MICROWAVE SWITCHING CIRCUITS

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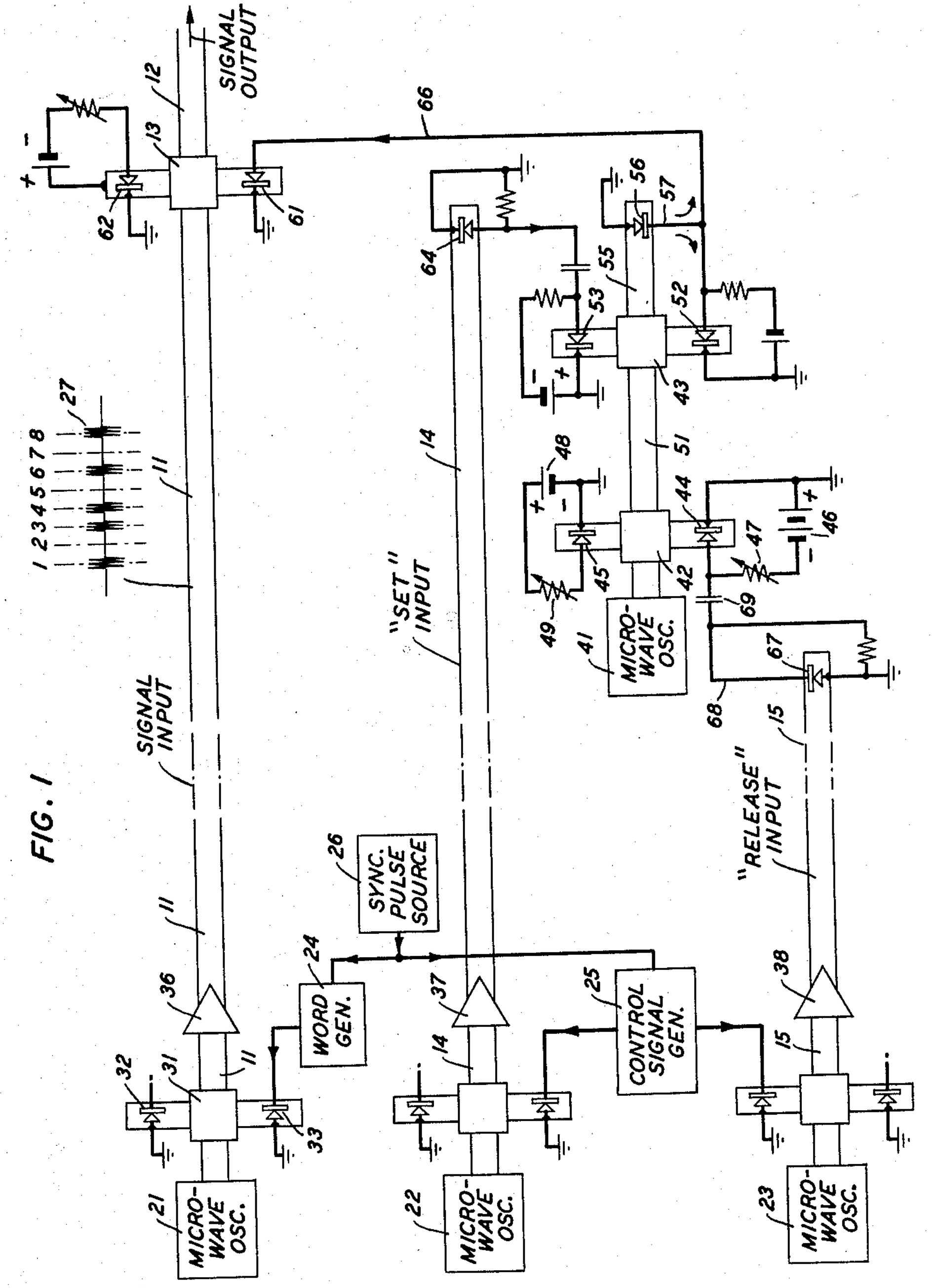

FIG. 1

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MICROWAVE SWITCHING CIRCUITS

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FIG. 2

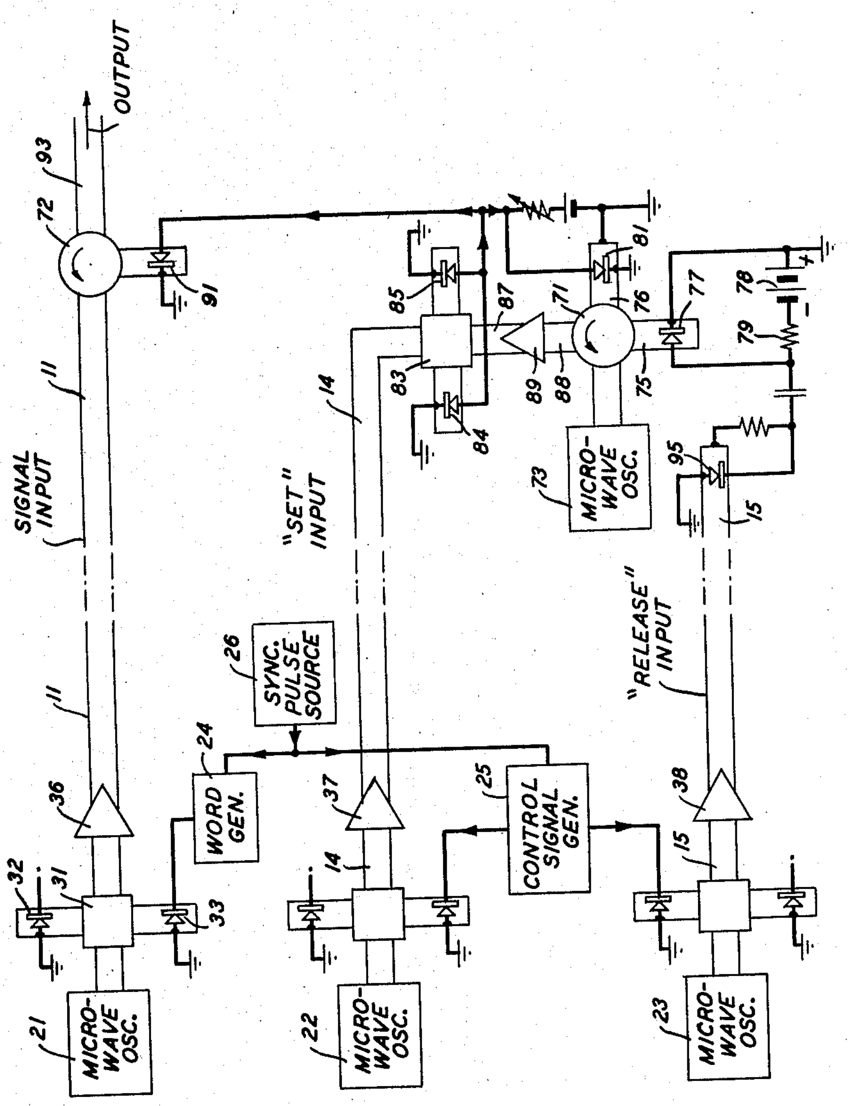

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FIG. 3

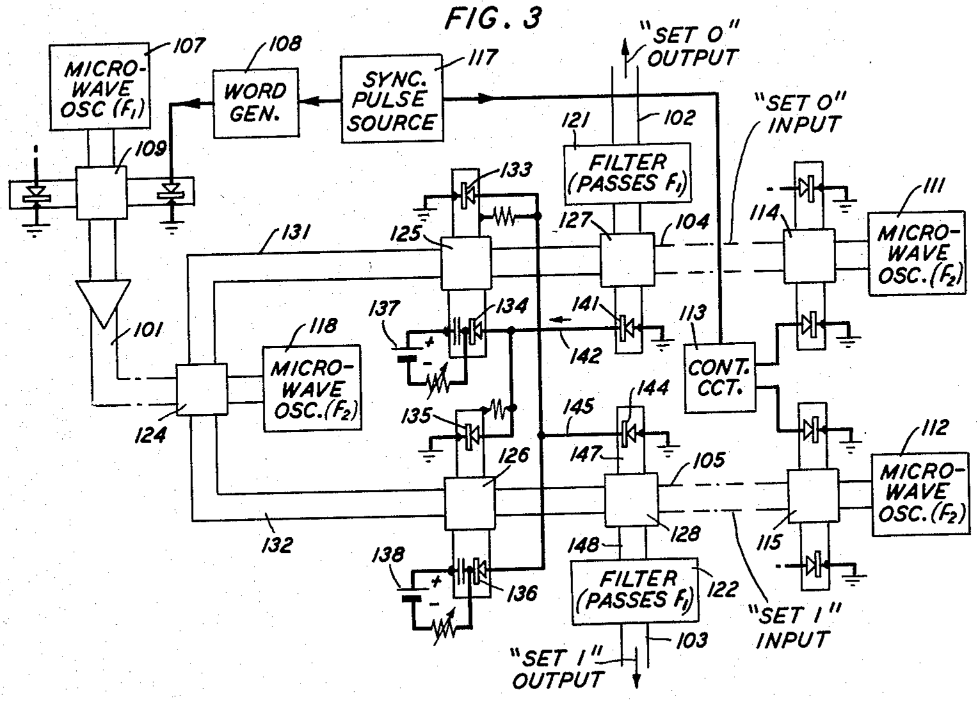
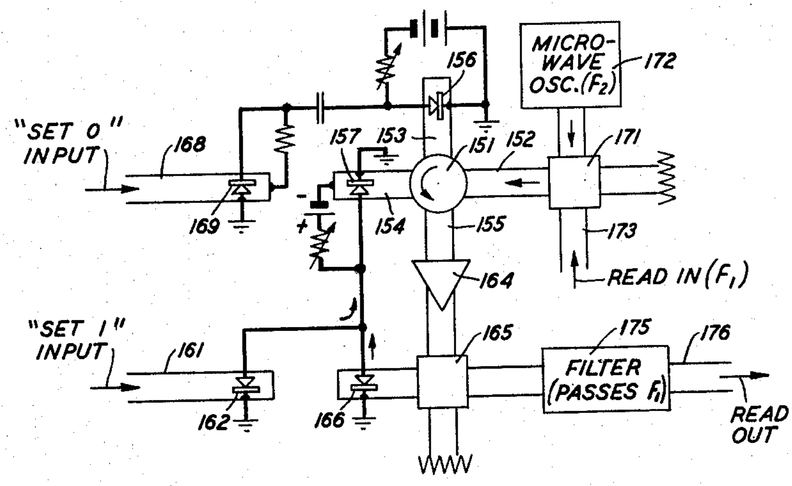


FIG. 4



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MICROWAVE SWITCHING CIRCUITS

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17 Claims. (Cl. 250—27)

The present invention relates to data processing circuits and more specifically to microwave switching and information storage circuitry. In W. M. Goodall, application Serial No. 619,435, entitled "Microwave Data Processing Circuits" and filed on October 31, 1956, a computer or a data processing technology is disclosed in which microwave pulses are employed. The data processing circuits are serial binary circuits, and have pulse repetition rates of up to 50,000,000 to 100,000,000 pulses per second.

In computer and data processing systems, it is desirable to have switching circuits available which may be set to either of two states, and which remain in a given state until reset to another state. In one sense, such circuits are simple binary storage circuits. Bistable multivibrators and lock-up circuits are two well known examples of this type of circuit.

A principal object of the present invention is to provide storage and switching circuits of the type described above for microwave computer systems.

In accordance with the invention, a source of microwave energy is coupled to a wave guide junction which switches the microwave energy from one output to another in accordance with the bias on a control diode in one of the branch wave guides. A detector in one of the two output wave guides is connected to bias the control diode in the sense required to route the microwave energy to the detector. Suitable circuits are also provided to energize the lock-up circuit by applying control signals to the detector or directly to the control diode, and to reset the lock-up circuit by blocking the microwave energy from the detector.

It is a feature of the invention that a microwave lock-up circuit may be realized by the application of control signals from two different sources to the control diode of a microwave switching circuit.

In accordance with another aspect of the invention, a single-pole, double-throw type switch for microwave purposes may be instrumented by the application of microwave signals to two microwave switching circuits including control diodes. The control diodes in the two circuits are interconnected and are energized by a common source or sources.

Other objects, features and advantages of the invention may be readily apprehended from a consideration of the detailed description and from the drawings, in which:

Fig. 1 is a microwave lock-up circuit utilizing hybrid junctions in accordance with one specific embodiment of this invention;

Fig. 2 is a lock-up circuit in which both circulators and hybrid junctions are employed as the switching elements, in accordance with another specific embodiment of this invention;

Fig. 3 is another embodiment of the invention in which microwave input signals are routed to either of two output circuits in accordance with the state of a microwave multivibrator circuit; and

Fig. 4 is another switching circuit in accordance with this invention which circuit may be set to either of two distinct states.

With reference to the drawings, Fig. 1 shows, by way of example, a lock-up circuit and the associated pulse generation circuitry. From an over-all standpoint, the circuit of Fig. 1 is designed to control the transmission of signals from wave guide **11** to the output wave guide **12**. Under normal conditions, no signal is transmitted through the hybrid **13** from wave guide **11** to wave guide **12**. Following an application of a microwave pulse to the "set" pulse input wave guide **14**, however, the hybrid **13** passes signals from wave guide **11** to the output wave guide **12**. This situation continues until a microwave release pulse is applied on wave guide **15**. This restores the switching circuit to its original state, and the hybrid **13** blocks signals applied to it on wave guide **11**.

Turning to a consideration of the detailed circuitry required to accomplish the functions described above, the pulse generation circuits will be reviewed first. The pulse generation circuitry includes the microwave oscillators **21**, **22**, and **23**, the word generator **24**, the control signal generator **25**, and the synchronizing pulse source **26**. The microwave oscillators **21**, **22**, and **23** may, for example, be klystron oscillators, and may have output frequencies of approximately five kilomegacycles. The pulse trains produced by the pulse generation circuits of Fig. 1 have a relatively high pulse repetition rate. For example, the repetition rate of the digits represented by the modulated pulses shown at **27** as associated with wave guide **11** may range from 50,000,000 to 100,000,000 digits per second.

In serial binary computing apparatus, numbers are characteristically represented by a series of pulses. In general, a series of time slots is established, and binary signals are represented by the presence or absence of pulses in successive time slots. The presence of a pulse in a particular time slot or digit period may correspond to the binary symbol "1", and the absence of a pulse may correspond to the binary symbol "0." The pulses representing a single number or code group appear in a group appear in a group of consecutive digit periods which is normally designated a "word period."

Referring to Fig. 1, it has been noted that the modulated pulse pattern **27** is present in wave guide **11**. The pulse pattern **27** represents an eight-digit "word" corresponding to the binary number 10110101. The correspondence between the pulse pattern **27** and the binary number indicated above may be noted from the presence in the pulse train **27** of pulses in digit periods 1, 3, 4, 6, and 8.

The synchronizing pulse source **26** applies pulses to the control signal generator **25** concurrently with the application of pulses to the word generator **24**. The word generator **24** may, for example, include a tapped delay line through which the synchronizing pulses are transmitted. Diode switching circuits connected to taps along the delay line may have their outputs connected in parallel. In accordance with the enabling or disabling of the successive switching circuits connected to the taps of the delay lines, pulses appear in successive digit periods. The direct current pulses from the word generator **24** are impressed on microwave signals from the oscillator **21** in the hybrid junction **31**. The hybrid junction **31** may, for example, be a "magic T" wave guide structure, such as that shown in Fig. 12.4–7 on page 643 of a text entitled "Principles and Applications of Wave Guide Transmission" by George C. Southworth, D. Van Nostrand Co., Inc., New York, 1950. The hybrid junction may also take the form described in an article entitled "Directional Couplers" by W. W. Mumford, Proceedings of the

I.R.E., February 1947, at page 160. Other known hybrid junctions may also be employed.

The diodes **32** and **33** are located in the two arms of one pair of conjugate arms of the hybrid junction **31**. When no bias is applied to the diodes **32** and **33**, microwave energy from the oscillator **21** is reflected equally and in phase from the two crystals, and no microwave energy is coupled to wave guide **11**. However, when pulses from the word generator **24** are applied to crystal **33**, its impedance state is changed with respect to that of diode **32**, and a pulse of microwave energy appears on wave guide **11**. Accordingly, the train of microwave pulses **27** corresponds to the direct current pulses at the output of the word generator **24**. Similarly, microwave control pulses are applied to wave guides **14** and **15**. However, because the control pulses on wave guides **14** and **15** are normally employed to switch complete "words" of information on the signal input wave guide **11**, the control pulses on wave guides **14** and **15** normally occur just before digit period 1, and immediately after digit period 8 of the wave form **27**.

The microwave pulses in wave guides **11**, **14**, and **15** are amplified by the amplifiers **36**, **37**, and **38** which may, for example, be traveling wave tubes. Traveling wave tubes and similar broad-band amplifiers which employ the drift time of electrons to obtain amplification may be employed to amplify the microwave pulses.

The lock-up circuit per se includes the microwave oscillator **41** and the hybrid junctions **42** and **43**. The diodes **44** and **45** are located in two arms of the hybrid junction **42**. The diodes **44** and **45** each have their own biasing circuits, including the voltage source **46** and the resistor **47** connected in series with diode **44**, and the voltage source **48** and resistor **49** connected in series with diode **45**. The two diodes are biased unequally however, so that microwave energy from the oscillator **41** is normally coupled to wave guide **51** and to the hybrid junction **43**. The two crystals **52** and **53** in the control arms of hybrid junction **43** are normally equally biased so that no energy is coupled to wave guide **55**. The detection diode **56** is therefore not energized, and no control signal is developed on lead **57**.

The crystals **61** and **62** associated with hybrid junction **13** are normally biased to present the same impedance. Therefore, in the absence of control signals from leads **57** and **66**, no signal energy is coupled from the input wave guide **11** to the signal output wave guide **12**.

When a microwave "set" pulse is applied to wave guide **14**, however, the detection diode **64** is energized, and a negative pulse is applied to control diode **53**. This increases the negative bias on diode **53**, and changes its impedance state with respect to diode **52**. When diodes **52** and **53** have different impedance states, energy is coupled to the wave guide stub **55** and energizes diode **56**. The energization of diode **56** produces a positive direct current signal on the control lead **57**. This has the effect of biasing diode **52** in the low resistance sense. The impedance state of diode **52** is now significantly different from the normal state of the two diodes **52** and **53**, so that even after the termination of the set pulse applied to wave guide **14**, the diode **56** will remain energized. A positive control pulse on lead **57** is also coupled to diode **61** by the lead **66**. The diode **61** is switched to its low resistance state to unbalance the hybrid junction **13**. Accordingly, signals are transmitted from the input wave guide **11** to the signal output wave guide **12**.

When signals are to be blocked at the hybrid junction **13**, a microwave release pulse is applied to wave guide **15**. The diode **67** produces a positive pulse on control lead **68**, and this is coupled to the diode **44** by condenser **69**. The diode **44** is driven positively, so that it presents the same impedance as diode **45**. When the two conjugate arms of the hybrid **42** which include the crystals are balanced, no signals are transmitted to wave guide **51**. The microwave signals which have been transmitted through hybrid **43** to energize diode **56** are interrupted. Diodes **52** and **53** are then restored to their normal balanced condition. Following the termination of the release pulse on wave guide **15**, microwave signals are again applied to hybrid **43** on wave guide **51**. However, with diodes **52** and **53** in the balanced condition, the microwave signals are blocked from diode **56**.

At the time the diode **56** is de-energized, control signals on leads **57** and **66** are terminated, and the hybrid **13** is restored to its blocking state. No signals are transmitted from input wave guide **11** to the signal output wave guide **12** unitl the arrival of the next subsequent set pulse on wave guide **14**.

The circuit of Fig. 2 performs much of the same function as the circuit of Fig. 1. However, in Fig. 2 switching components of the type known as "circulators" are employed, instead of hybrid junctions. The pulse generation circuitry associated with Fig. 2 is much the same as that associated with Fig. 1. Accordingly, the circuit components up to and including the input wave guides **11**, **14**, and **15** bear the same numbers as the corresponding circuit components of Fig. 1.

The switching circuit of Fig. 2 includes two circulators **71** and **72**. A circulator is a nonreciprocal device which couples electrical signals to successive output terminals. Thus, for example, microwave energy applied to circulator **71** from the microwave oscillator **73** is coupled to the wave guide stub **75**. Microwave energy which may be reflected back from wave guide **75** toward circulator **71** is coupled to the wave guide stub **76**. This is, of course, contrary to the normal reciprocal mode of operation expected of passive wave guide components. The nonreciprocal properties of circulators are normally obtained by the use of magnetized non-conducting material such as the bimetallic ferrites. One typical circulator structure is disclosed in the application of W. M. Goodall cited above.

Considering the mode of operation of the circuits associated with circulator **71** in detail, the diode **77** is normally biased in the high resistance direction by the voltage source **78** and resistor **79**. When the diode **77** is in the high resistance state, it does not block the transmission of microwaves to any appreciable extent. Microwave energy from the oscillator **73** is therefore reflected from the end of the wave guide stub **75** and is coupled to wave guide **76**. The diode **81** in the wave guide stub **76** is normally in the low resistance state to absorb microwave energy applied to wave guide **76**. However, when a set pulse is applied on wave guide **14** to the hybrid junction **83**, the detection diodes **84** and **85** supply a negative pulse to diode **81**. The negative pulse biases diode **81** to the high resistance direction, and microwave signals are coupled to output wave guide **87**.

Signals on output wave guide **87** are amplified by the traveling wave tube amplifier **89** and applied to the hybrid junction **83**. The signals from wave guide **87** continue to energize the crystal detectors **84** and **85** so that a negative control voltage is still applied to diode **81** after the set pulse has terminated.

Control signals from the detectors **84** and **85** are also applied to diode **91** associated with the circulator **72**. The diode **91** is normally in the low resistance state to absorb signals applied to circulator **72** on the input wave guide **11**. However, when negative pulses are applied to it from the crystal detectors **84** and **85**, it is biased in the high resistance state and energy is coupled to the signal output wave guide **93**.

Microwave release pulses on wave guide **15** control diode **77** by positive direct current pulses from the detector diode **95**. The positive direct current pulses bias diode **77** in the low resistance direction so that microwave energy from the oscillator **73** is absorbed in the wave guide stub **75**. This interruption of the microwave signals causes the de-energization of diodes **84** and **85**, and results in the restoration of diodes **81** and **91** to the low resistance or absorbing states. Under these circumstances, signals on wave guide **11** are blocked from wave guide **93**. The arrival of the next subsequent set pulse on wave guide **14**, however, restores the connection between wave guides **11** and **93**.

Fig. 3 shows a microwave equivalent of a single-pole, double-throw switch in accord with a preferred form of the invention. Thus, for example, signals on input wave guide **101** may be coupled either to output wave guide **102** or output wave guide **103**, in accordance with the state of the control circuitry. When a control pulse has been received on the "set 0" input wave guide **104**, for example, input signals on wave guide **101** are coupled to wave guide **102**. Following the receipt of a "set 1" microwave pulse on wave guide **105**, however, input signals on wave guide **101** are routed to output wave guide **103**.

The pulse generation circuitry for Fig. 3 is much like that required for Figs. 1 and 2. Signals from the microwave oscillator **107** are modulated by pulses from the word generator **108** in the hybrid junction **109**. The microwave oscillators **111** and **112** are modulated by signals from the control circuit **113** in hybrid junctions **114** and **115** to provide the "set 0" and "set 1" microwave pulses, respectively. The synchronizing pulse source **117** is employed to control the timing of pulses from the word generator **108** and the control circuit **113**. An additional source of microwave signals **118** is also provided to supply microwave energy for lock-up signal purposes. In view of the presence of both control signals and signal information pulses in the wave guide circuitry of Fig. 3, the microwave oscillator **107** has a different frequency (f_1) than the frequency (f_2) of the microwave oscillators **111**, **112**, and **118**. In addition, the filters **121** and **122** are provided at the output circuits to discriminate against signals having a frequency (f_2) and to pass the signal information pulses which have a frequency (f_1).

Considering the mode of operation of the switching circuit itself in some detail, it will initially be assumed that no input signals are being received on wave guides **101**, **104**, and **105**, and that the circuit is in the "set 0" state. The switching circuit includes five hybrid junctions **124**, **125**, **126**, **127**, and **128**. Microwave signals from the oscillator **118** are coupled to wave guides **131** and **132** by the hybrid junction **124**. Depending on the state of the switching circuit, microwave signals from oscillator **118** are blocked by hybrid **125** and passed by hybrid junction **126**, or vice versa.

The diodes **133** and **134** in the two control wave guide arms associated with hybrid **125** are normally unbalanced. Similarly, the two diodes **135** and **136** associated with hybrid **126** are normally unbalanced. The voltage source **137** is connected to bias diode **134** in the conducting state and to bias diode **135** in the reverse current direction in the absence of additional control signals. In a like manner, voltage source **138** biases diode **136** in the low resistance state, and diode **133** in the reverse current sense.

When a "set 0" microwave pulse is applied to hybrid junction **127**, the detection diode **141** applies a positive direct current pulse to control lead **142**. The application of a positive control pulse to diode **135** changes its impedance to the low resistance state. Diode **135** then presents the same impedance to microwave signals as diode **136**. The hybrid junction **126** therefore blocks signals from the wave guide **132**.

The positive pulse on lead **142** has little effect on diode **134**, as it is already biased in the low resistance direction. With diode **133** biased in the high resistance sense, the hybrid **125** is unbalanced, and signals from the microwave oscillator **118** on wave guide **131** are transmitted to hybrid **127**. After the "set 0" pulse terminates, microwave energy from oscillator **118** is still applied to detection diode **141** to maintain the positive bias on control lead **142**.

When a "set 1" pulse is received on wave guide **105**, however, the detection diode **144** is energized, and applies a positive direct current pulse on control lead **145**. The energization of control lead **145** with a positive direct current signal biases the diode **133** associated with hybrid **125** in the low resistance direction. When diodes **133** and **134** are both in the low resistance state, the hybrid junction **125** is balanced, and no microwave signals are transmitted through it to hybrid junction **127**. With no microwave signals being picked up by detection diode **141** associated with hybrid junction **127**, the control diode **135** resumes its normal impedance state in which it is biased in the reverse current direction. The positive voltage on lead **145** reinforces the action of voltage source **138** in biasing diode **136** in the low resistance direction. Now, with control diodes **135** and **136** in opposite impedance states, the hybrid junction **126** is unbalanced, and microwave signals on wave guide **132** are transmitted to hybrid junction **128**. Microwave signals are then applied to the detection diode **144** so that positive control signals are still applied to control lead **145** even after the termination of the "set 1" microwave pulse on wave guide **105**.

When the switching circuit of Fig. 3 is in the "set 1" state, microwave signals from the oscillator **118** are applied to hybrid junction **128**. Similarly, input pulse signals on wave guide **101** are applied to hybrid junction **124** and are coupled through hybrid junctions **124** and **126** to hybrid junction **128**. All the microwave energy applied to hybrid junction **128** is coupled both to the wave guide stub **147** and to wave guide **148**. However, with microwave oscillator **107** operating at one frequency (f_1) and microwave oscillator **118** operating at a second frequency (f_2), the filter **122** may be adjusted to pass only the desired output signals at the first frequency (f_1) and reject microwave signals having the second frequency (f_2) which originate from the oscillator **118**. Similarly, microwave signals from the input wave guide **101** are coupled to output wave guide **102** during the interval following the "set 0" control signal. The filter **121** performs the same function as filter **122** in blocking the undesired control signals from oscillator **118**.

The circuit of Fig. 4 is another microwave switching circuit which can be set to either of two distinct states. The circuit of Fig. 4 is patterned closely after that of Fig. 2, and operates in much the same manner.

The central switching component of the circuit of Fig. 4 is the circulator **151**. The circulator **151** has an input wave guide **152**, two control wave guide stubs **153** and **154**, and an output wave guide **155**. Signals applied to the circulator **151** on the input wave guide **152** are coupled to the output wave guide **155** if each of the control diodes **156** and **157** in the wave guide stubs **153** and **154**, respectively, is in the high resistance state.

Under normal conditions, diode **156** is in the high resistance state, while diode **157** is biased to the proper low resistance state for absorbing microwave signals. Under these circumstances, microwave energy applied to the circulator **151** from wave guide **152** is reflected from the end of wave guide stub **153** and is absorbed in the wave guide stub **154**. When a "set 1" microwave input pulse is applied to wave guide **161**, a negative pulse is developed by the detection diode **162**. This negative pulse biases the diode **157** to the high resistance state, and energy is reflected back to the circulator **151** and is coupled to wave guide **155**. After transmission through the traveling wave tube amplifier **164**, the output microwave energy is applied to hybrid junction **165**. The detection diode **166** associated with hybrid junction **165** also supplies a negative control voltage to diode **157**. Accordingly, even after the termination of a "set 1" signal on wave guide **161**, the control diode **157** remains in the high resistance state.

As in the lock-up circuit of Fig. 2, the control diode **156** in the first wave guide stub **153** is normally biased in the high resistance state. When a "set 0" input signal is applied on wave guide **168**, however, the detector diode **169** applies a positive pulse to the control diode **156**, and changes its impedance state. In its new low resistance impedance state, control diode **156** absorbs microwave signals applied to wave guide stub **153**, and blocks signals from diode **166**. With diode **166** de-energized, the diode **157** resumes its normal low resistance state. Under these conditions, microwave energy is absorbed in wave guide stub **154** and does not reach wave guide **155** even after the termination of a "set 0" microwave pulse on wave guide **168**.

The input circuitry to the wave guide **152** may include the hybrid junction **171** to which is coupled a microwave oscillator **172**. A wave guide **173** is connected to another input terminal of the hybrid junction **171**. The signals applied on wave guide **173** are at a first microwave frequency (f_1), and the microwave oscillator **172** operates at a second frequency (f_2). At the output from hybrid junction **165**, a filter **175** is provided to block microwave signals of the second frequency (f_2) originally at oscillator **172**, and to pass microwave signals of the first frequency (f_1) from wave guide **173**.

The switching circuit of Fig. 4 is essentially a circuit for storing binary information. When the circuit is in the "set 1" state, the application of a pulse on lead **173** results in an output pulse on wave guide **176**. When the circuit is in the "set 0" state, however, the switching circuit blocks pulses applied to lead **173** and no signals appear at output wave guide **176**.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In a microwave logic system, a microwave switching circuit having at least three arms, detector means in one of said arms, diode means in a second of said arms, a source of microwave signals connected to a third of said arms, said switching circuit normally preventing application of said microwave signals through said switching circuit to said detector means, means for enabling said microwave signals to be applied to said detector means, means connecting said detector means to said diode means for causing said diode means to continue to enable the application of said microwave signals to said detector means, and means for disabling the application of said signals to said detector means to cause said switching circuit to return to its normal state.

2. In a microwave logic system, a microwave switching component having at least three arms, control means including at least one control diode in one of said arms, detector means in another of said arms, means for applying microwave signals to a third of said arms, means connected to said control means for enabling said microwave signals to be applied to said detector means, means connecting said detector means to said control means to cause said control means to continue to enable the application of said microwave signals to said detector means, and means for interrupting the application of said microwave signals to said detector means.

3. In combination, a wave guide switching circuit, an oscillator connected to apply microwave energy to an input of said switching circuit, means including a diode connected in one arm of said switching circuit for switching the microwave output from said switching circuit to a second arm of said switching circuit, a microwave detector connected to said second arm of said switching circuit, additional means for periodically applying microwave signals to said detector, means connecting said detector to said diode for changing the impedance of said diode and switching said microwave energy to said second arm, and resetting means for interrupting the transmission of microwave energy from said oscillator to said detector.

4. In combination, a wave guide switching circuit, an oscillator connected to apply microwave energy to an input of said switching circuit, means including a diode connected in one arm of said switching circuit for coupling the microwave output from said switching circuit to a second arm of said switching circuit, a microwave detector connected to said second arm of said switching circuit, additional means for periodically applying microwave signals to said detector, means connecting said detector to said diode to change the impedance of said diode and thereby to switch said microwave energy to said second arm, resetting means for interrupting the transmission of microwave energy from said oscillator to said detector, an additional wave guide switching circuit including another diode, and means for applying a signal from said detector to said last-mentioned diode to control the switching action of said additional wave guide switching circuit.

5. In combination, a wave guide switching circuit, an oscillator connected to apply microwave energy to an input of said wave guide circuit, means including a diode connected in one arm of said wave guide circuit for switching the microwave output from said wave guide circuit to a second arm of said wave guide circuit, a microwave detector connected to said second arm of said wave guide circuit, means connecting said detector to said diode for changing the impedance of said diode and thereby switching said microwave energy to said second arm, an additional source of microwave signals, means for coupling direct current control signals derived from said microwave signals to said diode, and resetting means for interrupting the transmission of microwave energy from said oscillator to said detector.

6. In combination, a circulator, means for applying microwave energy to one arm of said circulator, a first control diode in a second arm of said circulator, means for applying control signals to said first diode for switching said diode between one impedance state in which signals are absorbed by said second arm of said circulator and another impedance state in which signals are reflected back to said circulator, a second control diode in a third arm of said circulator, and means for switching said second diode between a first impedance state in which signals are absorbed by said third arm and another impedance state in which signals are reflected in said circulator.

7. In combination, a circulator, means for applying microwave energy to one arm of said circulator, a first control diode in a second arm of said circulator, means for applying control signals to said first diode for switching said diode between one impedance state in which signals are absorbed by said second arm of said circulator and another impedance state in which signals are reflected back to said circulator, a second control diode in a third arm of said circulator, means for switching said second diode between a first impedance state in which signals are absorbed by said third arm and another impedance state in which signals are reflected to said circulator, and additional means responsive to wave guide energy reflected back to said circulator from said third arm of said circulator for applying signals to one of said control diodes.

8. In combination, a first wave guide, means for applying binary signals in microwave pulse form to said first wave guide, second and third wave guides, means for applying control signals in microwave pulse form to said second and third wave guides, a microwave switching component connected to said first wave guide, means including a control diode for changing the state of said switching component, means responsive to the application of a microwave pulse to said second wave guide for applying control signals to change the state of said control diode, means for maintaining said control signals

following the termination of the control pulse on said second wave guide, and means for interrupting said direct current control signals in response to the application of a microwave pulse on said third wave guide.

9. In combination, a wave guide switching circuit, an oscillator connected to apply microwave energy to an input of said switching circuit, means including a diode connected in one arm of said wave guide switching circuit for switching the microwave output from said switching circuit from said first arm to a second arm of said switching circuit, a microwave detector connected to said second arm of said switching circuit, additional means for periodically applying microwave signals to said detector, means connecting said detector to said diode for applying control signals to said diode and switching said microwave energy to said second arm, and resetting means for stopping the application of said control signals to said diode.

10. In combination, a wave guide switching circuit, an oscillator connected to apply microwave energy to an input of said switching circuit, means including a variable impedance element coupled to one arm of said switching circuit for switching the microwave output from said switching circuit from said first arm to a second arm of said switching circuit, a microwave detector connected to said second arm of said wave guide switching circuit, additional means for periodically applying microwave signals to said detector, means connecting said detector to said variable impedance element for applying control signals to said element and switching said microwave energy to said second arm, and resetting means for stopping the application of said control signals to said variable impedance element.

11. In combination, a wave guide switching circuit, an oscillator connected to apply microwave energy to an input of said switching circuit, means including a diode connected in one arm of said switching circuit for selectively coupling the microwave output from said switching circuit to a second arm of said switching circuit, a microwave detector connected to said second arm of said wave guide switching circuit, additional means for periodically applying microwave signals to said detector, means connecting said detector to said diode for applying direct current control signals to said diode and for coupling said microwave energy to said second arm, and resetting means for interrupting said direct current control signals.

12. In combination, a first wave guide, means for applying binary signals in microwave pulse form to said first wave guide, second and third wave guides, means for applying control signals in microwave pulse form to said second and third wave guides, a microwave circulator connected to said first wave guide, means including a control diode for changing the switching state of said circulator, means responsive to the application of a microwave pulse to said second wave guide for applying control signals to change the impedance state of said control diode, means for maintaining said control signals following the termination of the control pulse on said second wave guide, and means for interrupting said control signals in response to the application of a microwave pulse on said third wave guide.

13. In combination, a first wave guide, means for applying binary signals in microwave pulse form to said first wave guide, second and third wave guides, means for applying control signals in microwave pulse form to said second and third wave guides, first and second microwave switching components connected to receive microwave energy from said first wave guide, means including control diodes coupled to said first and second switching components for changing the states of said first and second switching components, means responsive to the application of a microwave pulse to said second wave guide for applying direct current control signals to change the impedance states of said control diodes, means for maintaining said direct current control signals following the termination of the control pulse on said second wave guide, and means for interrupting said direct current control signals in response to the application of a microwave pulse on said third wave guide.

14. In a microwave logic system, a microwave switching component having at least three arms, diode means connected to one of said arms, detector means connected to another of said arms, a source of microwave signals connected to a third of said arms, said component normally preventing application of said signals to said detector means, means for causing said signals to be applied to said detector means, means connected between said detector means and said diode means for transmitting detected signals from said detector means to said diode means to cause said component to continue to pass said signals to said detector means, and means for disabling the passage of said detected signals to said diode means to cause said component to return to its normal state.

15. In a microwave logic system, a first wave guide, a source of microwave pulses connected to said first wave guide, a microwave switching component connected to said first wave guide, an output wave guide connected to said component, diode means connected to said component for determining the transmission of said pulses through said component from said wave guide to said output wave guide, a microwave oscillator, a detector, means for applying signals from said oscillator to said detector, means for applying a signal from said detector to said diode means to determine the impedance state of said diode means, first control means including first pulse means for enabling the application of said oscillator signals to said detector, second control means including second pulse means for preventing the application of said oscillator signals to said detector, and means responsive to said first control means for maintaining the application of said oscillator signals to said detector, said last-mentioned means being disabled by said second control means.

16. In combination, a microwave switching circuit, a plurality of wave guides coupled to said switching circuit, means including a diode located in one of said wave guides for changing the state of the switching circuit, first and second control means each including diode means for changing the impedance state of said first-mentioned diode, means responsive to the energization of said first control means for enabling said second control means, and means for disabling said second control means.

17. In combination, a microwave switching circuit, a plurality of wave guides coupled to said microwave swtiching circuit, means including a diode located in one of said wave guides for changing the state of the switching circuit, means for applying binary signals in microwave pulse form through one of said wave guides to said microwave switching circuit, first and second control means each including diode means for changing the impedance state of said first-mentioned diode, means responsive to the energization of said first control means for enabling said second control means, and means for disabling said second control means.

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