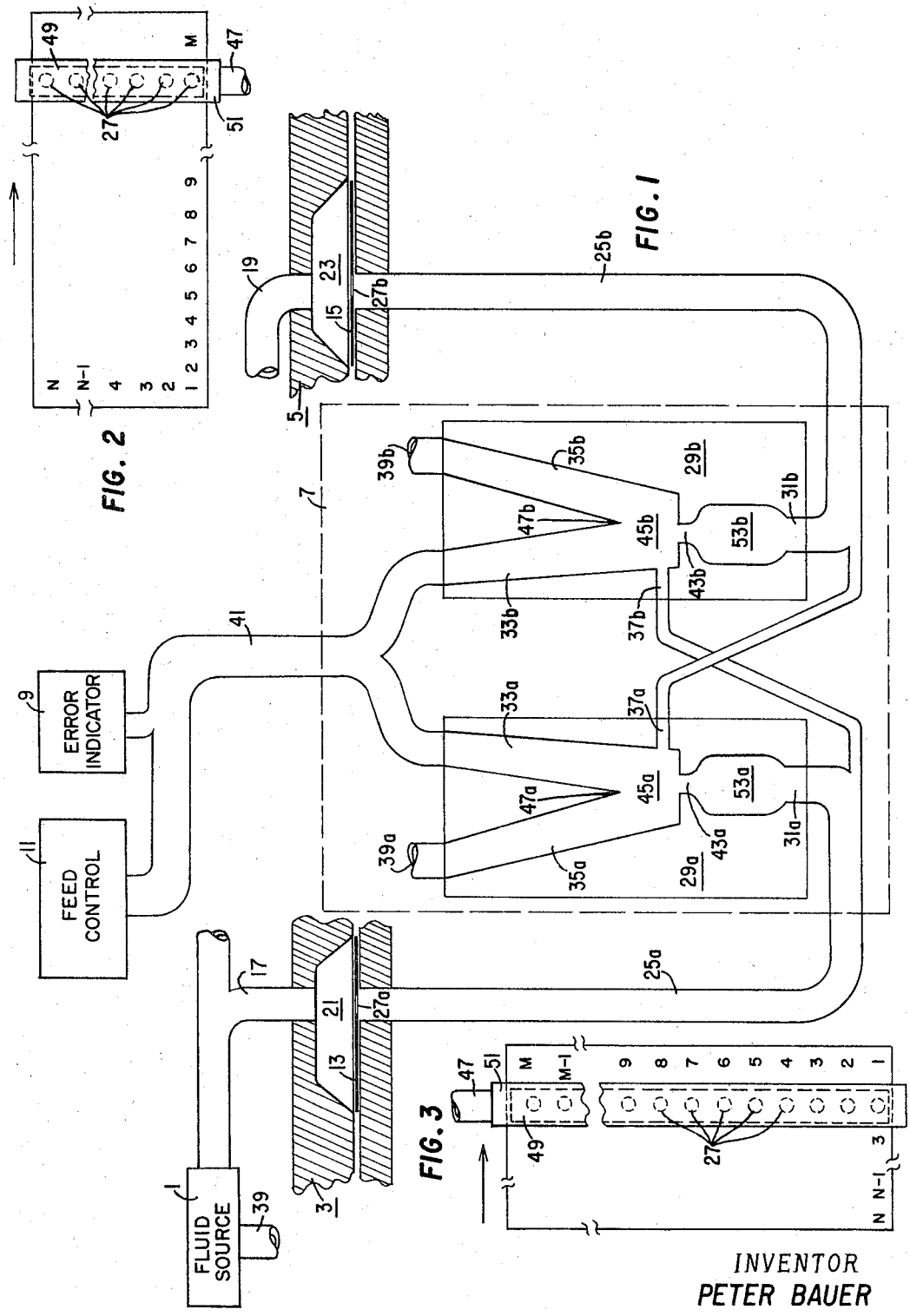
Jan. 17, 1967 P. BAUER 3,299,255

FLUID DATA COMPARATOR

Filed Oct. 18, 1962



INVENTOR
PETER BAUER

BY Griffin and Stokes
ATTORNEYS

United States Patent Office 3,299,255 Patented Jan. 17, 1967

3,299,255

FLUID DATA COMPARATOR

Peter Bauer, Rockville, Md., assignor to Sperry Rand Corporation, New York, N.Y., a corporation of Delaware

Filed Oct. 18, 1962, Ser. No. 231,404
13 Claims. (Cl. 235—61.7)

The present invention relates to fluid operated devices for comparing data-representing indicia recorded on two record media and producing an error indication when the indicia sensed are not equal. More particularly, the present invention relates to pure fluid operated devices for performing the logical function of Exclusive-Or on two digital data signals and producing an output signal when at least one but not both of said signals is present.

Electronic and electromechanical devices for comparing data recorded on two records are well known in the data processing art. However, these devices are expensive and in many instances require a considerable number of electronic and mechanical parts. An object of the present invention is to provide pure fluid operated devices for performing data comparison, said devices being relatively inexpensive and having no moving parts other than the fluid working medium.

An object of the present invention is to provide first and second record sensing means for sensing the indicia on two records and producing a fluid signal if said indicia are of one kind, first and second single-sided pure fluid amplifiers each having a power stream input, a control stream input, and an output, means for applying the output signals from one of said sensing means to the power stream input of said first amplifier and the control stream input of said second amplifier, and means for applying the output signals from the other of said sensing means to the control stream input of said first amplifier and the power stream input of said second amplifier. The arrangement of the control and power stream inputs is such that a power stream flows into the output of one of said amplifiers only when one but not both of the sensed indicia are of said one kind.

A further object of this invention is to provide two fluid amplifiers having a common output channel, said amplifiers being responsive to the same two fluid input signals for producing a fluid signal in the output channel only upon the occurrence of one of said input signals concurrently with the absence of the other of said input signals.

Another object of the invention is to provide two fluid amplifiers connected as described in the preceding paragraph in combination with fluid operated sensing means for sensing the indicia carried by two records, said sensing means producing said two fluid input signals whereby the presence of a signal in the common output channel indicates that the sensed indicia are not of the same kind.

A further feature of the invention is the provision of a pure fluid operated device for performing the Exclusive-Or logical function on first and second signals, said device comprising first and second pure fluid amplifiers each having means responsive to a fluid signal for producing a power stream, output channel means for normally receiving said power stream, and control signal input means responsive to a fluid signal for deflecting a power stream into a path whereby it is not received by said output channel means; means responsive to said first signal for applying fluid signals to said power stream producing means of said first amplifier and said control signal input means of said second amplifier; and means responsive to said second signal for applying fluid signals to said power stream producing means of said second amplifier and said control signal input means of said first amplifier whereby the truth of the Exclusive-Or logical function is manifested by the presence of power stream flow into one of said output channel means. The output channel means may be connected to an error indicating device to indicate an error condition when the logical function is true.

Other objects of the invention and its mode of operation will become apparent upon consideration of the following description and the accompanying drawings in which:

FIGURE 1 shows a simplified embodiment of the invention;

FIGURE 2 illustrates an alternate arrangement for sensing a record; and

FIGURE 3 illustrates still another arrangement for sensing a record.

Referring now to FIGURE 1, a simplified embodiment of the invention comprises a fluid source **1**, first and second record sensing stations **3** and **5**, a pure fluid operated Exclusive-Or circuit **7**, an error indicator **9**, and a feed control mechanism **11**.

Feed control mechanism **11** includes the circuits and conveying means for moving record media **13** and **15** through the sensing stations **3** and **5**. The particular feed control mechanism employed depends upon the type of record media being sensed. If record media **13** and **15** are record cards one type of feed control mechanism is required while a different type of feed control mechanism is required if the record media are punched tapes. For purposes of the following description it is assumed that the record media **13** and **15** are punched cards but it should be understood that the present invention is equally applicable for comparing data recorded on punched tapes.

Fluid source **1** continuously supplies fluid through pipes **17** and **19** to cavities **21** and **23** in each sensing station. Fluid source **1** may be a pump or compressor and preferably includes a pressure regulator of conventional design such that the fluid is applied to channels **17** and **19** at a substantially constant pressure. As shown in FIGURE 1, the cavities **21** and **23** are immediately above the feed paths of the record cards and form openings immediately above the record cards. These openings are of substantially the same dimensions as the records being sensed so that all possible recording positions in the cards may be sensed simultaneously.

The record media **13** and **15** bear coded data-representing indica elements. These indicia elements may be of a first kind, that is, a punched hole, or of a second kind, that is, the absence of a punched hole.

Although FIGURE 1 illustrates the sensing of only one predetermined location in each record card to determine the kind of indicia recorded thereat, it will be obvious to those skilled in the art that in actual practice the data may be represented by a plurality of indicia elements recorded according to the binary coded decimal, Baudot, Morse or other suitable code.

As shown in FIGURE 1, each sensing station has a fluid conducting element **25** which may be a pipe, duct or channel. One end of pipe **25***a* terminates an orifice **27***a* underneath chamber **21** and record **13** with the orifice being positioned to sense the presence or absence of a hole at a single position on the record. In like manner, one end of pipe **25***b* terminates at an orifice **27***b* to sense the presence or absence of a hole at a single position in record **15**. The other ends of pipes **25***a* and **25***b* are connected to the pure fluid operated Exclusive-Or circuit **7**.

The Exclusive-Or circuit comprises first and second pure fluid amplifiers **29***a* and **29***b* each of which has a power stream input channel **31**, a first output channel **33**, a second output channel **35** and a control signal input channel **37**. Channel **25***a* is connected to power stream input channel **31***a* and a control signal input channel **37***b* while

channel 25*b* is connected to power stream input channel 31*b* and control signal input channel 37*a*. The channels 35 may exhaust into the surrounding atmosphere or may be connected by means of channels 39 to the fluid return side of the fluid source. Channels 33*a* and 33*b* are connected to a common output channel 41 which conducts error signals to the error indicator 9 and the feed control mechanism 11.

Amplifiers 29*a* and 29*b* are shown as being made of a clear plastic material for the sake of clarity. However, the amplifiers may be made of ceramic, metallic or other material and constructed in accordance with any one of several techniques known in the art. For example, each amplifier may be made of two plates or flat pieces of material. The desired channel configuration is molded, etched, cut or otherwise formed in the face of one plate and this surface is then closed or covered with a second plate to form a substantially solid and fluid-tight body having the desired configurations of channels for defining paths of fluid flow.

Amplifier 29*a* functions as follows. A fluid power stream applied to input channel 31*a* passes through orifice 43*a* and enters chamber 45*a*. The cross-sectional area of the orifice is less than the cross-sectional area of the power stream channel 31*a* so that the power stream enters chamber 45*a* as a high velocity jet stream. The design of chamber 45*a* is such that a power stream emerging from the orifice 43*a* in the absence of a control stream from channel 37*a* passes through chamber 45*a* and flows into output channel 33*a*. This may be accomplished in any one of several ways such as, for example, offsetting dividing element 47*a* to one side of the path of the power stream or by rounding off the right edge of orifice 43*a*.

When a power stream is applied to power stream input channel 31*a* and a control stream is applied to control stream input channel 37*a*, the power stream jet flows into output channel 35*a*. The power stream emerges from orifice 43*a* into the chamber 45*a* as described above. However, the control signal applied to control signal input channel 37*a* creates a fluid control jet stream which enters chamber 45*a* and strikes the power stream jet so that it is deflected to the left of dividing element 47*a* and flows into output channel 35*a*.

Fluid amplifier 29*b* functions in a similar manner. That is, a power stream applied to power stream input channel 31*b* emerges from orifice 43*b* as a high velocity jet stream and in the absence of a control signal flows into channel 33*b*. When a fluid control signal is applied to control signal input channel 37*b* is creates a control jet stream which strikes the power jet and deflects it into the output channel 35*b*.

The present invention compares the indicia recorded in a predetermined position in record 13 with the indicia recorded in a predetermined position in record 15 as follows. The records 13 and 15 are moved into sensing position as shown and fluid source 1 applies fluid under pressure to the chambers 21 and 23. There are four possible conditions which may occur. Cards 13 and 15 may both have holes punches therein, neither card 13 nor 15 has a hole punched therein, card 13 contains a hole but card 15 does not, or card 15 contains a hole but card 13 does not.

Consider first the case where neither card contains a hole. In this case the fluid from fluid source 1 enters chambers 21 and 23 but because of the absence of holes in the cards 13 and 15 this fluid cannot enter the channels 25*a* and 25*b*. As a result, no fluid signals are applied to the Exclusive-Or circuit and no fluid flows in its output channel 41.

Consider now the second case where cards 13 and 15 both have holes punched therein. Fluid from source 1 passes through channel 17, chamber 21, the hole in card 13, channel 25*a*, and enters power stream input channel 31*a* and control stream input channel 37*b*. At the same time, fluid from source 1 flows through channel 19, chamber 23, the hole in card 15, channel 25*b*, and enters power stream input channel 31*b* and control signal input channel 37*a*. Thus, the hole in card 13 results in a power stream in amplifier 29*a* and a control stream in amplifier 29*b* while the hole in card 15 results in a power stream in amplifier 29*b* and a control stream in amplifier 29*a*. The control stream from channel 37*a* deflects the power stream of amplifier 29*a* so that it flows into output channel 35*a*. In like manner, the control stream emerging from channel 37*b* deflects the power stream of amplifier 29*b* so that it flows into output channel 35*b*. Since both power streams have been deflected away from the channels 33, there is no flow through the output channel 41 of the Exclusive-Or circuit.

Consider now the case where there is a hole in card 13 but no hole in card 15. The indicia are not equal so it is desired to produce fluid flow in channel 41 to set the error indicator 9. The hole in card 13 permits flow from source 1 to flow into channel 25*a* to create a power stream jet in amplifier 29*a* and a control stream jet in amplifier 29*b*. Since there is no hole in card 15 there is no fluid flow in channel 25*b* to create a power stream in amplifier 29*b* or a control stream in amplifier 29*a*. As a result, the power stream emerging from orifice 43*a* flows into output channel 33*a* and from there it flows through channel 41 to indicator 9 and feed control mechanism 11.

At this point is may be noted that error indicator 9 may be one of the many types known in the art and may, for example, comprise a conventional bistable pure fluid amplifier having an output channel connected to a mechanical flag. The fluid signal flowing in channel 41 may also be conveyed to the feed control mechanism for the purpose of stopping card feeding until the source of error has been determined. If the feed control mechanism includes electrical circuits obviously the fluid signal in channel 41 may be converted to an electrical signal by a pressure-operated electrical switch of conventional design. After the source of error has been determined, the machine operator may apply a reset signal through a keyboard (not shown) to reset the error indicator and restart the feeding operation.

Consider now the case where card 15 contains a hole at the position being sensed and card 13 does not contain a hole. Fluid from source 1 passes through the hole in card 15 and flows through channel 25*b* to create a power stream jet in amplifier 29*b* and a control stream jet in amplifier 29*a*. However, because there is no hole in card 13 there is no fluid flow through channel 25 to create a power stream jet in amplifier 29*a* or a control stream jet in amplifier 29*b*. As a result, the power stream emerging from orifice 43*b* flows through channel 33*b* and output channel 41 to set the error indicator and stop at the card feed operation.

In the preceding description it has been assumed that chambers 21 and 23 are of sufficient size to apply pressure to the entire surface of the records underneath them but that only one position in each card was being sensed. Obviously, every possible indicia location on each card may be sensed simultaneously if a sufficient number of channels 25*a* and 25*b* and Exclusive-Or circuits 7 are provided. Each position being sensed requires a channel 25*a*, a channel 25*b* and an Exclusive-Or circuit 7. The outputs of all of the Exclusive-Or circuits may be applied to the error indicator 9 and the feed control 11.

Although simultaneous sensing of all indicia locations on a card is the fastest, it requires MN Exclusive-Or circuits where M is the number of card columns and N is the number of possible positions in a column where indicia may be recorded.

FIGURE 2 shows an arrangement wherein the time required for sensing is M times as great but only N Exclusive-Or circuits are required. In this arrangement fluid from a fluid source is applied through a channel

47 to a chamber 49 in a sensing head 51. Chamber 49 has an opening adjacent the card feed path which extends across the width of the card and is at least as wide as orifices 27. There are N orifices, one for each possible indicia position in a single column of the record. Although not shown in FIGURE 2, each orifice is connected by a fluid conducting channel to one input of an Exclusive-Or circuit. A similar sensing arrangement is provided for sensing a second record to provide a second input to each of the Exclusive-Or circuits. In FIGURE 2 the record moves from left to right with N indicia locations being sensed on each sensing operation. After M sensing operations all indicia locations on the record have been sensed.

FIGURE 3 shows a different arrangement particularly suited for sensing punched cards. The corresponding indicia position in each column is sensed simultaneously to produce fluid signals which enter orifices 27. This arrangement requires M Exclusive-Or circuits but all indicia locations in the card may be sensed in N sensing operations.

Referring again to FIGURE 1 it will be obvious to those skilled in the art that certain timing considerations must be taken into account to prevent the error indicator 9 from being set when, in fact, no error exists.

Consider the case where cards 13 and 15 are sensed and both have holes punched therein. If the fluid flowing in channel 25*a* creates a power stream jet in amplifier 29*a* before the fluid flowing in channel 25*b* creates a control stream jet in the amplifier, the power stream jet enters output channel 33*a* and flows through channel 41 to set the error indicator even though the recorded indica are the same. Also, if the fluid flowing in channel 25*b* creates a power stream jet in amplifier 29*b* before the fluid flowing in channel 25*a* creates a control stream jet in the amplifier, the power stream jet enters channel 33*b* to give a faulty error indication.

These conditions may be overcome by providing artificial delays which delay the production of the power stream jets until after the control stream jets have begun to flow. This can be accomplished by providing power stream input channels which are longer than control stream input channels. Alternatively, chambers forming fluid capacitances may be provided in each power stream input channel. This latter method is illustrated in FIGURE 1 wherein chambers 53 are formed by enlarging the power stream input channels.

It is intended therefore to be limited only by the scope of the appended claims.

I claim:

1. A digital data comparator comprising: first means selectively operable in response to a first sequence of data signals for producing first and second fluid jet streams; second means selectively operable in response to a second sequence of data signals for producing third and fourth fluid jet streams; output channel means for normally receiving said first and third fluid jet streams, said second and fourth jet streams being directed against said third and first jet streams respectively to deflect said third and first jet streams away from said output channel means whereby a jet stream is received by said output channel means only upon the presence of a data signal in one of said sequences concurrently with the absence of a data signal in the other of said sequences.

2. A digital data comparator as claimed in claim 1 wherein said first means includes fluid conducting means terminating at first and second orifices and a source of fluid for applying fluid to said fluid conducting means to produce said first and second fluid jet streams at said first and second orifices, said fluid conducting means having a discontinuity at a point intermediate said source and said orifices, said first sequence of data signals comprising holes punched in a record medium movable through said discontinuity to selectively permit the flow of fluid from said source to said first and second orifices.

3. A digital data comparator as claimed in claim 2 wherein said second means includes second fluid conducting means terminating at third and fourth orifices and a source of fluid for applying fluid to said second fluid conducting means to produce said third and fourth fluid jet streams at said third and fourth orifices, said second fluid conducting means having a discontinuity at a point intermediate said source and said orifices, said second sequence of data signals comprising holes punched in a record medium movable through said discontinuity to selectively permit the flow of fluid from said source to said third and fourth orifices.

4. A pure fluid operated device comprising first and second fluid amplifiers; means for selectively producing first and second fluid signals; means responsive to said first fluid signal for producing a power stream in said first amplifier; means responsive to said second fluid signal for producing a power stream in said second amplifier; output channel means in each of said amplifiers for normally receiving the power stream produced therein; control signal input means responsive to said first fluid signal for producing a control signal in said second amplifier to deflect the power stream therein away from the output channel means; and control signal input means responsive to said second fluid signal for producing a control signal in said first amplifier to deflect the power stream therein away from the output channel means whereby power stream flow into either of said output channel means indicates that said first and second signals are not present simultaneously.

5. A pure fluid operated device as claimed in claim 4 and further including means connected to both of said output channel means and responsive to power stream flow therein for indicating the concurrent presence of one of said first and second signals and the absence of the other.

6. A pure fluid operated device as claimed in claim 4 and further including second output channel means for each of said amplifiers for receiving power streams deflected by said control signal input means.

7. A pure fluid operated device as claimed in claim 6 wherein each of said amplifiers has an interaction chamber formed by the intersection of its two output channels, said power stream producing means and said control signal input means including fluid channels terminating at orifices in said chamber.

8. A data comparator for comparing data recorded on first and second record media wherein each bear coded data in the form of indicia of a first or a second kind, comprising in combination: means for sensing a predetermined location on said first record medium and producing first and second fluid streams upon sensing an indicia of said first kind thereat; means for sensing a predetermined location on said second record medium and producing third and fourth fluid streams upon sensing an indicia of said first kind thereat; output channel means for normally receiving said first and third fluid streams, said second and fourth fluid streams being directed against said third and first fluid streams, respectively, to prevent said third and first fluid streams from being received by said output channel means; and means responsive to fluid flow into said output channel means for producing an error signal indicating that the indicia sensed at said predetermined locations are not the same kind.

9. A pure fluid operated device for performing the logical function of Exclusive-Or on first and second fluid signals, said device comprising: means responsive to said first fluid signals for producing first and second fluid jet streams; means responsive to said second fluid signal for producing third and fourth fluid jet streams; output channel means for normally receiving said first and third fluid jet streams, said second and fourth jet streams being directed against said third and first jet streams, respectively, to deflect said third and first jet streams away from said output channel means whereby said output channel means

receives said first jet stream only when said first but not said second fluid signal is present and receives said third jet stream only when said second but not said first fluid signal is present.

10. A digital data comparator for sensing data recorded on first and second record means wherein each bear coded data in the form of indicia of a first or a second kind comprising: first and second pure fluid amplifiers, each of said amplifiers having a power stream input channel, first and second output channels and a control signal input channel, said channels intersecting whereby a power stream emerging from said power stream channel normally flows into said first output channel but flows into said second output channel in response to a control signal applied to said control signal input channel; first and second sensing means for sensing predetermined indicia positions in said first and second record means, respectively, said first sensing means being connected to the power stream input channel of said first amplifier and the control signal input channel of said second amplifier and operative upon sensing the presence of an indicia of said first kind for applying a fluid signal thereto, and said second sensing means being connected to the power stream input channel of said second amplifier and the control signal input channel of said first amplifier and operative upon sensing the presence of an indicia of said first kind for applying a fluid signal thereto; and means responsive to fluid flow in one of said first output channels for indicating that the indicia sensed at said predetermined positions are not of the same kind.

11. A pure fluid operated device for performing the Exclusive-Or logical function on first and second fluid signals, said device comprising: first and second pure fluid amplifiers, each of said amplifiers having a power stream input channel, first and second output channels and a control signal input channel, said channels intersecting whereby a power stream emerging from said power stream channel normally flows into said first output channel but flows into said second output channel in response to a control signal applied to said control signal input channel; means for applying said first fluid signal to said power stream input channel of said first amplifier and said control signal input channel of said second amplifier; means for applying said second fluid signal to said power stream input channel of said second amplifier and said control signal input channel of said first amplifier; and means responsive to power stream flow into either of said first output channels for producing a signal indicating that only one of said first and second fluid signals is present.

12. A comparator comprising: first means selectively operable in response to a first signal for producing first and second fluid jet streams; second means selectively operable in response to a second signal for producing third and fourth fluid jet streams; output channel means for normally receiving said first and third fluid jet streams, said second and fourth jet streams being directed against said third and first jet streams, respectively, to deflect said third and first jet streams away from said output channel means whereby a jet stream is received by said output channel means only upon the presence of one of said first or second signals concurrently with the absence of the other of said first or second signals.

13. A comparator as claimed in claim **12** wherein said first and second means include first and second delay means for delaying the production of said first and third fluid jet streams, respectively, until after said second and fourth fluid jet streams have begun.

No references cited.

MAYNARD R. WILBUR, *Primary Examiner.*

J. I. SCHNEIDER, *Assistant Examiner.*