Jan. 27, 1959 W. E. INGHAM 2,871,379

PULSE SEPARATING CIRCUITS

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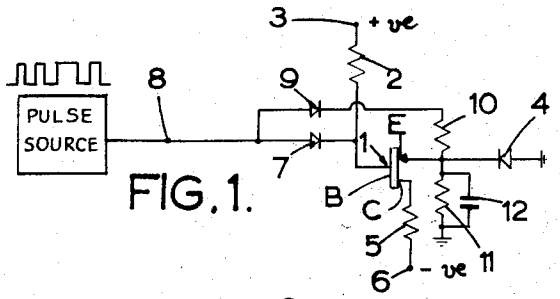



FIG. 1.

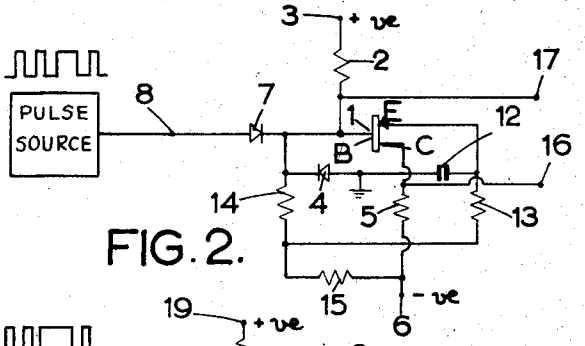



FIG. 2.

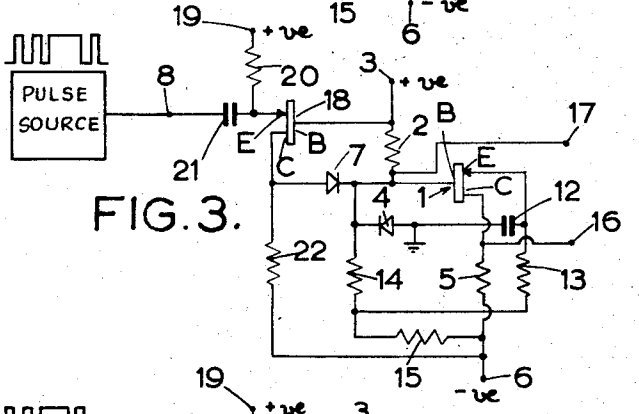



FIG. 3.

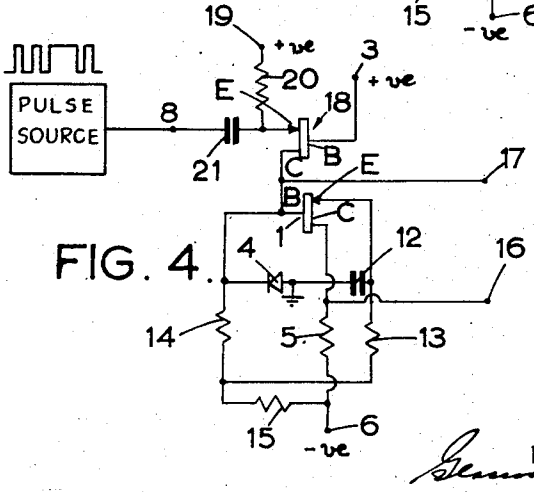



FIG. 4.

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# PULSE SEPARATING CIRCUITS

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6 Claims. (Cl. 307—88.5)

This invention relates to pulse separating circuits for separating narrow and broad pulses.

Such circuits are frequently required in television receivers in order to separate the line frequency synchronising pulses from the frame frequency synchronising pulses, such separator circuits also sometimes serving to separate the picture signals from the synchronising pulses.

The object of the present invention is to provide an improved pulse separating circuit for separating broad pulses from a sequence of narrow and broad pulses in which the output pulses due to the broad pulses have a sharp leading elge and in which the circuit is capable of discriminating from noise impulses such as are likely to be present in received signals.

According to the invention there is provided an electrical pulse separator for separating narrow and broad pulses comprising a source of narrow and broad pulses, a valve arrangement having electrodes coupled together regeneratively to provide a trigger circuit having at least one stable state and also having two control points, a path for feeding narrow and broad pulses to the first of said points, a separate path including an integrator through which said pulses are fed to said second control point, said integrator being chosen to set up potentials of different amplitudes derived respectively from said narrow and broad pulses and means for biasing said arrangement to cause both control points to rise in potential by substantially the same amount when a broad pulse is present and to enable, with the cessation of a broad pulse, said integrator to cause said second control point to change less rapidly in potential than said first control point, thereby to change the stable state of said valve arrangement to generate an output pulse on the termination of a broad pulse. Preferably said valve is a transistor so that the power consumption of the circuit is very small.

The term "stable state" employed herein includes states in which the circuit can remain permanently and states in which the circuit can remain during some predetermined finite duration, these latter states being usually called "quasi-stable." In the case where one of the states is quasi-stable it will, of course, be appreciated that the duration of the quasi-stable condition should be longer than the interval between the pulses which are to be separated.

In order that the said invention may be clearly understood and readily carried into effect, it will now be more fully described with reference to accompanying drawings

Figure 1 illustrates a circuit embodying the principle of the invention, and

Figures 2, 3 and 4 illustrate practical embodiments of the arrangement shown in Figure 1.

Referring first to Figure 1 of the drawings, which illustrates the principle of the circuit in accordance with the invention, the reference numeral 1 indicates a transistor which is of the point contact type, the base electrode B of which is connected through a base impedance 2 to a positive voltage supply terminal 3. The emitter



electrode E is connected to earth through an emitter impedance 4 which is in the form of a rectifier. The collecting electrode C of the transistor is connected through a collector impedance 5 to a negative voltage supply terminal 6. The base electrode of the transistor which constitutes one control point is also connected through a rectifier 7 to an input terminal 8 to which a sequence of broad and narrow pulses are arranged to be applied. Connected between the input terminal 8 and the emitter electrode E which constitutes a second control point is a rectifier 9 in series with a resistance 10, the point of connection of the resistance 10 to the emitter electrode E being connected to earth through a resistance 11 which is shunted by a condenser 12. The resistance 10 and condenser 12 form an integrator the purpose of which will be hereinafter referred to. The circuit shown in Figure 1, due to the regenerative action of the base electrode impedance 2, is a bi-stable trigger circuit and has two permanent states and when the transistor is non-conducting the emitter electrode E will be at about zero potential, the base electrode B somewhat negative with respect to the positive supply terminal 3 due to the passage of leakage current and the collector electrode C will be at about the potential of the terminal 6. When the transistor is conducting the base electrode B will be at about zero potential and the collector electrode C slightly negative with respect thereto. Neglecting for the moment the presence of the rectifier 9, resistance 10 and condenser 12, it will be appreciated that when a sequence of narrow and broad pulses are applied to the terminal 8 so as to change the potential of the terminal 8 from a negative value to a more positive value compared with the potential of the base electrode B of the transistor 1 when the latter is non-conducting the rectifier 7 is caused to conduct so that the pulses fed through this path raise the base electrode B to a potential more positive than the emitter electrode so that the transistor remains in a non-conducting condition. At the end of an input pulse the rectifier 7 ceases to conduct and the bi-stable circuit would thus remain non-conducting. However, during the occurrence of the pulses at the terminal 8 the rectifier 9 is also caused to conduct and the pulses passed through the rectifier 9, are integrated by the circuit 10 and 12 and applied via this separate path to the emitter electrode E so that the latter is also raised to a positive potential when pulses are present at the input terminal 8 due to charging of the condenser 12. At the termination of a pulse, the rectifier 9 ceases to conduct and the condenser 12 starts to discharge through the resistance 11. When a sequence of broad and narrow pulses are applied to the terminal 8, it will be appreciated that providing each broad pulse has a sufficient duration compared with a narrow pulse the condenser 12 will be charged to a potential above the normal non-conducting potential of the base electrode B of the transistor during a broad pulse but not during a narrow pulse, so that at the termination of a broad pulse when the potential of the base electrode B, i. e. the first control point, falls towards its non-conducting potential, the potential across the condenser 12 will be sufficient to maintain the emitter electrode E more positive than the base electrode B, so that the transistor is rendered conducting and is thereafter rendered non-conducting with the leading positive edge of the next pulse. Thus an output pulse is produced across the collector impedance 5. The circuit shown in Figure 1 is capable of separating the broader pulses from a sequence of narrow and broad pulses and of producing a steep edged output pulse precisely defined in time with respect to the broad pulses. The term "separating" is employed in its usual significance as applied to the frame pulse separator in

television apparatus, since although such separators provide an output only from the frame synchronising pulses, the output is usually of a different shape to the shape of the broad input pulse. Thus in the present invention the output obtained from the broad pulses consists of pulses which are narrow compared with the broad pulses from which they are derived.

Figure 2 of the drawings illustrates a practical circuit embodying the principle shown in Figure 1 and which serves to separate the broad pulses from a sequence of narrow and broad pulses, such as the frame and line synchronising pulses of a television waveform and to provide an output of line frequency pulses and an output of frame frequency pulses. The elements of the circuit shown in Figure 2 which correspond to those shown in Figure 1 are given the same reference numerals. In Figure 2 it will be observed that the emitter electrode E of the transistor is connected through the condenser **12** to earth and the rectifier **4** is connected to earth and to the junction point between the rectifier **7** and the base electrode B of the transistor. The emitter electrode E is also connected through a resistance **13** to the junction point of a pair of resistances **14** and **15** which are connected between the rectifier **7** and the negative voltage supply terminal **6**. With this circuit the potential of the base electrode B of the transistor when the latter is non-conducting is maintained substantially at earth potential or slightly positive with respect thereto by the resistances **14** and **15** which, as will be seen, are in parallel with the leakage path of the transistor. The resistance **13** which, as stated above, is connected to the junction point of the resistances **14** and **15** serves to maintain the emitter electrode E at a negative potential with respect to the potential of the base electrode B when the transistor is non-conducting. For example, the emitter electrode E may be held at a negative potential of about two volts when the supply terminals **3** and **6** are supplied with ten volts respectively. Combined picture and synchronising pulses are applied to the terminal **8** with the picture signals extending in a negative direction. The synchronising pulses extend in the positive direction and serve to cause the rectifier **7** to conduct only when the synchronising pulses are present. The integrating circuit in Figure 2 comprises the condenser **12** and resistance **13** and the potential set up across the resistance **14** is so chosen that the transistor **1** is rendered conducting only when the broad or frame synchronising pulses terminate at the first control point as described in connection with Figure 1. It will be observed from Figure 2 that the rectifier 4 is arranged in the base electrode circuit of the transistor and functions to prevent the potential of the base electrode falling below zero when the transistor is rendered conducting. The output pulses which appear across the collector impedance **5** are thus substantially equal in amplitude to the potential of the supply terminal **6**. In the arrangement show nin Figure 2, the transistor circuit has one permanent and one unstable state (i. e. a quasi-stable state in which the circuit does not remain for a duration as long as the interval between pulses) so that the output pulses which are set up across the collector impedance **5** do not persist until the occurrence of a subsequent synchronising pulse with the result that the same output is obtained on odd and even frames in an interlaced system. Furthermore, in Figure 2 the input pulses applied to the terminal **8** are not required to render the transistor non-conducting so that the load imposed on the circuit feeding the signals to the terminal **8** is less than would otherwise be the case. The separated frame frequency pulses are derived from the terminal **16**, whilst the terminal **17**, which is connected to the base electrode impedance **2**, serves to provide a pulse output free from picture signals which can be employed to synchronise the line frequency scanning oscillator of a television receiver.

If desired, the circuit shown in Figure 2 can be combined as shown in Figure 3, with a further transistor **18**, the emitter electrode E of which is connected to a positive supply terminal **19** through a resistance **20** and to the input terminal **8** through a condenser **21**. The collector electrode C is connected through a resistance **22** to the negative supply terminal **6** and to the rectifier **7** as shown. With the arrangement shown in Figure 3 the transistor **18** operates as a clipper amplifier so as to enable the circuit to function with small amplitude input signals and also serves to re-insert the D. C. component of the signals which is lost when the signals are transmitted through the condenser **21**. Since the picture signals extend in the negative direction as described with reference to Figure 2, the picture signals do not appear in the waveform which is set up across the resistance **22**. The resistance **20** is employed in order to feed current into the emitter electrode of the transistor **18** and to provide a leakage path for the condenser **21**, in order to equalise the output set up across the resistance **22** during the occurrence of line and frame frequency pulses.

Figure 4 of the drawings illustrates a further embodiment of the invention similar to the arrangement shown in Figure 3, in which the transistor **18** is directly coupled to the transistor **1**, thus enabling the resistance **2**, rectifier **7** and resistance **22** of Figure 3 to be omitted, the load for the collector electrode of the transistor **18** being thus constituted by the separator circuit comprising the transistor **1**, and the base electrode impedance of the transistor **1** is the transistor **18** instead of the resistance **2** and rectifier **7** of Figure 3. The circuit shown in Figure 4 can operate satisfactorily with fairly wide changes in the leakage current of the transistors **1** and **18**, since the resistances **14** and **15** cause the terminal **17** to be maintained at about zero potential when the circuit is non-conducting. The circuit will operate with input signals from, for example, less than one volt to tens of volts with no appreciable change in the level of the output.

The circuits shown in Figures 3 and 4 illustrate a manner of feeding signals to the separator circuit shown in Figure 2 from a transistor amplifier, although it will be understood that, if desired, the circuit shown in Figure 2 may be driven from a conventional thermionic valve circuit.

Although the invention has been described above as applied to separators in which the valve employed is a transistor, it will be appreciated that the invention can also be applied to separators in which the transistor is replaced by a thermionic valve or valves arranged to form a multi-vibrator which has two states both of which are quasi-stable or to a flip-flop circuit which has one permanent state and one quasi-stable state or to circuits which have two permanent states.

What I claim is:

1. An electrical pulse separator for separating narrow and broad pulses comprising a source of narrow and broad pulses, a valve arrangement having electrodes coupled together regeneratively to provide a trigger circuit having at least one stable state and also having two control points, a path for feeding narrow and broad pulses to the first of said points, a separate path including an integrator through which said pulses are fed to said second control point said integrator being chosen to set up potentials of different amplitudes derived respectively from said narrow and broad pulses and means for biasing said arrangement chosen to cause both control points to rise in potential by substantially the same amount when a broad pulse is present and to enable, with the cessation of a broad pulse, said integrator to cause said second control point to change less rapidly in potential than said first control point, thereby to change the stable state of said valve arrangement to generate an output pulse on the termination of a broad pulse.

2. An electrical pulse separator for separating narrow and broad pulses comprising a source of narrow and broad pulses, a transistor, a regenerative coupling between

the emitter and collector electrode circuits of said transistor to provide a trigger circuit having at least one stable state, a path for feeding said broad and narrow pulses to the base electrode of said transistor, a separate path including an integrator for feeding said pulses to the emitter electrode of said transistor, said integrator being chosen to set up potentials of different amplitudes derived respectively from said narrow and broad pulses, thereby to cause said transistor to change from its stable state to generate an output pulse on the termination of a broad pulse at the base electrode thereof.

3. An electrical pulse separator for separating narrow and broad pulses comprising a source of narrow and broad pulses, a transistor, a regenerative coupling between the emitter and collector electrode circuits of said transistor to provide a trigger circuit having at least one stable state, a resistive path between the base electrode and the collector electrode, a path for feeding said broad and narrow pulses to the base electrode of said transistor, a separate path including an integrator for feeding said pulses to the emitter electrode of said transistor, said integrator being chosen to set up potentials of different amplitudes derived respectively from said narrow and broad pulses thereby to cause said transistor to change from its stable state to generate an output pulse on the termination of a broad pulse at the base electrode thereof.

4. An electrical pulse separator for separating narrow and broad pulses comprising a source of narrow and broad pulses, a transistor, a regenerative coupling between the emitter and collector electrode circuits of said transistor to provide a trigger circuit having at least one stable state, a resistive path between the base electrode and the collector electrode, a path for feeding said broad and narrow pulses to the base electrode of said transistor, a separate path for feeding said pulses to the emitter electrode of said transistor, said separate path including an integrator comprising a condenser connected between



the emitter electrode and earth and a resistance between the emitter electrode and a point in said resistive path, said integrator being chosen to set up potentials of different amplitudes derived respectively from said narrow and broad pulses thereby to cause said transistor to change from its stable state to generate an output pulse on the termination of a broad pulse at the base electrode thereof.

5. An electrical separator according to claim 2, wherein said pulses are fed to said separator through a transistor amplifier the collector electrode of which is connected to said base electrode of said first mentioned transistor and through an impedance to a source of negative potential whilst the emitter electrode of said amplifier is connected through a further impedance to a source of positive potential thereby to equalise the voltage set up across said impedance connected to the collector electrode during the occurrence of said pulses.

6. An electrical separator according to claim 2, wherein said pulses are fed to said separator through a transistor amplifier the collector electrode of which is directly connected to the base electrode of said transistor of the separator circuit.

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