric signals, comprising a luminescent discharge tube N associated with an electron discharge tube T. When electric signals are applied between the input terminals 1 and 2 of the arrangement, a corresponding signal, distorted in a certain manner, is obtained between the output terminals 3 and 4. The operation of the arrangement of Fig. 1 may be explained, for example, by referring to the curves illustrated in Figs. 2, 3, 4, 5 and 6.

Fig. 2 shows the relation existing between the difference of potential applied to the terminals of a luminescent discharge tube associated in series with a resistance R. It is seen, on the figure, that when the potential applied to the unit N—R increases from O to the value V_1 , an extremely weak and practically negligible current passes through the

circuit, and from the potential V_1 the luminescent discharge tube N abruptly lights up. If thereafter the potential V varies around the value V_1 , the corresponding current will
 5 vary in accordance with the curve AB, and when the potential V reaches the value V_2 corresponding to the point B, the luminescent discharge tube, which may, for example, be a neon tube, will be abruptly extinguished.
 10 It may be noted that the inclination of the portion AB of the curve will vary according to the value of the resistance R associated in series with the luminescent discharge tube. The properties of illumination and extinction of a luminescent discharge tube are employed, according to the characteristic of the present invention, to obtain predetermined modifications of the shape of electric signals.

It will be noted that in the plate circuit of
 20 the tube T, a resistance R_1 has been provided in series with a battery E and parallel to the terminals of this arrangement is placed a luminescent discharge tube N in series with a resistance R . The conditions of operation
 25 of this unit may be studied by superposing so as to add the diagram of operation of the electron discharge tube T to the diagram of operation of the neon tube N associated with the resistance R .

In order to understand how the arrangement of Fig. 1 can modify the shape of a signal applied between the terminals 1 and 2, we may refer to the network of curves of Fig. 3 which shows how the current varies
 35 in the plate circuit J of the electron discharge tube T by function of the difference of potential V between the points P_1 and P_2 for different values $e_1, e_2, e_3, e_4, e_5, e_6$, of the potential V_g applied to the grid of the tube T and to the network of curves of Fig. 4, which shows how the resultant current varies in the resistance R_1 placed between the points
 40 P_1 and P_2 by function of the same potential V . The curves of Fig. 4 are obtained by adding for each value of V the corresponding ordinates J and I of the curves of Figs. 2 and 3.

The points of operation on the network of curves of Fig. 4 are obtained by cutting these
 50 curves with the straight line DE representing the relation $E - R_1(I + J) = f(I + J)$. For example, for a potential e_6 applied to the grid of the tube T, the corresponding point of operation will be the point c shown
 55 on Fig. 4. The points a and b shown on Fig. 4 are the points for which the characteristics are tangents to the vertical lines corresponding to the lighting and extinction potentials V_1 and V_2 .

When the fixed polarization tension of the grid, such as e_1 is greater than that which corresponds to the tangent curve at the straight line ED by its region b , the system
 60 returns to the point of operation 1 after the application of any signals to the input of the

system. When the fixed polarization tension such as e_6 is less than that which corresponds to the tangent curve to the straight line ED by its region a , discontinuity is produced in the variation of I, J and V by function of the signal applied to the input when
 70 $e = e_a$.

It is easy to understand by means of this curve that if a signal having, for example, by function of time the shape shown by Fig. 5, is applied between the terminals 1 and 2 of the arrangement of Fig. 1, this signal will be transformed into a signal at the output having the shape shown in Fig. 6. It is to be noted that this distorted signal increases and decreases abruptly at the beginning and the end. It will thus be seen that when a signal having the form of the signal of Fig. 5 is applied to the grid of the circuit of Fig. 1, and when this circuit is suitably adjusted the signal in the output circuit remains zero until the input signal has reached a potential V''_0 for which value the signal in the output circuit suddenly increases to a value dependent upon adjustment of the elements of the system; afterwards the signal in the output circuit follows the variations of the signal in the input circuit as long as the potential of the input signal does not fall below a value V''_0 . When this latter value is reached the signal in the output circuit falls abruptly to a value approximately zero. It will thus be seen that this arrangement enables a signal of any shape to be transformed into a signal which abruptly increases or decreases. In the case of the arrangement which has just been described, it is necessary to dispose of the signal producing a grid voltage variation exceeding the interval e_b and e_a to light and extinguish the luminescent discharge tube.
 The circuit of Fig. 8 shows an arrangement which permits of the use, for the same purpose, of much weaker grid voltage variations. Supposing that the initial grid voltage is e_4 and that 4 is the point of operation on the characteristic of Fig. 4; if the voltage of the signal diminishes to the value e_a the grid voltage becomes equal to $e_4 + RI$; when the grid voltage is e_b the characteristic is tangent to the vertical line corresponding to the potential V_2 and there remains a certain drop of potential RI_b in the resistance R which depends upon the constants of the circuit (batteries, tubes, resistances, etc. . . .). If RI_b is smaller than $e_b - e_a$, the current in the luminescent discharge tube is maintained until e reaches the value $e_b - RI_b$. If consequently, e_4 is greater than $e_b - RI_b$, a signal whose maximum value exceeds $e_4 - e_a$ is sufficient to light and to extinguish the neon tube. It is thus clear, in accordance with the foregoing, that the circuit of Fig. 8 may be adjusted so as to be sensitive to relatively weak grid voltage variations. If RI_b is greater than $e_b - e_a$, the circuit is unstable and will
 130

produce relaxation oscillations when e is smaller than e_0 . If then a condenser is placed in parallel between the extremities of any impedance placed in the circuit, or if a choke coil is inserted on the path of the currents, the interruption and establishment of the current in the neon tube will take place with a certain inertia, so that the circuit will oscillate with a frequency determined by the constants of the circuit.

When it is desired to transform a signal of any shape into a shape of rectangular shape and independent amplitude, between certain limits of the input signal, the arrangement shown in Fig. 7 may be employed which comprises two arrangements similar to that of Fig. 1 arranged in cascade; the similar elements are designated in one of the arrangements by the same references as in Fig. 1 and in the second arrangement by the same references but with the addition of the sign '. The elements of the circuit are adjusted so that when the luminescent discharge tube N, for example, is lighted, the luminescent discharge tube N' is extinguished, and vice versa. If we imagine that in the absence of any signal applied between the terminals 1 and 2, the luminescent discharge tube N is extinguished, then, on account of the regulation of the arrangement, the luminescent discharge tube N' will be lighted and a current of constant amplitude will circulate in the resistance R'. This current will be independent of the signals which might be applied between the terminals 1 and 2, since the tube N is extinguished and consequently has a practically infinite impedance, which means that the tubes T and T' are practically independent.

When a signal of any shape by function of time is applied between the terminals 1 and 2 it will be seen, in accordance with the foregoing, that when the amplitude of this signal increases sufficiently a moment will arrive when the tube N will light, which will produce a current in the resistance R which will change the grid polarization of the grid T' so that the tube N' will be abruptly extinguished. The system may be adjusted so that the tube N' remains extinguished until the current I is reduced below the value I_1 of Fig. 6. In this case it will thus be seen that the signals of any shape by function of time, but exceeding a certain amplitude, will be transformed in the output circuit into signals of constant amplitude and independent of the amplitude of the input signals, and of rectangular form. It should be noted that the same battery may be employed for the two vacuum tubes T and T' of Fig. 7.

It will be noted that an essential function of the resistance R_1 in the circuits of Figs. 1 and 8 or R_1 and R_1' in the circuit of Fig. 7 is to produce a variation of potential in the

plate circuits corresponding to the variations of grid voltage. When these variations are not too slow said resistances may be replaced by suitable choke coils.

Fig. 9 shows an arrangement for modifying the shape of signals, in which a filter F is provided. This filter is formed by impedance elements associated in such a manner that the neon tube is extinguished after the application of the alternating voltage V, and that the mean difference of potential applied between the grid and the filament of the tube T is modified by the unidirectional current passing through the neon tube under the effect of the alternating voltage V. An alternating voltage V may be applied between the terminals 1 and 2 with a constant potential E lower than the lighting potential of the luminescent discharge tube N. The filter F prevents the alternating voltage of the source E from being transmitted to the grid of the electron discharge tube T and consequently if we suppose that signaling currents of alternative form and sufficient amplitude are applied between the input terminals 1 and 2, rectified impulses are produced between the output terminals 3 and 4 of the tube T when the voltage applied between the terminals 1 and 2 exceeds the potential of lighting of the luminescent discharge tube N.

The relation existing between the difference of potential at the terminals and the current passing through a luminescent discharge tube is clearly shown in Fig. 12. By examining the condition of operations corresponding to the different points of the curve it will be seen that these conditions may be classified in several categories. In the first category we can place the operation for which the current through the tube N varies without any abrupt change when the voltage applied to the tube N varies around the point in question. We may place in a second category the operations for which the current in the tube changes abruptly when the potential applied to the tube varies around the corresponding points of the curve.

The point of operation on the curve of Fig. 12 for the tension U_2 applied to the unit N—R is the point P obtained by the intersection of the curve with the straight line U_2P representing the drop of potential in the resistance.

It is thus seen that it is possible to displace the point P on the curve either by causing the resistance R to be varied or by varying the tension applied to the whole tube N—resistance R or by varying these two magnitudes at once. The points B and C of the curve are particular points or regions of operation corresponding to the illumination and extinction of the luminescent discharge tube N.

Certain of the properties of the curve of

Fig. 12 are employed in the arrangements described in the following.

If we suppose that an alternating voltage is applied to the tube N in addition to a constant voltage various conditions of operation will be obtained of which the more interesting are enumerated below:

Let us suppose that a direct tension $U_2 V_1$ is applied to the whole of the resistance R in series with the tube N and that moreover an alternating tension whose maximum amplitude may vary is superposed on the direct tension U_2 . The conditions of operations will be as follows: The variations due to the alternating tension will displace the straight line $U_2 P$ parallel to itself and it will be seen that according to the curve of Fig. 12 discontinuity is produced at the moment when the straight line in question becomes tangent to the curve in the region B, that is to say, that the maximum value of the alternating voltage applied exceeds $U_2 - U'_2$.

If the direct tension applied is $U_1 V_2$ and an alternating voltage of variable maximum voltage is superposed on the tension U_1 , it will be seen that no current passes through the tube until the difference of potential exceeds the value $V_1 - U_1$, for which value the tube N abruptly lights up and a mean current of finite value is obtained.

If the direct tension U_3 is comprised between V_1 and V_2 and if moreover the resistance R is greater than that corresponding to the straight line $U_3 Q$ brought by U_3 and tangent to the curve in the region B it will be seen that no current passes through the luminescent discharge tube until the alternating voltage exceeds the value $V_1 - U_3$ for which value the current is established and is canceled alternately and will have a mean finite value. In these three cases the mean current circulating in the neon tube varies in an intermittent manner when the difference of alternating potential exceeds a certain limit and moreover the system returns to its normal state when the alternating tension is canceled in any way.

If, for example, an impedance, a resistance is placed in series with a luminescent discharge tube operating under the above indicated conditions, and a portion or all of the drop of potential produced in said impedance is employed to polarize or control the potential of an electrode of an electron discharge tube, it is possible to obtain particularly interesting effects such, for example, as the rectification or detection of signals applied to the input of the electron discharge device.

Fig. 10 relates to an arrangement permitting the attainment of rectification effects of the signals applied between the input terminals 1 and 2 of a circuit comprising an electron discharge tube T by employing, in order to polarize the grid of the tube T, the drop of potential produced in an impedance which

is represented on the figure by resistance R placed in series with a luminescent discharge tube which is situated in the output circuit of the tube T. The arrangement of the circuits is shown in Fig. 10 in which Z is an impedance in series with the battery E. Suitable batteries may be provided as indicated on the drawings.

The elements of the circuit of Fig. 10 are chosen so that the whole tube N, resistance R and the tensions applied to this unit are such that any one of the three conditions of operation considered above may be satisfied.

If, under these conditions, an alternating voltage is such that the modulated wave shown at *a* in Fig. 11 is applied between the input terminals 1 and 2 of the arrangement of Fig. 10 there will thus be produced in the plate circuit corresponding variations of potential and the voltage V applied to the unit neon tube N, resistance R will vary with the variations of the voltage applied to the input terminals 1 and 2. This voltage V is equal to the voltage of the batteries less the drop of potential in the impedance at Z.

An alternating voltage such as that shown at *a* in Fig. 11 causes the appearance of a drop of potential U in the impedance Z: the form of the grid voltage Vg and the plate voltage V by function of time would correspond to the curves *e* and U shown at *b* and *c* in Fig. 11, if the neon tube N were removed from the circuit. When the impedance Z is chosen sufficiently high, the potential U is substantially proportionate to Vg and of opposite phase.

The difference of potential applied between the terminals 1 and 2 varying by function of time, the potential V applied to the unit N—R will vary in a corresponding manner and the position of the point of operation on the curve of the tube N will also vary. For example, if at the moment t_1 the voltage V applied to the unit N—R exceeds the value of V_1 a current I passes through the resistance R, producing a drop of potential RI which is applied between the grid and the filament. If R is chosen so that the circuit of the neon tube is situated in any one of the conditions of operation mentioned above, the current I will be interrupted after a certain time depending on the inductances or capacities existing in the circuit, and current impulses will be obtained between the terminals 3 and 4 having, for example, the shape shown at *d* in Fig. 11.

The difference of potential Vg between the grid and the filament is equal to $e + RI - Eg$ and is represented by the continuous line Vg at *b* in Fig. 11. The curve showing the difference of potential V at the terminals of the neon tube system N, resistance R is represented by the continuous line curve V at *c* in Fig. 11.

It is clear that during the interval of time $t_1 t_2$ the mean value of potential Vg is in-

creased by the mean value of a drop of potential in the resistance R . It will be noted that by mean value is meant the mean value taken during a short interval of time compared with $t_2 - t_1$ and long with respect to the period of alternating voltage applied between the terminals 1 and 2.

If a useful apparatus having a fairly high inductance such as a relay, for example, is placed between the terminals 3 and 4 the current I_u in this apparatus may have, by function of time for example, the form indicated at e in Fig. 11.

The curve of the potential V_g may be considered as the superposition of the potential curve and alternating and direct components of the drop of potential RI . It may be admitted that the drop of alternating potential in the choke coil or inductance coil Z is in proportion to the alternating component of the voltage applied; the value of the potential V_g corresponding to the voltage V_1 applied to the unit neon tube N resistance R will consequently become less negative during the time interval $t_1 - t_2$ than previously. The circuit may be arranged so that the ratio of the drop of alternating potential in the choke coil or impedance Z to the input voltage between the terminals 1 and 2 increases during the period t_1, t_2 ; this would be the case, for example, when the potential V_g varies in the curved portion of the characteristic of the vacuum tube T . In such a circuit, current impulses will still be obtained in the resistance R when the difference of alternating potential between the terminals 1 and 2 falls to a lower value than that for which the current begins to be established. This characteristic of the circuit may be employed to correct the distortion of signals applied between the terminals 1 and 2.

With variations of voltage such as those shown at a in Fig. 11 it is possible under certain conditions to obtain current variations in the useful apparatus placed between the terminals 3 and 4, whose shape is substantially rectangular. For this purpose a resistance R_1 may be inserted in parallel with a condenser C in the grid circuit of the tube T . The different elements of the circuit may then be chosen so that a rectified current passes through the grid circuit when the neon tube is lighted up. Generally an increase of the value of the difference of alternating potential applied between the terminals 1 and 2 produces an increase of the mean value of the drop of potential in the two resistances R and R_1 ; by suitably adjusting the elements of the circuit it may be arranged that these variations of drop of potential tend to balance each other; the condenser placed in the grid circuit shows the resistance of the grid circuit for the alternating currents, so as to

obtain between the grid and the filament a suitable portion of the difference of alternating potential existing in the grid circuit.

It will be noted that when a condenser is employed in the grid circuit the grid potential at the moment t_2 does not immediately return to its original value because the condenser has been charged by the drop of potential produced in the resistance, and this condenser takes some time to be discharged through its resistance; however, this will have very little influence on the form of the variations in function of time of the current in the useful apparatus branched between the terminals 3 and 4 if the time constant of the resistance-condenser circuit placed in the grid circuit has been chosen sufficiently low.

Fig. 13 shows a modification of the arrangement of Fig. 10 in which the input circuit is coupled to the grid circuit of the electron discharge tube T by means of a transformer Tr . A resistance R_1 shunted by a condenser C_1 may be placed in the grid circuit, so as to control between certain limits the polarization of the grid of the tube T . A useful apparatus L , such as a relay may be placed between the tube terminals 3 and 4 of the tube T ; this apparatus may be shunted by a condenser of suitable size C' . A choke coil Z is placed in series with the plate tension E .

Fig. 14 is a generalization of the arrangement shown in Fig. 10. In this figure the apparatus A and A' placed in the input and output circuits of the electron discharge tube T may, for example, be amplifiers. 1 and 2 are the input terminals of the arrangement, 3 and 4 the output terminals.

With this arrangement, it is necessary to have conducting channels between the points c and d , a' and b' , c' and d' .

Fig. 15 represents an arrangement similar to those shown in Figs. 10, 13 and 14 in which impedance Z is formed by one of the windings of a transformer whose other winding may be branched in series with a neon tube N which enables the tension due to the signal applied on the neon tube to be increased. The arrangement may thus be more sensitive than that shown in Fig. 10. The sensitivity may be still more increased by providing three windings T_1, T_2, T_3 on the transformer, as shown in Fig. 16 and by branching the winding T_1 in the grid circuit of the tube T so as to form a reaction between the input and output circuits of said tube. It will be noted that by acting either on the coupling or on the transformation ratio of the transformer the sensitivity of the arrangement may be varied.

Fig. 17 shows a modification of the arrangement of Fig. 10 in which a pair of tubes T, T' mounted according to a sym-

metrical or "push-pull" arrangement is employed. In this case two neon tubes N and N' may be placed in the plate circuits of the tubes T and T'. 1 and 2 are the input terminals of the arrangement, 3 and 4 the output terminals. The input circuit is coupled to the grid circuits of the tubes T and T' by means of a transformer Tr, and the grid circuits of the tubes T and T' may comprise shunted resistances $C_1 R_1$ and $C'_1 R'_1$. The plates of the tubes T and T' are connected by means of a choke coil Z, whose middle point is connected to the battery E through the circuit 3—4; a choke coil Z may be provided in series with this battery.

The circuits of the tubes N and N' have a common resistance R which plays the same part in the circuit of Fig. 17 as the similar resistance R in the other circuits. The middle point of the secondary of the transformer Tr, is connected to this resistance r either directly or by means of a resistance R which may be shunted by a condenser. Batteries may be provided as shown in Fig. 17.

This arrangement has among others the advantage of employing the two consecutive half waves of the signal applied between 1 and 2 to produce the corresponding detected signal which is again found between the terminals 3 and 4.

The shunted resistances $R_1 C_1$ and $R'_1 C'_1$ fulfill a similar part to the corresponding elements in the preceding circuits. These shunted resistances may in the case of Fig. 17 be replaced by a resistance r which may be shunted by a suitable capacity condenser.

In the arrangements described above only luminescent two-electrode discharge tubes have been employed, but it should be understood that luminescent tubes having a greater number of electrodes may also be employed.

Figs. 18 and 19 relate to systems employing three-electrode luminescent discharge tubes.

Fig. 18 shows a luminescent three-electrode discharge tube E_1, E_2 and G_1 . The three electrodes E_1, E_2, G_1 may be placed for example in a container N full of neon. When a voltage is applied to the electrodes E_1 and E_2 , the electrode G_1 being free, a certain voltage is necessary for current to pass through the space $E_1 E_2$. When the difference of potential between E_1 and E_2 is lower than the voltage mentioned above, it is possible to cause a current to pass between E_1 and E_2 by applying a suitable potential to the electrode G_1 . In the case of Fig. 18, all the electrodes of the tube N are connected to the same battery S; resistances R and R' may be provided as shown on the drawings to protect the electrodes.

Fig. 19 shows an arrangement employing luminescent three-electrode discharge tubes adapted to transform electric oscillations of

any shape applied to the input terminals 1 and 2 into oscillations of approximately rectangular shape, the duration of said transformer oscillations varying according to the duration of the electric oscillations applied.

The luminescent discharge tubes N and N' in Fig. 19 are chosen to have characteristics as similar as possible. As shown on the drawings the electrodes E_1 and E'_2 are directly connected to one of the poles of the battery S. The electrodes E_2 and E'_1 are connected to a point of the battery S by means of the resistances R_1 and R_2 and by means of inductances L_1, L_2 which have identical characteristics and which are placed on the same iron core so that their flux is opposite. The electrodes G_1 and G'_1 are connected to another point of the battery by means of resistances R'_1, R'_2 and r_1, r_2 . The common points to the resistances R'_1, r_1 and R'_2, r_2 are connected to the input terminals 1 and 2.

If we suppose that a difference of alternating potential having any wave form is applied between the terminals 1 and 2 the arrangement will operate in the following manner:

When current is circulating between the terminals 1 and 2 the drop of potential in the resistance r_1 will cause an increase of potential of the electrode G_1 and for a certain value of the current the potential of G_1 will reach the value at which a current will pass through the tube N, that is to say that a current will circulate in the circuit comprising the inductance L_1 , the resistance r_1 and the electrodes E_1, E_2 . At the same moment the potential applied to the electrode G'_1 has decreased and the tube N' will not operate, that is to say no current will circulate between the electrodes E'_1 and E'_2 .

When during the following half period the current is circulating between the terminals 2 and 1, the differences of potential at r_1 and r_2 will increase the voltage of the electrode G'_1 and at the same time decrease the potential of the electrode G_1 . The voltage of the electrode G'_1 will reach a certain value at which the tube N' will permit the passage of current between the electrodes E'_1 and E'_2 that is to say, current will circulate in the inductance L_2 , the resistance R_2 and the electrodes E'_1 and E'_2 and battery. It will be noted that when this current increases from zero to its final value an E. M. F. will be induced in the inductance L_1 and this E. M. F. will act against the voltage applied by the battery and render the tube N inoperative if the voltages and characteristics of the circuit have been suitably chosen and adjusted. It will thus be seen that an alternating current applied between the terminals 1 and 2 of the arrangement of Fig. 19 will be transformed into current of regular form which can be

corrected between the terminals 3 and 4 or 3' and 4'.

The principle of employing intermittence, which may be produced under certain conditions in the operation of luminescent discharge tubes to modify the form of the electric signals is of great importance particularly in the art of electric signaling and it should be noted that the various arrangements which have been indicated above have been mentioned purely as an indication and not as a limitation. For example, the case has generally been considered where the difference of potential applied to a luminescent discharge tube unit in series with an impedance was caused to vary so as to modify the position of the point of functioning of this unit, but it should be noted that other means of modifying the point of functioning in question may be employed and in particular the value of the impedance in series with the luminescent discharge tube made be modified. For this purpose said impedance may be formed, for example, by the plate filament space of an electron discharge tube whose grid potential is controlled so as to cause said impedance to vary. This arrangement may be combined with any one of the above mentioned arrangements and may have in certain cases particular advantages.

What is claimed is:

1. A system for modifying the form of electric signals, comprising a three-electrode space discharge device having an input circuit on which said signals are impressed, and an output circuit, a source of space current and a resistance element in series in said output circuit, a circuit connected across said space current source and series resistance element, and comprising a gaseous space discharge device and an impedance element in series, and means for taking off the voltages across said impedance element.

2. A system for modifying the form of electric signals comprising a three-electrode space discharge device having an input circuit and an output circuit, means for impressing said signals on said input circuit, a source of space current and a resistance element in series in said output circuit, a circuit connected across said space current source and series resistance element and comprising a gaseous space discharge device and an impedance element in series, a second three-electrode space discharge device having an input circuit connected across said impedance element, and an output circuit, a second source of space current and a second resistance element in series in the output circuit of said device, a circuit in parallel with said second space current source and said second resistance element and comprising a second gaseous space discharge device and second impedance element in series, and means for taking off the voltages across said second impedance element, the

constants of the system being adjusted so that when an operating voltage is applied to the first gaseous device, the voltage applied to the second gaseous device will be insufficient to cause its operation and when the voltage applied to said first gaseous device is insufficient to cause its operation, an operating voltage will be applied to said second gaseous device.

3. A system for modifying the form of electric signals comprising a space discharge device having an output circuit, and a cathode, an anode and a control electrode, a source of space current and a resistance element in series in said output circuit, a circuit connected in parallel with said space current source and series resistance element, and comprising a gaseous space discharge device and an impedance in series, means for applying signals between said control electrode and said cathode through a portion of said impedance and means for taking off the voltage across said impedance.

4. A system for modifying the form of alternating current signals comprising a space discharge device having a cathode, an anode and a control electrode, and an input and an output circuit, said output circuit comprising connected between said anode and said cathode, a parallel circuit comprising a source of space current and an impedance in series, shunted by a gaseous space discharge device in series with a second impedance, and a load circuit connected between said anode and said parallel circuit, said input circuit comprising connected in series between said control electrode and said cathode, said second impedance and means for impressing said signals on said input circuit.

5. A system, according to claim 4, and in which said first mentioned impedance comprises a choke coil, and said means for impressing said signals on said input circuit comprising a transformer.

6. A system for modifying the form of alternating current signals comprising two three-electrode space discharge devices connected in push-pull relation and having a portion of their input and output circuits in common, each of said space discharge devices having a cathode, an anode and a control electrode, the common portion of the output circuits of said devices comprising a source of space current, and a load circuit in series, two two-terminal, gaseous space discharge devices connected in parallel with each other and respectively to an anode of a different one of the two three-electrode devices, a circuit connected in shunt with said common portion of said output circuits, and comprising said parallel gaseous devices and a second impedance in series, the common portion of the input circuits of said two three-electrode devices comprising said second impedance

ance, and means for impressing said signals on the individual portions of the input circuits of both three-electrode devices.

In witness whereof, we hereunto subscribe
our names this 14th—16th day of December,
1931.

FLORENT E. A. SMETS.
CARL F. HANSEN.

DISCLAIMER

1,895,774.—*Florent E. A. Smets and Carl F. Hansen, Paris, France. SIGNAL SHAPING CIRCUIT. Patent dated January 31, 1933. Disclaimer filed May 14, 1936, by the assignee, Western Electric Company, Incorporated.*

Hereby enters this disclaimer to claim 1 of said Letters Patent.
[*Official Gazette June 2, 1936.*]

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