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MAGNETIC CORE GATE

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FIG. 1

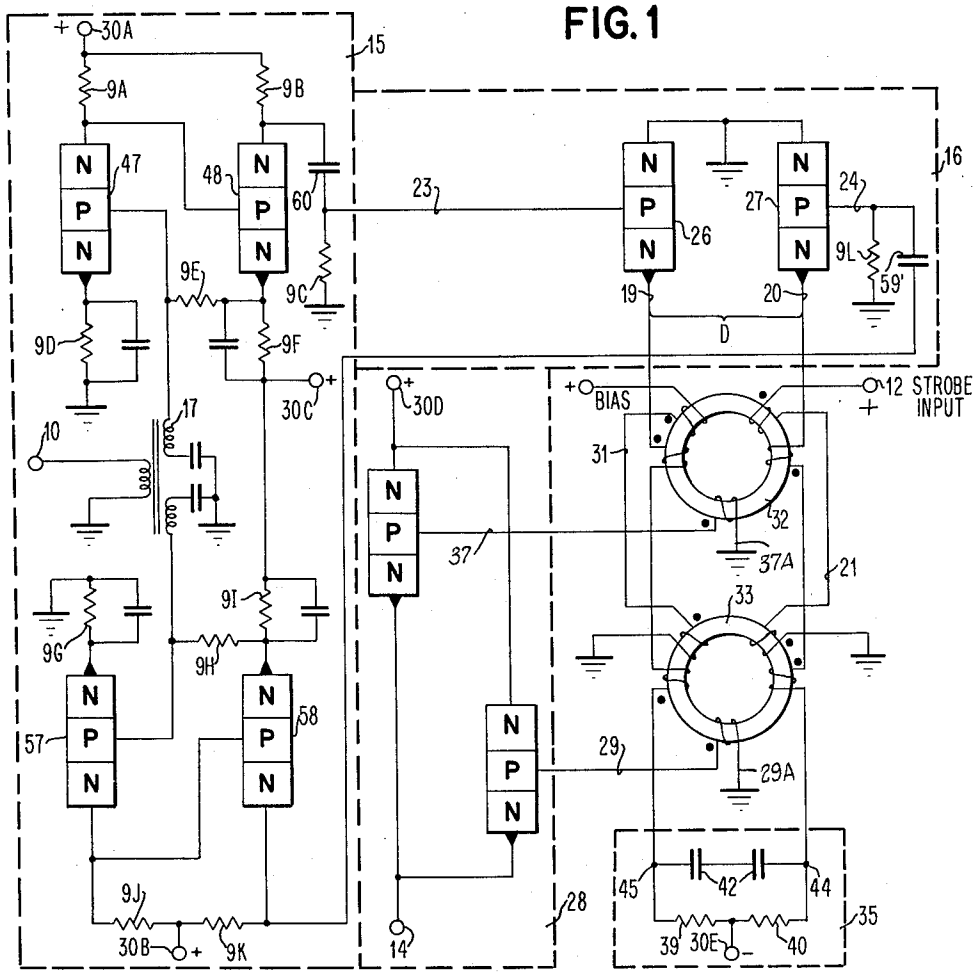
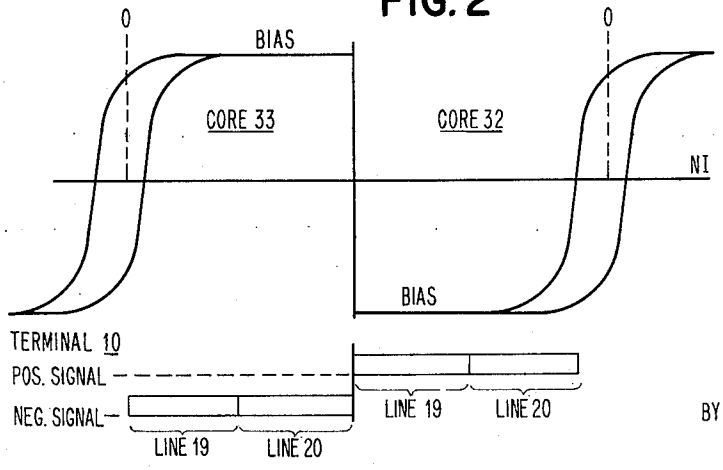


FIG. 2



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MAGNETIC CORE GATE

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This invention relates to electrical circuitry and, more particularly, to magnetic core gating circuitry.

Magnetic core gating circuits in general operate on the principle that certain well known magnetic materials having substantially square hysteresis characteristics can assume two stable magnetic states and that the magnetic state of such a magnetic material may be changed from one stable state to the other by the application of a suitably polarized magnetomotive force to the material.

In general, the magnetic core gating systems shown in the prior art have two drive means for creating magnetomotive forces to be applied to each core and they operate on the principle that a signal on one of the core driving means will not supply enough magnetomotive force to change the state of the core, but that coincident signals on both of the core driving means will supply the required amount of magnetomotive force to change the magnetic state of the core, thereby producing a signal indicative of such change of state in an output winding on said switched core.

The prior art is replete with magnetic core gating circuits of the above type. However, the gating systems shown by the prior art are generally designed to operate in systems wherein the magnitude of any spurious noise voltages is much less than the magnitude of the signal voltages. If no precautions are taken, a large noise signal on one of the drive means could switch a core (whereas the core should only be switched when there is a signal on each of the drive means), thereby producing a false output. Furthermore, the systems shown in the prior art are generally designed to operate with input signals of one polarity only.

The object of the present invention is to provide an improved magnetic core gating system.

A further object is to provide a magnetic core gating system which will not be affected by large noise signals.

A further object is to provide a magnetic core gating system which will give a positive output pulse regardless of the polarity of the input signal.

A further object is to provide a system in accord with the above objects which will be extremely reliable.

Consonant with the above mentioned objectives, a novel magnetic core system is provided wherein the drive means for the magnetic cores are provided with means for limiting the amount of magnetomotive force that can be produced by a signal on one input.

Furthermore, a novel combination is provided whereby a positive output pulse will result irrespective of the polarity of the input signal.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIGURE 1 is a circuit diagram of preferred embodiment of the invention.

FIGURE 2 is a diagram of the hysteresis loops for magnetic cores employed in carrying out the invention.

In the specific embodiment shown, positive and negative voltage signals are received at terminal **10** and gating or strobing pulses are received at terminal **12**. The device shown will produce a positive output at terminal **14** when input signals are simultaneously present at both terminals **10** and **12**.

Circuit **15** is a dual channel balanced (or push pull) feedback amplifier and transformer **17** is a center tapped high frequency transformer which drives the two channels of the amplifier in opposite directions. Hence, any signal input received at terminal **10** will be amplified in opposite directions by the two channels of the amplifier **15** and the signal will appear on lines **23** and **24** as a differential voltage (i.e., the voltage on one line will increase and that on the other line will decrease).

Transistors **26** and **27** in circuit **16** are connected as emitter followers. The differential voltage signals on lines **23** and **24** drive the emitter followers in circuit **16** and these emitter followers in turn differentially drive lines **19** and **20**. Hence, an input signal supplied to terminal **10** will be amplified by circuit **15** and it will appear as a differential current signal on lines **19** and **20** (i.e., a signal at terminal **10** will cause the current in one line **19** or **20** to increase, and it will cause the current in the other lines **20** and **19** to decrease).

The lines **19** and **20** are wound on the magnetic cores **32** and **33**. With respect to each core **32** or **33**, the lines **19** and **20** are oppositely wound; therefore, a decrease in current in one line and an increase in current on the other line produces similar flux changes in each core **32** and **33**, i.e., the effect of differential changes in current in lines **19** and **20** is cumulative in each core (see the bar graph in FIG. 2). The bias winding **31** is wound on the cores **32** and **33** in opposite directions, hence, core **33** is biased to positive saturation and core **32** is biased to negative saturation. The magnetomotive force from the signal windings must exceed the bias before it can switch the cores. The gate or strobe pulse which is supplied to terminal **12** activates line **21** which is wound in opposite directions on cores **32** and **33**. Winding **21** is wound on each core in a direction opposite to that of the bias winding **31**.

The net result of the various directions of the winding is that (*a*) strobe or gate pulses at terminal **12** produce flux in a direction opposite to the bias winding in each core and (*b*) depending on the direction of the voltage differential on lines **19** and **20**, the signals on lines **19** and **20** will produce flux in a direction opposite to the bias winding in either core **32** or **33**. The magnitude of the bias is such that neither a normal signal at the input **10** (which will produce a current differential in lines **19** and **20**) nor a signal at terminal **12** can alone switch either of the cores **32** or **33**. A core will only be switched when signals occur simultaneously at input terminals **10** and **12**. When the state of one of the cores, **32** or **33**, changes, a voltage pulse is produced on one of the output lines **37** or **29**. A voltage pulse on one of the lines **37** or **29** will drive one of the emitter followers in output circuit **28** and the voltage pulse will then appear at terminal **14**. Note that the polarity of the signal at terminal **14** is positive irrespective of the polarity of the signal applied to terminal **10**.

Network **35** serves to prevent a large signal at terminal **10** from creating so large a voltage differential on the drive means comprising lines **19** and **20** that the latter would create sufficient magnetomotive force to switch the

magnetic state of one of the magnetic cores **32** or **33** without any signal being present on line **21**. An exceptionally large signal at terminal **10** will drive one of the lines **23** or **24** sufficiently negative to cut off the associated emitter follower in circuit **16** and the same signal will tend to cause an exceptionally large current flow through the other emitter follower in circuit **16**. As will be explained in detail later, when one of the emitter followers in circuit **16** is cut off, the result is reflected (through circuit **35**) as an increase in the impedance seen by the emitter of the other emitter follower in circuit **16**. The increase in impedance tends to limit the amount of emitter current in the transistor which is conducting, thus preventing one of the lines, **19** or **20**, from alone producing enough magnetomotive force to switch either core **32** or **33**. Since a large noise signal at terminal **10** will cut off one of the emitter followers in circuit **16** and since circuit **35** will prevent the other emitter follower from producing enough current to switch a core, it can be seen that a large noise signal at terminal **10** cannot cause drive means **26** to switch one of the cores **32** or **33** unless drive means **21** is activated by a signal at terminal **12**.

The specific embodiment of the invention shown herein will now be explained in greater detail. The amplifier **15** is a dual-channel balanced (or push-pull) feedback amplifier. Each channel of the amplifier has a pair of NPN transistors connected in a feedback configuration, transistors **47** and **48** forming one channel and transistors **57** and **58** the second channel. The voltage on the emitters of the second transistors **48** and **58** in each channel feedback through their respective resistors **9E** and **9H** to their respective bases of first transistors **47** and **57** in each channel. The feedback makes the transistor amplifier insensitive to temperature and transistor variation and it increases the band width of the amplifier. Input signals of either polarity are supplied to the amplifier **15** through the center tapped pulse transformer **17** which provides an impedance match between the input circuitry and the amplifier. The amplifier **15** supplies a differential voltage output (i.e., as the voltage on one line increases the voltage on the other line decreases and vice versa) on lines **23** and **24**. The amplifier **15** is connected to the emitter follower circuitry **16** by the coupling capacitors **59** and **60**. In the emitter follower circuitry **16**, NPN transistors **26** and **27** respectively receive differential voltage inputs from lines **23** and **24**, and respectively produce differential currents on lines **19** and **20**. The resistors **9A**, **9B**, **9C**, . . . **9L**, **39** and **40** have such values as to establish the appropriate D.C. operating points for the particular transistors which are used. Resistors **9D**, **9F**, **9G** and **9I** have A.C. bypass capacitors connected across their terminals. The use of such capacitors is well known in the art.

The polarity of the voltages applied to terminals **30A**, **30B**, **30C** and **30D** will be positive, and the magnitude of the voltage applied to terminals **30A** and **30B** will be greater than the magnitude of the voltage applied to terminal **30C**. A negative voltage will be applied to terminal **30E**. Naturally, the specific voltages used will depend on the characteristics of the particular transistors which are used.

The magnetic cores **32** and **33** which may be fabricated from one of the well known bistable magnetic materials have windings thereon from the signal lines **19** and **20**, the strobe or gate line **21**, the bias line **31**, and the output windings **37A** and **29A**. For ease in explanation the following definitions of positive and negative windings will be established. Current (flowing from a positive potential to ground) in a winding wound in a positive direction will drive the associated core towards positive saturation, and current carried by a winding wound in a negative direction will drive the associated core towards negative saturation. Naturally, all polarities could be reversed without affecting the operation of the circuit. The direction of the windings is shown in the following table.

	Core 32	Core 33
Line 19	−	+
Line 20	+	−
Bias line 31	−	+
Strobe line 21	+	−
Output	+	+

Since lines **19** and **20** are wound on each core **32** and **33** in opposite directions, the magnetomotive force produced by the steady state currents in lines **19** and **20** cancel; however, when any differential changes in current occur (an increase in one line and an equal decrease in the other line), the effect on each of the cores **32** and **33** from both lines is cumulative. With respect to core **32**, the differential change in the current in lines **19** and **20** which results from a positive signal at input **10** will tend to overcome the effect of the bias winding **31** and therefore it will tend to switch the core whereas this same differential change in currents will push the core **33** further into positive saturation. The differential change in the current in lines **19** and **20** resulting from a negative input pulse at terminal **10** will tend to switch core **33** and to push core **32** further into negative saturation. In order for either core to switch, it is necessary that a positive signal appear on terminal **12** since a current differential in lines **19** and **20** does not produce enough magnetomotive force to overcome the bias produced by line **31**.

Hence, when a positive signal is present on line **21** and either a positive or a negative signal appears at terminal **10**, one of the cores **32** or **33** will be switched. Since the direction of the current differential on lines **19** and **20** depends on the polarity of the signal applied to terminal **10**, the particular core **32** or **33** which is switched depends on the polarity of the signal applied to terminal **10**.

The current limiting action of circuit **35** will now be described in detail. Under normal conditions, as the potential of terminal **44** decreases, the potential of terminal **45** increases and vice versa. The net effect upon the emitter circuit of each transistor in circuit **16** is to make the effective value of the capacitance of capacitor **42** appear to be larger than it actually is, hence, the reactance or impedance of the capacitor **42** appears to be lower than it actually is. For example, viewed from line **19**, a decrease in current on line **20** as the current on line **19** is increasing causes an increase in the charging current of capacitor **42** above the amount of charging current which would be present if the potential of point **44** were fixed. The increase in charging current can be considered as an increase in the effective value of the capacitor or as a decrease in the effective value of the impedance of the capacitor circuit.

However, when one of the emitter followers in circuit **16** is driven to cut off, the associated point **44** or **45** achieves a more nearly static potential. Hence, viewed from the emitter circuit of the other emitter follower in circuit **16**, the impedance of circuit **35** appears to increase. The result is that the current in the emitter circuit of the corresponding transistor is limited. Large noise signals which may appear at terminal **10** are therefore prevented from driving the emitter followers in circuit **16** hard enough to switch one of the cores **32** or **33** when the line **21** is not activated.

The action of circuit **35** could also be explained by realizing that during the normal differential operation of transistors **26** and **27** a dynamic balance exists across points **44** and **45**, essentially eliminating any effect from resistors **39** and **40** upon the transient operation of transistors **26** and **27**. When one of the transistors is cut off, the dynamic balance is destroyed and the resistors **39** and **40** thereafter affect the operation of the

transistor which is still conducting. The effect can be described as an increase of the impedance in the emitter circuit.

If desired, instead of driving one of the transistors to cut off as described herein, the operating points of the transistors could be so established that one transistor would be driven into saturation, thereby affecting the dynamic equilibrium of circuit **35** in a similar manner.

It should be noted that the cores **32** and **33** can be considered as having two drive means. The first drive means is the lines **19** and **20** which together can be considered as one drive means D, since in each core **32** and **33**, both lines in effect produce magnetomotive forces in the same direction. The second drive means for each core **32** and **33** is line **21**, which is connected to terminal **12**.

The magnetic cores **32** and **33** provide output pulses on lines **37** and **29**, one of which is positively pulsed whenever a core switches from the positive to the negative magnetic state. The activation of one of the lines **37** or **29** activates the associated emitter follower in circuit **28**, thereby producing an output pulse at terminal **14**. The output pulse at terminal **14** has a positive polarity regardless of the polarity of the input pulse at terminal **10**.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

We claim:

1. A magnetic core gating system comprising in combination first and second magnetic cores, said cores having positive and negative states of magnetic saturation and adapted to be switched between said states by the application of polarized magnetomotive force, means for biasing the magnetic state of each of said cores to opposite states of saturation, a first core driving means for producing magnetomotive force, said first driving means adapted to drive said first core toward positive saturation and said second core toward negative saturation, a second core driving means for producing magnetomotive force, said second driving means adapted to drive said first core toward negative saturation and said second core toward positive saturation, means for differentially activating said first and second drive means, means for preventing said first and second drive means from together producing enough magnetomotive force to switch the magnetic state of either of said cores, a third drive means for producing magnetomotive force in each core in a direction opposed to the magnetomotive force produced by said bias means whereby said first core will be switched if said third drive means is activated and said first and second drive means are differentially activated in one direction and the second core will be switched if said third drive means is activated and said first and second drive means are differentially activated in the other direction.

2. A magnetic core gating system comprising in combination first and second magnetic cores, said cores having positive and negative states of magnetic saturation and adapted to be switched between said states by the application of polarized magnetomotive force, means for biasing the magnetic state of said cores to opposite states of saturation, a first emitter follower adapted to drive said first core toward positive saturation and said second core toward negative saturation, a second emitter follower adapted to drive said first core toward negative saturation and said second core toward positive saturation, each of said emitter followers having a transistor with an emitter and a load resistor connected to said emitter, means for differentially activating said first and second emitter followers, a capacitor connected between the emitters of said emitter followers, whereby the effective impedance in the emitter of one of said transistors is increased when the other transistor is cut off, a third drive means for producing magnetomotive force in each core in a direction opposed to the magnetomotive force produced by said bias means whereby said first core will be switched if said third drive means is activated and said first and second drive means are differentially activated in one direction and the second core will be switched if said third drive means is activated and said first and second drive means are differentially activated in the other direction.

3. A magnetic core gating system comprising in combination a balanced amplifier having first and second channels, first input means for supplying differential signals to the two channels of said amplifier, two magnetic cores, namely a first core and a second core, each having positive and negative states of magnetic saturation and being adapted to be switched between said states by the application of polarized magnetomotive force, means for biasing said cores to opposite states of magnetic saturation, a first drive means associated with the first channel of said amplifier for producing magnetomotive force, said first drive means being adapted to drive said first core toward positive saturation and said second core toward negative saturation, a second drive means associated with the second channel of said amplifier for producing magnetomotive force, said second drive means being adapted to drive said first core toward negative saturation and said second core toward positive saturation, means responsive to each channel of said amplifier for activating its associated core driving means, means for preventing said first and second drive means from together producing enough magnetomotive force to switch the magnetic state of either of said cores, a third drive means for producing magnetomotive force in each core in a direction opposed to the magnetomotive force produced by said biasing means whereby said first core will be switched if said third drive means is activated and said first and second drive means are differentially activated in one direction and the second core will be switched if said third drive means is activated and said first and second drive means are differentially activated in the other direction.

4. In combination a magnetic core, said core adapted to be switched between positive and negative states of magnetic saturation by the application of polarized magnetomotive force, means for producing magnetomotive force to bias said core to positive saturation, first and second means for producing magnetomotive force, said means adapted to produce magnetomotive force in opposite directions, means for differentially activating said first and second means, means for limiting the amount of magnetomotive force produced by said first and second means to an amount less than that produced by said bias means, third means for producing magnetomotive force opposed to that produced by said bias means, whereby the joint action of said first, second and third means can switch said core to negative saturation.

5. In combination first and second magnetic cores, said cores adapted to be switched between positive and negative states of magnetic saturation by the application of polarized magnetomotive force, means for producing magnetomotive force to bias said first core to positive saturation and said second core to negative saturation; first and second drive means for producing magnetomotive force to be applied to each core, said drive means being adapted to produce magnetomotive force in opposite directions, each drive means producing magnetomotive force in the opposite direction in said first core from the direction of the magnetomotive force produced by said means in the second core, a first input means, means responsive to said input means for differentially activating said drive means, whereby a positive pulse on said input means serves to increase the magnetomotive force produced by one of said drive means and to decrease the amount of magnetomotive force produced by the other drive means and a negative pulse on said input means

has a reverse action, means for limiting the amount of magnetomotive force produced by said first and second drive means to an amount less than that produced by said bias means, a second input means, third means responsive to said second input means for producing magnetomotive force in each core opposite to that produced by said bias means, whereby a positive signal on said first input means coincident with a signal on said second input means will switch one of said cores and a negative signal on said first input means coincident with a signal on said second input means will switch the other core.

No references cited.