Oct. 25, 1949. P. F. M. GLOESS ET AL 2,485,821

TRANSLATION OF DURATION MODULATED CODE PULSES INTO EQUAL LENGTH CODE PULSES

Filed April 28, 1949 4 Sheets-Sheet 1

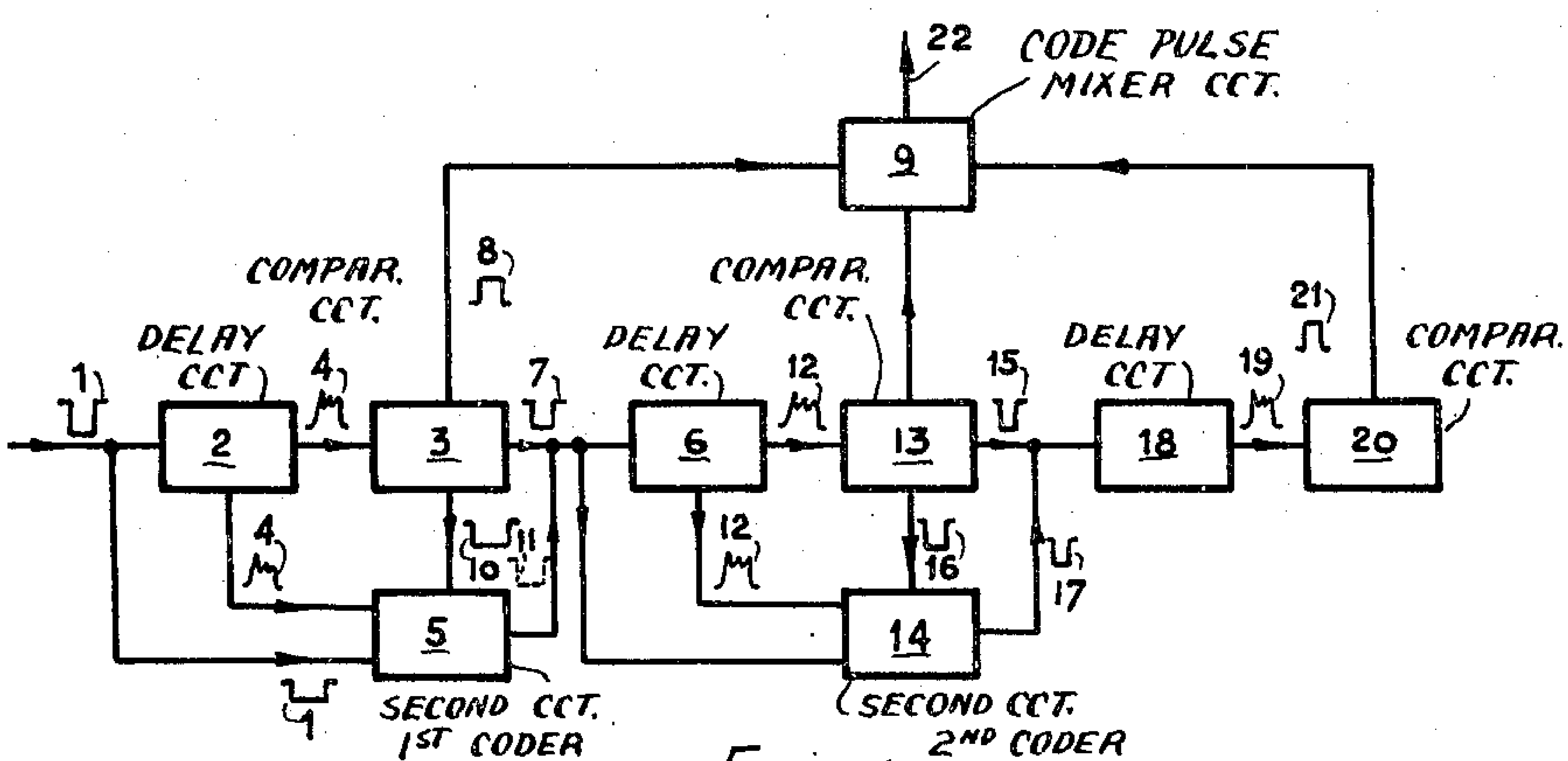


Fig. 1

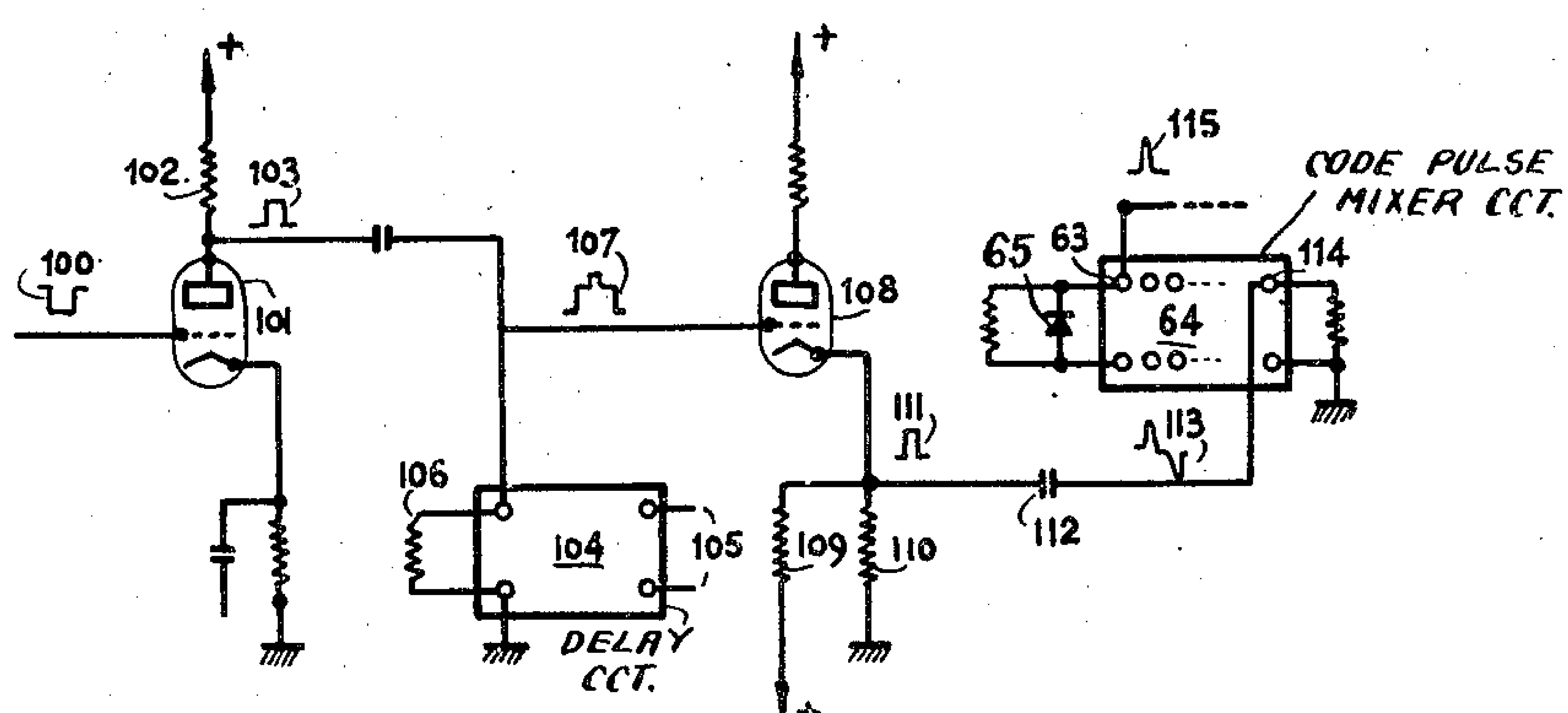


Fig. 5

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Filed April 28, 1949 4 Sheets-Sheet 2

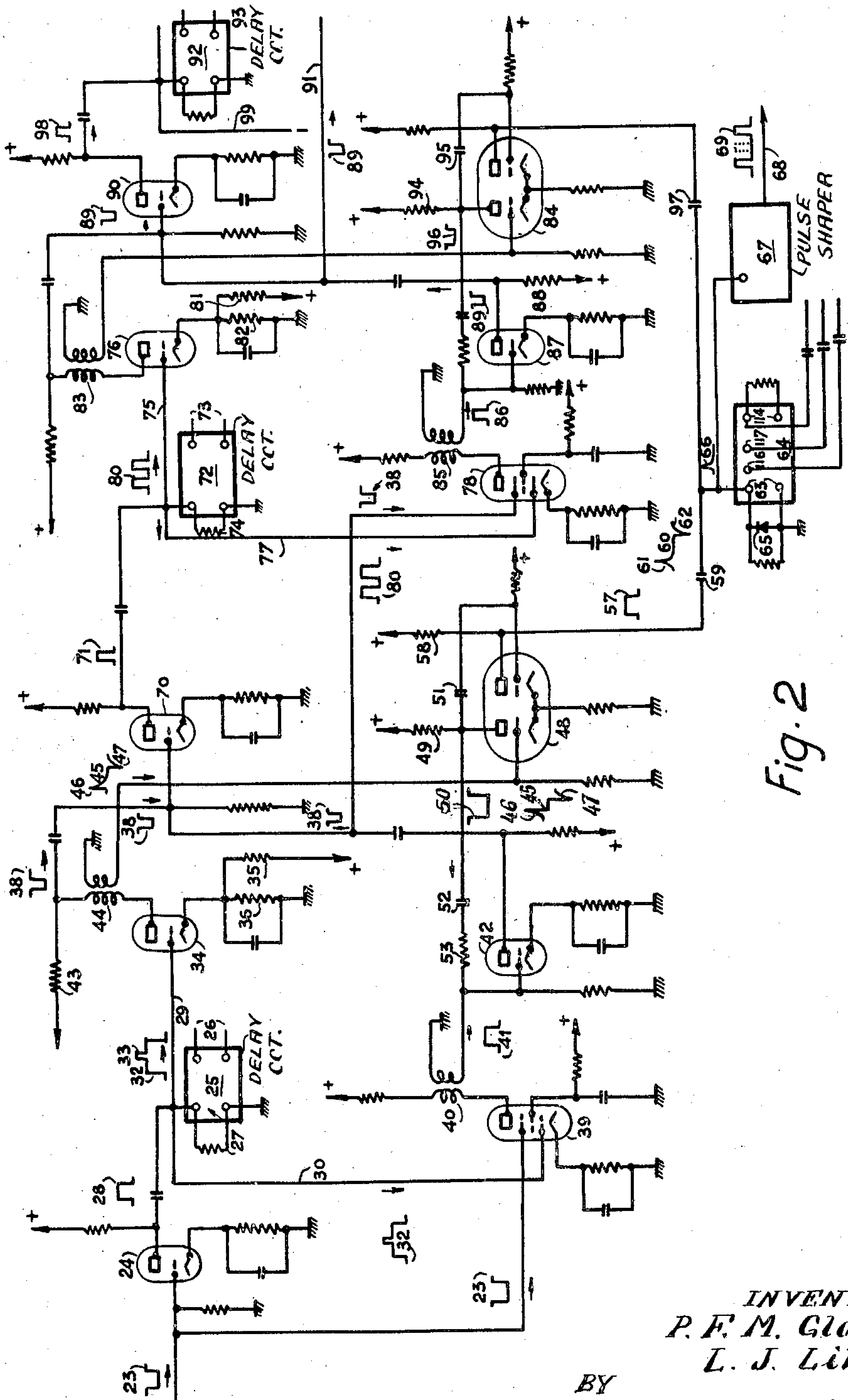

Fig. 2

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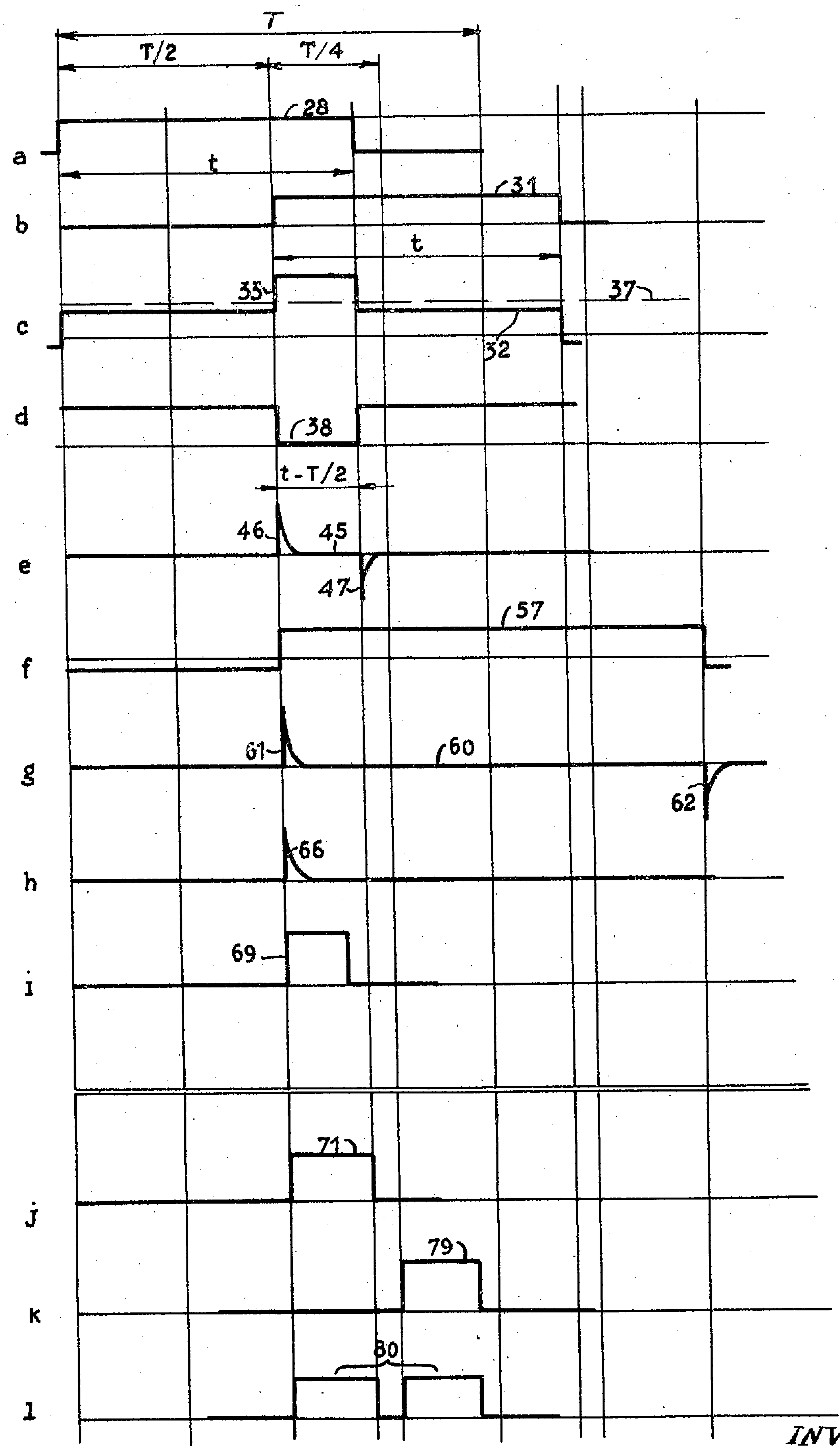


Fig. 3

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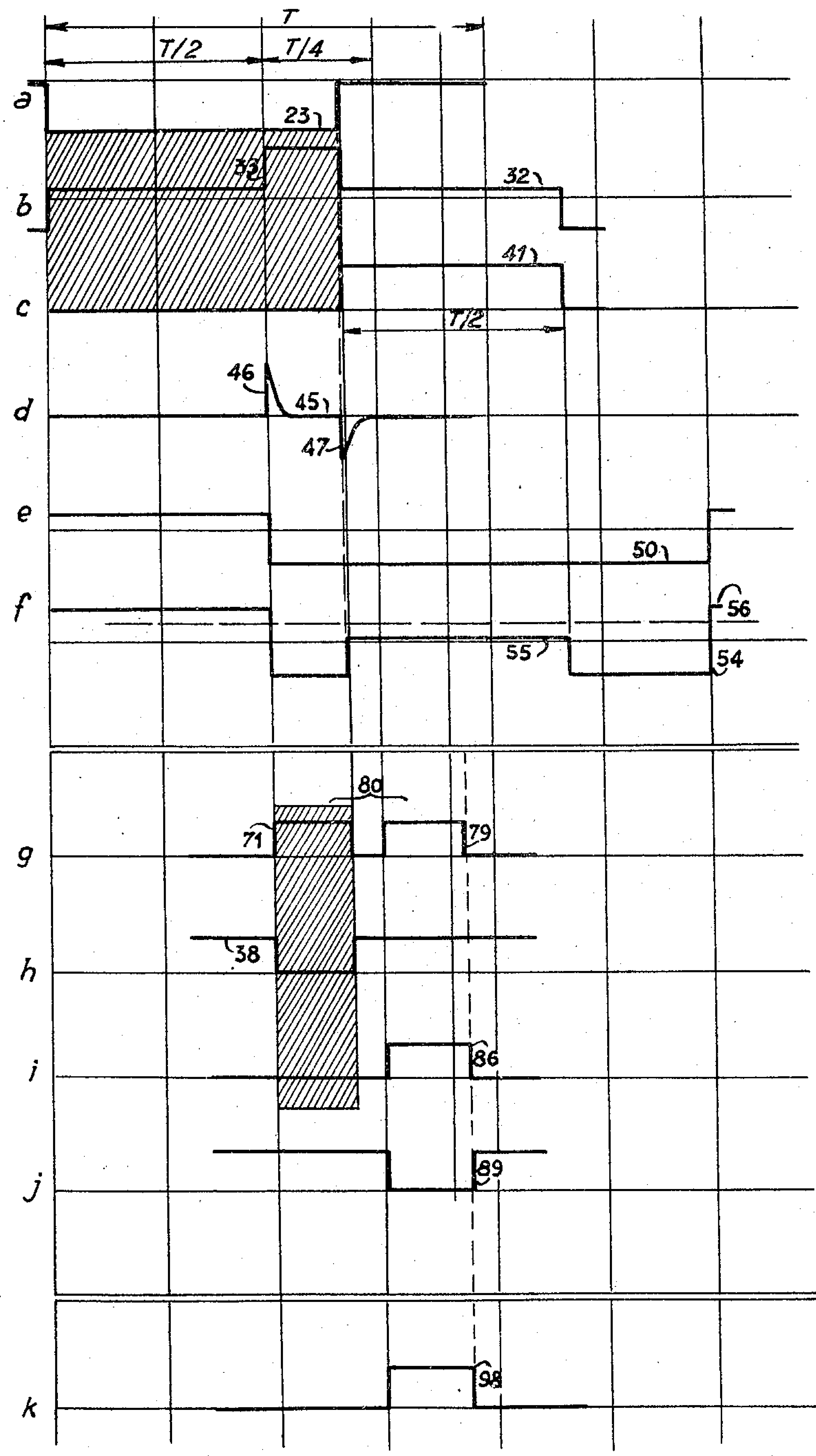


Fig. 4

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# UNITED STATES PATENT OFFICE

2,485,821

## TRANSLATION OF DURATION MODULATED CODE PULSES INTO EQUAL LENGTH CODE PULSES

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11 Claims. (Cl. 177—380)

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The present invention relates to improvements in electrical codification systems and more particularly in the translation of duration modulated pulses into code pulses.

It is known that the modulation of electric signals by code pulses may be effected as follows:

The low frequency signal to be transmitted modulates, in a known manner, pulses repeated at a suitable rhythm or repetition frequency, modifying, according to the amplitude of the signal, one of the characteristic parameters of the pulses used, this parameter being generally the amplitude, the duration or the position in time.

The pulses thus modulated, from a number of communication channels are then grouped, as is well known, in the multiplex pulse transmission systems.

These modulated pulses are transmitted to a coding device which converts each one of them into a train of $n$ code pulses, each of which can assume each of two values according to the importance of the modulation of the pulse of the corresponding channel, in such a manner as to define $2^n$ different levels for the modulation parameter of the channel pulses. It is known that, practically, one of the two amplitude values of the code pulses is zero, i. e. an absence of the corresponding pulse, the other value having generally a predetermined constant level.

The present invention has, as an object, a coding device enabling the conversion, into code pulses, of pulses modulated in duration by a displacement of their trailing edges.

According to one characteristic of the invention, the coding device successively compares duration modulated pulses with predetermined intervals, each one of which is half the previous one, said time intervals offering a simple relationship with the maximum duration of the initial pulses.

According to another characteristic, the coding device comprises a number of successive stages equal to the number of elements of the code considered, each stage being connected to the next one by two different circuits, and, in each stage, means, controlled by the signal applied to said stage, to direct the signal through one or the other of said circuits, according to its duration referred to a time interval characteristic of the stage considered and, simultaneously, to render inoperative the circuit not utilized.

According to another characteristic, one of the circuits of each stage passes only the signals having a duration longer than the reference time interval of the stage considered and produces, under the control of these through-going signals, a code pulse together with a signal rendering the other circuit of the same stage inoperative, and supplies the following stage with a signal whose duration is decreased by the reference interval of the stage considered and which is delayed by this duration.

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According to another characteristic, the other circuit receives the signals which have a duration smaller than the reference time interval of the stage considered, delays these signals by this time interval and transmits them to the next stage without decreasing their duration.

According to another characteristic of the invention, the last stage of the coding device comprises only one circuit and means are provided in this circuit to pass only signals having a duration greater than the shortest reference interval and to produce then a code pulse.

Finally, according to another characteristic, the first of the circuits of each stage preceding the last one comprises an electronic device with two stability positions, controlled by a signal derived from the signal applied to the stage when said applied signal has a duration greater than the reference interval of the stage, said electronic device controlling, when operated, the emission of a code pulse and further creating a blocking signal for the second circuit, this blocking signal having a duration substantially double that of the reference interval of the stage considered.

The invention will now be described in detail, with reference to a preferred example of embodiment, which will illustrate exactly its purpose, characteristics and advantages. This description will be made with reference to the appended drawings wherein:

Figure 1 shows, schematically, a coder in accordance with the invention;

Figure 2 shows in greater detail, the electrical circuits of the two first stages of a coder in accordance with the invention;

Figures 3 and 4 are diagrams of pulses occurring at various points of the coding chain; and

Figure 5 shows an example of embodiment of the circuits of the last stage of a coder in accordance with the invention.

For greater simplicity, Figure 1 shows, schematically, a coder giving three code pulse positions and giving, consequently, a definition corresponding to $2^3$ different levels, but it will be obvious, upon reading the description, that the code might comprise any larger number of elements and that, in such a case, a number of stages would be utilized equal to the number of these elements, each stage being similar to those whose functions will now be defined in connection with Figure 1.

In the description, T will designate the maximum duration selected for the modulation of the incoming pulses and $t$ the duration of any pulse.

In Figure 1, the pulses **1**, modulated in duration and which are negative, for instance, are applied to a delay device **2**, delaying said pulses by a time T/2, and delivering to a comparator circuit **3** a signal **4** whose shape will be defined in connection with Figures 2 and 3. The signal **4** will be positive, for instance. Further, a circuit **5** receives, on one hand, the initial pulse **1** and on the other hand the signal **4**.

If the duration $t$ of pulse **1** is larger than T/2, the circuit **3** delivers to a second delay circuit **6** an impulse **7** delayed by T/2 and having a duration ($t$–T/2); further, it sends out a code pulse **8** which is transmitted to a mixing circuit **9** and, finally, it applies to device **5** a blocking signal **10** whose duration will be substantially equal to T so as to prevent this device **5** from transmitting any signal to the circuit **6**.

On the contrary, if the duration of pulse **1** is smaller than T/2, the device **3** does not operate and consequently does not supply any of the signals **7**, **8** and **10**. The device **5** therefore is not blocked and it transmits to the delaying circuit **6** a pulse **11** corresponding to pulse **1**, i. e. whose duration is $t$, but it delays this pulse **11** by T/2 with respect to pulse **1**.

The device **6** subjects the signals it receives to a delay T/4 and, as previously, the signal **12** produced is applied simultaneously to a comparator device **13** and to a device **14** which also receives the pulse **7** or **11**. The devices **13** and **14** act, respectively, in a manner similar to that of the devices **3** and **5** of the first stage: if the pulse **7** or **11** entering the second stage of the coder has a duration greater than T/4, the device **13** projects a code pulse towards the mixer **9** and it also supplies a pulse **15** whose duration is decreased by T/4 with respect to that of signal **7** or **11** and which is delayed by T/4 with respect to said signal, and it sends to circuit **14** a blocking signal **16** whose duration will be about T/2, this duration being sufficient to prevent the circuit **14** from operating while the pulse **7** or **11** is applied to it, since these signals **7** or **11** can only have a duration equal to or smaller than T/2 by virtue of the adjustment of the first stage of the coder.

If, on the other hand, the pulse **7** or **11** has a duration smaller than T/4, the comparator circuit **13** cannot operate and the device **14** delivers a pulse **17** which is identical but delayed by T/4.

One or the other of pulses **15** or **17** reaches the third stage of the coder which is the last stage in the example considered. It is applied to a delay circuit **18** causing a delay T/8 ($T/2^n$ in the case of a coder with $n$ pulse positions) and delivering a signal **19** applied to a last comparator circuit **20** which delivers a code pulse **21** if the signal **15** or **17** has a duration greater than T/8 but delivers no signal in the opposite case.

For this last stage, it is obviously unnecessary to provide a second circuit for the direct transmission of the pulses since signals of a duration smaller than $T/2^n$ do not give rise to the production of any code pulse.

The code pulses eventually delivered by the circuits **3**, **13** and **20** are suitably distributed by the mixer **9** which may also, if desired, give them the characteristics suitable for transmission, and they are received at **22**.

Figure 2 shows an example of embodiment of a coder according to the invention. For greater simplicity, only two stages of this coder have been shown, since all the stages are similar. However, an example of embodiment of the last stage is shown in Figure 5.

It will be noticed that certain electron tubes used have been represented under the shape of triodes or pentodes, but it is obvious that in practice tubes can be used comprising a different number of electrodes, and that such tubes may offer operating characteristics which make it possible to obtain in better conditions the desired results. The circuit modifications to be effected in such a case will be obvious to technicians.

It will be assumed in the description that the duration of the incoming pulse considered is between T/2 and (T/2+T/4):

$$T/2<t<(T/2+T/4)$$

With this assumption, the first stage of the coder gives a code pulse but the second stage does not give any and this makes it possible to explain completely the operation of the system in connection with the two stages shown.

It will further be assumed that the incoming pulses **23** are modulated in duration by displacement of their trailing edges and that they are of a negative polarity, as shown.

The description of the operation of the circuits of Figure 2 will be made in connection with the diagrams of Figures 3 and 4. Figure 3 shows schematically the shapes of the signals produced by the circuits corresponding respectively to the assemblies **2**, **3**, **6** and **13** in Figure 1. Figure 4 shows the shapes of the signals produced by the circuits corresponding to the devices **5** and **14** of said Figure 1.

The incoming pulse **23** is applied to the control electrode of an electron tube **24** whose anode circuit comprises particularly a delay line **25**, open at its end **26** and closed at its input **27** on its characteristic impedance so as to reflect the signals applied to it. The back and forth transmission time on line **25** has been selected equal to T/2. The pulse **28**, appearing on the anode of the tube **24** under the action of the pulse **23** is shown on line $a$ of Figure 3.

This pulse **28** is transmitted simultaneously to the input **27** of the delay line **25** and over connections **29** and **30**. These connections also transmit the pulse **31**, shown on line $b$ of Figure 3, caused by the reflection of pulse **28** in line **25** and delayed therefore by T/2 with respect to this pulse **28**. The combination of pulses **28** and **31** produces the signal **32** shown at $c$, Figure 3; this signal offers a crest **33** of duration ($t$–T/2) caused by the partial superposition of the pulses **28** and **31**. The signal **32** is applied to the control electrode of a second electron tube **34**, normally biassed beyond cut-off voltage by means, for instance, of a voltage divider **35**—**36** designed in such a manner that the cut-off voltage, shown at **37** on line $c$ of Figure 3 allows the tube to pass only signals having an amplitude higher than that of the pulse **28**. Thus, only the crest **33** of the signal **32** goes through the tube **34** which delivers on its anode a negative signal **38** shown at $d$ on Figure 3 and whose duration is that of the crest **33**, i. e. ($t$–T/2).

The said signal is further transmitted, through lead **30** to the control electrode of an electron tube **39**, such as a pentode, to the suppressor grid of which is applied the incoming pulse 23 which thus suppresses during a time $t$ the anode current of this tube, as has been shown on lines $a$ to $c$ of Figure 4. In the anode circuit of tube 39 is inserted an inverter-transformer 40 at the output of which the positive signal 41 is received, whose duration is T/2 as shown by line $c$ of Figure 4 and which is delayed by $t$ with respect to the incoming pulse 23. Thus, the electron tube 42 controlled by the tube 39 through the transformer 40 cannot send out any signal pending the duration $t$ of the incoming pulse, as will appear below.

The anode load of tube 34 consists, in addition to resistor 43 at whose terminals appears the negative signal 38, of a transformer 44 which reverses and differentiates the pulse 38, producing a signal 45 as shown by line $e$ of Figure 3. This signal comprises a short positive pulse 46, corresponding to the first edge of the inverted signal from the pulse 38, and a short negative pulse 47, caused by the second edge of this inverted signal.

The signal 45 energizes an electronic device having one position of permanent equilibrium and capable of assuming, during a predetermined time interval, another position of equilibrium under the control of a suitable signal. Such devices are well known and the one which is represented by way of example in Figure 2 consists of a double triode tube 48, connected in a known manner.

The left hand element of this tube is normally non-conducting but it is made conducting by the positive potential applied to its control electrode by the pulse 46. The potential at the terminals of the load resistor 49 of this element thus decreases suddenly when this pulse 46 appears, which gives a negative pulse 50 shown on line $e$ of Figure 4. The time constant of the circuit formed by the resistor 49 and by the coupling capacitor 51 is determined in such a manner that the tube 48 comes back to its position of permanent equilibrium by unblocking of its right hand element, only after a time interval T, i. e. at a time 3T/2 after the beginning of the pulse 23. An examination of Figure 4 shows that this duration is sufficient to include the duration of the pulse 41 produced by the tube 39 even if the initial pulse 23 had the maximum duration T.

Of course, known devices (not shown) comprising, for instance, a detector circuit will be utilized so that the negative pulse 47 of the signal 45 does not cause the tube 48 to come back untimely to its position of permanent equilibrium.

Through the medium of a suitable capacity 52 and resistance 53, the negative pulse 50 is transmitted to the control electrode of the tube 42 which thus receives the signal shown on line $f$ of Figure 4. The circuit elements are proportioned in such a manner that the portion 55 of signal 54 caused by the appearance of signal 41 has an amplitude smaller than that of the cut-off voltage of the tube 42, a voltage which is indicated by the horizontal line 56; thus the tube 42 remains blocked in spite of the existence of the positive pulse 41.

The incoming pulse having a duration greater than T/2, the device 48 also controls the emission of a code pulse produced as follows:

When the pulse 46 modifies provisionally the equilibrium condition of the tube 48, the right hand element of this tube is blocked and a positive pulse 57 appears at the terminals of the load resistor 58; this pulse is represented on line $f$ of Figure 3. It is differentiated by a capacitor 59, whose values have been chosen sufficiently small, and gives a signal 60 ($g$ on Figure 3), consisting of a short positive pulse 61 and a short negative pulse 62. The signal 60 is applied at 63 to a mixer circuit 64 whose terminals are connected to a detector 65 which suppresses the negative pulse 62 and thus produces a signal 66, shown on line $h$ of Figure 3. As this figure shows, the signal 66 is produced by the leading edge of the initial pulse 23, delayed by T/2; it thus occupies a fixed position with respect to this leading edge, i. e., a fixed position in the iterative period of the pulses 23.

The pulse 66 is transmitted to a shaping device 67, for the purpose of giving the code signals suitable characteristics, and which delivers, for instance, at its output terminals 68 the signal 69 shown on line $i$ of Figure 3.

Further, the pulse 38 whose duration, ($t$–T/2), by hypothesis, is smaller than T/4, is applied to the control electrode of an electron tube 70 which is the input tube to the second coder stage and which corresponds in that stage to the tube 34.

The tube 70 converts this pulse into a positive pulse 71, shown on line $j$ of Figure 3 and which is applied to the input of a delay line 72 similar to line 25. Like the latter, the line 72 comprises an open end 73 but is closed at its input 74 on its characteristic impedance so as to reflect at one of its ends the signals applied to it. This line 72 has a back and forth transmission time equal to T/4 or $T/2^2$. Similarly, the delay line of any stage $p$ of the coder has a back and forth transmission time equal to $T/2^p$.

The pulse 71 is further transmitted through a lead 75 to the control electrode of an electron tube 76 and through a lead 77 it is also applied to the control electrode of another electron tube 78 such as a pentode tube.

The delay line 72 causes the appearance of a pulse 79 shown on line $k$ of Figure 3, identical with the pulse 71 but having with respect to that pulse 71 a delay T/4. Since, by hypothesis, the duration of the pulse 71 is smaller than T/4, the total signal 80 transmitted over leads 75 and 77 consists of two identical successive pulses as shown on line $l$ of Figure 3.

The tube 76 is biassed beyond cut-off voltage, like the corresponding tube 34 of the first stage, by means, for instance, of a voltage divider 81–82, so as to pass only signals having an amplitude greater than that of the pulse 71. Thus this tube does not transmit the signal 80, so that no control signal is sent through the differentiating transformer 83 to the device 84, similar to the device 48 of the first stage and, like it, shown in the form of a double triode tube. This tube thus remains at its permanent equilibrium position when the signal applied to the stage has a duration smaller than the back and forth propagation time of the delay line of this stage.

It was seen that the signal 80 is applied, on the other hand, through the lead 77 to the control electrode of the tube 78. On the suppressor grid of this tube is also applied the negative signal 38 which, having given rise to the signal 71 coincides in time with this signal. The signal 38 is again shown on line $h$ of Figure 4. The tube 78 is blocked pending the duration of the signal 38 and thus passes only the first pulse 71 of the signal 80. Only the pulse 79 goes through this tube and after inversion by the transformer 85 supplies a pulse 86 delayed by T/4 with respect to the pulse 71 and which is applied to the control electrode of an electron tube 87.

A circuit similar to that of the tube 42 of the first stage also connects the control electrode of the tube 87 with the anode of the left hand element of the tube 84; but since the latter tube does not leave its permanent equilibrium position, it delivers no signal capable of preventing the tube 87 from operating. Therefore, there is received at the terminals of the load resistor 88 of tube 87 a negative pulse 89 shown on line *j* of Figure 4.

This pulse 89, delayed by T/4 with respect to the pulse 38 is also applied to the control electrode of the input tube 90 of the third stage, and also, eventually, to a pentode tube not shown, such as 39 or 78 of the third coder stage, through the lead 91, unless this third stage is the last coder stage as will be discussed in the description of this last stage in connection with Figure 5.

The third stage, like the previous ones, comprises a delay line 92, open at its end 93 and whose back and forth propagation time is $T/2^3=T/8$.

It may be noted that the load resistor 94 of the left hand element of the tube 84, and the capacitor 95 for connecting the control electrode of the right hand element of this tube must be chosen so as to offer a time constant equal substantially to T/2. When the tube 84 leaves its equilibrium position under the control of a pulse such as 38, whose duration is greater than T/4, it thus delivers a negative blocking pulse 96, with a duration T/2 sufficient for blocking the tube 87 until the end of the signal transmitted in this case by the tube 78 since, in any case, the signal from the second coder stage cannot have a duration greater than T/2. On the other hand, the blocking pulse 96 must not have a duration substantially greater than T/2 in order not to hinder the operation of the coder when it receives the following pulse, which occurs substantially at a time T/2 after the appearance of the pulse 96.

Always in case the pulse such as 38 has a duration greater than T/4, the right hand element of the tube 84 delivers a positive pulse which is differentiated by the capacitor 97 and applied to the mixer device 64 as was seen during the description of the operation of the first stage.

The pulse 89 delivers, at the output of the tube 90 a positive pulse 98 represented on line *k* of Figure 4, a pulse which is transmitted to the delay line 92 and eventually through the lead 99 to the control electrode of the tube of the third stage, such as previous tube 39 or 78.

As concerns the last coder stage, the *n*th stage, it is quite obvious that it does not have to transmit signals whose duration is greater than $T/2^n$. Its circuits are therefore simpler than those of the previous stages, as shown by Figure 5.

We shall assume, for explanation purposes, that the last but one coder stage delivers a signal 100 whose duration is greater than $T/2^n$. This signal is applied to the control electrode of an electron tube 101, and there is received at the terminals of the load resistor 102 of this tube a positive pulse 103, which is applied to the input of a delay line 104. As in the preceding stages, this delay line is open at its end 105 and closed at its end 106 on its characteristic impedance and its back and forth propagation time is taken equal to $T/2^n$.

With the assumption made, the line 104 thus delivers a signal 107 built up by the partial overlapping of the pulse 103 and of the delayed reflected pulse, delayed by $T/2^n$. The signal 107 is applied to the control electrode of an electron tube 108 biassed beyond cut-off voltage by means, for example, of a voltage divider 109—110 in such a manner as to pass only signals having an amplitude greater than that of the pulse 103. There is thus received, for example, on the cathode of the tube 108, a positive pulse 111 delivered by the peak of the signal 107. This pulse 111 is differentiated by a capacitor 112 and thus produces a signal 113 applied to the mixer device 64, for instance, on its terminal 114. Owing to the detector 65, there is received on the terminal 63 a positive signal 115, transmitted to the shaping device 67 (Figure 2) to produce a code pulse.

Of course, the device described in connection with Figure 5 has been given by way of a purely illustrative example and might be made up in any suitable manner.

It may be noted that the system described in connection with Figures 2 to 5 delivers code pulses at fixed times with respect to the position in time of the leading edge of the initial pulses 23. As a matter of fact, under the action of the delay lines of the successive stages, and due to the clipping caused by the comparator tubes, these pulses, when they do exist, appear with respect to this leading edge, with respective delays T/2, (T/2+T/4), (T2+T/4+T/8) . . .

It is known that it is advantageous in practice, to distribute regularly, in time, these coded pulses so as to facilitate transmission.

According to one characteristic of the invention, this result may be obtained very easily by means of a mixer circuit 64 consisting, as shown on Figures 2 and 5, of a delay line closed at its two ends on its characteristic impedance. If it is assumed, for instance, that the code comprises four elements, the corresponding pulses may be spaced by a regular time interval equal to T/4. As the two first code pulses occur with a shift of T/4 as mentioned, they will be received successively on the input terminal 63 of the mixer circuit. The third pulse offers a delay T/8 with respect to the second one; it will be applied to a terminal 116 (Figure 2) located at a distance from the terminal 63 corresponding to a propagation time T/8 so as to have a total delay (T/8+T/8) with respect to the second pulse. Similarly, the fourth one will be received on a terminal 117 such that the propagation time from this terminal to terminal 63 is equal to 3T/16, etc. . . , the code signal being derived from the terminal 63 to be transmitted to the shaping device 67. As already mentioned, the pulse from the last stage of the system may be collected on the output terminal 114 of the circuit 64 and the total propagation time will then be equal to $(T/8+T/16+T/32+. . . .+T/2^n)$.

Of course, the time interval between two consecutive code pulse positions may be different from the one just indicated by way of example, especially if the code comprises more than four pulse positions. A simple calculation will allow the determination of the positions of the various terminals of the circuit 64 capable of giving the desired recurrence frequency.

It is quite obvious that the system described has been indicated only by way of illustrative example; numerous modifications to the circuits described will be obvious to those skilled in the art, but it must be understood that any modifications incorporating characteristics of the present invention are within its scope.

What is claimed is:

1. Method for translating recurrent electric

pulses modulated in duration by time displacement of their trailing edge into coded pulses, according to a chosen code, which comprises comparing successively, on the one hand, the duration of the initial pulses or the signals successively derived as modifications thereof with, on the other hand, a series of reference time intervals based on the maximum modulation duration and themselves serially inter-related by a common factor, and producing a code signal each time a comparison determines that the initial pulse or its signal modification exceeds in duration the corresponding reference interval.

2. Method according to claim 1, including staggering the produced code pulses in time in a predetermined order and with predetermined time intervals.

3. Method according to claim 1, wherein each comparing operation includes for the next comparison either diminishing the duration of the modulated pulse or of its signal modification proportionally with the change in the corresponding reference interval if said duration exceeds said interval, or retaining its duration in full if it does not exceed said interval.

4. A device for translating recurrent electric pulses, modulated in duration by time displacement of their trailing edges, into coded pulses, comprising a cascade of coupled coding stages equal in number to the code elements, means in each stage whereby the stages compare successively the duration of said modulated pulses with predetermined reference time intervals one for each stage and successively related in value by a common multiplier, the first one of said time intervals having a predetermined value amounting to a substantial part of the maximum modulation duration, and each stage also having means to transmit a code pulse corresponding to that stage in response to excess value of the modulation duration of the incoming pulse over the reference interval of that stage.

5. A translating device according to claim 4, wherein the coupling between stages comprises two signal transmission circuits, and the means to compare includes devices responsive to incoming signals to direct the signal selectively over one of said circuits in dependence on its duration respecting the reference interval of the directing stage, and to block the other circuit.

6. A translating device according to claim 5, wherein the comparing means includes devices responsive to incoming signals to pass over one of said circuits only signals having a duration in excess of the reference interval of the same stage, to produce a code pulse responsive to said signals, and to supply the following stage with a signal having a duration decreased by the reference interval of the passing stage and delayed by this last mentioned duration.

7. A translating device according to claim 5, wherein the comparing means includes devices adapted to respond to incoming signals, to delay signals having a duration smaller than the reference interval of the instant comparing stage, and to transmit them over a selected one of said circuits in their full duration.

8. A translating device according to claim 5, wherein a first one of said circuits in each stage having two circuits comprises an electronic device having two positions of stability, means by which said device is actuated by a signal derived from the signal applied to that stage, when said applied signal has a duration greater than the reference interval of that stage, connections whereby the said electronic device, when actuated, controls the emission of a code pulse and otherwise produces a signal blocking the second circuit, said blocking signal having a duration substantially double that of the reference interval of said stage.



9. A translating device according to claim 4, wherein the last stage of the cascade has a single signal transmitting circuit and the comparing means has devices for passing thereover only signals having a duration greater than the shortest reference interval, and for thereby producing a code pulse.

10. A translating device according to claim 4, wherein, with T representing the maximum modulation duration, and $n$ the number of code elements, the reference intervals are related successively as $T/2$, $T/2^3$ . . . $T/2^n$.

11. A device for translating recurrent electric pulses modulated in duration by time displacement of their trailing edges into coded pulses consisting of coding units with input and output terminals in cascade connection and in number equal to that of the elements of the chosen code, a first coding unit comprising means for applying primary duration modulated pulses to its input terminals, means for producing from said primary pulses secondary signals delayed by a given reference time interval with respect to said primary pulses, means for superimposing said secondary signals on said primary pulses so as to produce composite signals whose amplitude exceeds a predetermined value only in case the duration of said primary pulses exceeds said reference time interval, an electronic tube, means for applying said composite signals to a control electrode of said tube in such a way that said tube only transmits to its output circuit signals whose amplitude exceeds a predetermined value, means for transmitting said signals of excess amplitude to the output terminals of said first coding unit, means for deriving from said signals of excess amplitude a short duration pulse occurring at a fixed instant of the recurrence period of said primary pulses, an auxiliary circuit for transmitting the said secondary signals to the output terminals of said first coding unit, a second electronic tube, said auxiliary circuit including means for applying said primary pulses to a first control electrode of said second tube so as to render said auxiliary circuit inoperative for the duration of said primary pulses and for applying the said composite signals to a second control electrode of said second tube so as to render said auxiliary circuit inoperative for the duration of the said secondary signals, means for deriving from said short duration pulse a longer pulse having a duration approximately equal to twice said time reference interval, means for applying said longer pulse to said auxiliary circuit so as to render said auxiliary circuit inoperative for the duration of said longer pulse, means for transmitting signals received at the output terminals of said first coding unit to the input terminals of a second coding unit operating in a similar way but having a reference time interval equal to one-half of the reference time interval of said first coding unit, means for transmitting signals received at the output of said second coding unit to a third and in turn to successive coding units each having a reference time interval equal to one-half of that of the preceding coding unit, means for transmitting signals received at the output terminals of the last but one coding unit to the in-

put terminals of a last coding unit having a reference time interval equal to one-half of that of said last but one coding unit, said last coding unit operating in a way similar to preceding coding units but including only the circuit for transmitting to its output terminals signals whose duration exceeds the reference interval of its stage, means for applying short duration pulses generated by each of said coding units to a common mixer circuit, said mixer circuit comprising a delay circuit staggering said short duration pulses in time in a predetermined order and with predetermined time intervals, a circuit for shaping short-duration pulses received at output terminals of said mixer circuit into code pulses of predetermined wave shape and duration, and means for impressing said code pulses upon a transmission circuit.

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No references cited.