Jan. 7, 1969 J. A. MACHMER 3,420,254

PNEUMATICALLY SAMPLED SERIALIZER

Filed June 30, 1965 Sheet 1 of 2

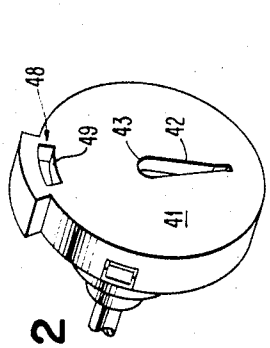


FIG. 2

FIG. 1

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FIG. 3

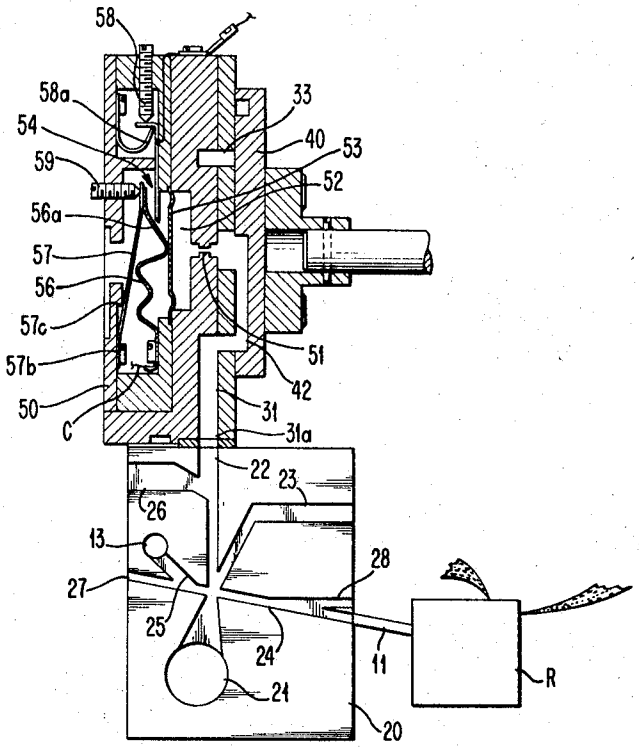
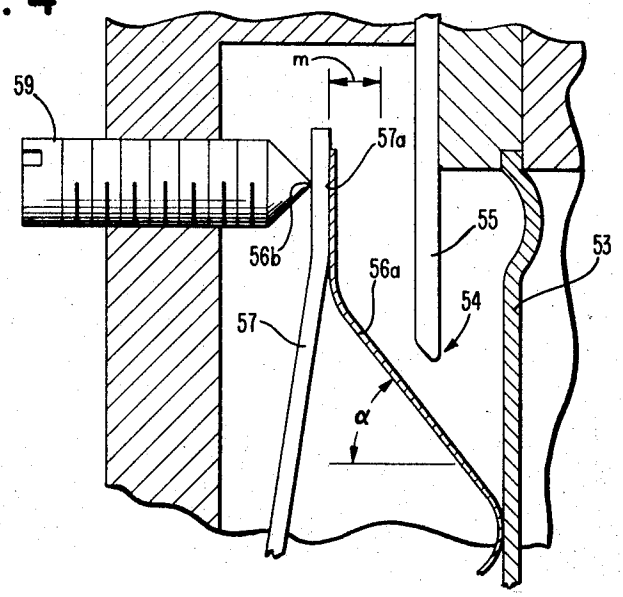

58
58a
54
59
56a
57
56
57c
57b
50
C
33
40
53
52
51
42
31
31a
22
23
26
13
27
25
24
21
20
28
11
R

FIG. 4


59
m
57a
56b
55
53
56a
54
57
α

United States Patent Office 3,420,254
Patented Jan. 7, 1969

3,420,254

PNEUMATICALLY SAMPLED SERIALIZER

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Filed June 30, 1965, Ser. No. 468,217
U.S. Cl. 137—81.5 10 Claims
Int. Cl. F15c 3/04

ABSTRACT OF THE DISCLOSURE

Pneumatic signalling pulses are reliably converted into electrical pulses by a diaphragm operated switch provided with a combination of fluid damping and a dual spring rate support for an electrical contact. The fluid signal pulses are derived from a mechanical distributor that sequentially samples the output of a plurality of pure fluid latches to provide for serial transmission of data having parallel significance.

Disclosure of the invention

The serializer of my invention employs a single sophisticated fluid-to-electric transducer in combination with a novel fluid commutator mechanism to achieve low cost reliable conversion of parallel data signals into serial form.

Coded space-mark data is employed in both serial and parallel form by various data handling mechanisms. Typewriters, tape readers, and similar local mechanisms usually operate on data in parallel form, whereas communications systems and computers find it more convenient to handle data in serial form, thus minimizing the number of data conduits which must be provided. Interfacing a parallel data handling system with a serial data handling system requires some mechanism for serializing or converting the data from one form to the other. Serializing mechanism is ordinarily required to inject synchronizing data commonly in the form of start and stop bits to permit the mechanism receiving the serial data to properly recognize the data channels of a received signal.

Existing serializing mechanism commonly takes the form of electric commutation, or more commonly electronic shift registers which are controlled by a precise time base. Existing systems, however, require a basic electronic power supply in addition to the electronic elements for performing the serializing function. In a system such as a wholly mechanical, or mechanical and pneumatic system, where an electronic power supply does not exist, the cost of the electronic serializer mechanism becomes prohibitive.

Accordingly, it has been an object of my invention to provide comparatively low cost reliable serializing mechanism for use particularly in systems lacking a separate electronic power supply.

Another object of my invention has been to provide serializing mechanism for use in a pneumatic or other fluid data handling system.

A further object of my invention has been to provide a versatile and inexpensive fluid-to-electric transducer for converting high frequency fluid pulses into electrical signals of precisely controllable duration.

One concept of my invention relates to the use of pure fluid latches or similar fluid actuated and fluid controlling bistable devices for temporary storage of data presented in parallel, together with a rotating fluid sampling commutator that is driven by a synchronous motor. The synchronous motor, usually available for other purposes, defines a convenient time base. The commutator sequentially delivers data representative fluid pulses to a single transducer for generating electrical output signals. By this concept it becomes practical to provide a highly reliable transducer without unduly adding to the overall cost of the mechanism.

Another concept of my invention involves the use of a specific pneumatic sampling commutator that sequentially engages coplanar sampling ports in a face-to-face relationship, thus providing an especially simple construction from both a parts manufacturing and assembly standpoint.

Another concept of my invention involves the particular fluid-to-electric transducer wherein a combination of fluid damping by a restricted orifice, and dual spring rate support for an electric contact, provides a rapid bounce-free circuit control that is readily and precisely adjustable to permit accurate equalization of ouput signal length.

The foregoing and other objects, concepts and advantages of my invention will be apparent from the following specific description of a preferred embodiment thereof wherein reference is made to the accompanying drawings of which:

FIGURE 1 is a partially exploded perspective view of a serializer constructed according to my invention as operatively connected with a typical schematically shown data source;

FIGURE 2 is a perspective view of a part of the mechanism shown in FIGURE 1 showing a surface construction that does not appear in FIGURE 1;

FIGURE 3 is a cross-sectional elevational view of the mechanism shown in FIGURE 1 and taken along line III—III thereof, and

FIGURE 4 is an enlarged cross-sectional view of a portion of FIGURE 3 illustrating some specific construction details thereof.

In FIGURE 1 there is shown a partially exploded perspective view of a serializer or converter S constructed in accordance with this invention. The serializer S is shown constructed to receive information from a typical data source such as a tape reader R that generates fluid data pulse signals in fixed channel parallel "space-mark" coded form, and convert the code into serial-form including, if desired, synchronizing start and stop bits. The path of data flow may be traced from the source R to data storage block **10** through parallel fluid channels or signal input conduits **11**, then through distributor block **30**, serially through rotating commutator **40** to fluid-electric transducer **50** and to electrical output conductor C.

Data storage block 10

The data storage block **10** is made up of a plurality of bistable, fluid actuated, fluid output devices that preferably take the form of pure fluid latches **20** of the construction shown in FIGURE 3. Each latch **20** includes a supply portion or air source **21** that delivers a gaseous jet to either of two output conduits **22** or **23**. The output conduits **22** are positioned along straight line **12** for ease of communication with the distributor block **30**.

The latch **20** is constructed according to known principles whereby the jet, once established in flow through one of the output conduits **22** or **23**, will remain in that output conduit until an input signal is received to switch it to the other output conduit. Switching signals in the form of fluid pulses are applied to data signal conduit **24** and to reset conduit **25** to respectively enter and clear data from storage. Overload or dump conduit **26** is provided to prevent reswitching of the fluid jet which might be induced due to loading by the relatively closed passageway presented by the serializer mechanism. Also, suitable vents **27** and **28** are provided to insure that the

latches **20** will be bistable. The signal conduits **11** from the tape reader R are connected individually to the conduits **24** of the respective latches **20**. As shown for convenience, the presence of fluid flow in a conduit **11** indicates a "space" signal and the absence of flow indicates a "mark" signal. The latches **20** normally direct flow through output conduit **23**. A "space" signal received in a conduit **11** switches the output flow from conduit **23** to conduit **22**. The reset conduits **25** are supplied from a common manifold **13** formed in the storage block **10** and having an inlet **14** (FIGURE 1) communicating externally of the storage block and conveniently aligned with latch output conduits **22**.

One latch **20** is provided in the storage block **10** for each channel of the parallel input code and in addition a latch **15** is provided to generate a "start" bit having flow pressure characteristics similar to those of the latches **20**. Start bit latch **15** is generally identical to latches **20**, but has no reset conduit **25** or vent **27**. The asymmetric lack of venting causes the latch **15** to produce a continuous flow or "space" signal at its output **22**.

Distributor block 30

The distributor block **30** is formed with internal fluid flow signalling pathways **31** that communicate individually by inlets **31***a* with output conduits **22** and terminate at their other end in a sampling port **33** formed in an enclosure plate **32**. All of the sampling ports **33** lie in a common plane at the surface of the closure plate **32**, and on a common circular arc **34** that is centered about an axis **35**.

In addition to signalling pathways **31**, the distributor block contains a reset control pathway **36** having a supply portion **36***a* that continuously receives fluid from a port **16** connected to supply portion **21** and a delivery portion **36***b* that is fluidly connected to reset manifold **13** through inlet **14**. The supply portion **36***a* terminates in an outlet port **36***c* and the delivery portion commences with an inlet port **36***d*, both of which preferably lie in the plane of sampling ports **33**.

The distributor block **30** also includes a "stop bit" port **37** that is located on arc **34** and in the plane of the sampling ports **33**. The "stop bit" port **37** is vented to atmosphere at **38** through the distributor block **30** to provide a "mark" signal having a characteristic similar to that generated by the latches **20**.

Rotating commutator 40

The commutator **40** is rotatable about axis **35** and has an operating surface **41** that abuts or effectively lies in the plane of sampling ports **33**. The operating surface **41** includes an elongated slot or conduit means **42** extending radially from an outlet portion **43** adjacent axis **35** to beyond arc **34** to provide sequential communication with the sampling ports **33**. The fluid received by slot **42** from sampling ports **33** is delivered to a center bore or supply portion **44** in the distributor block **30**.

The commutator **40** is driven at a predetermined rate by a timing shaft **45** when connected thereto by single revolution clutch **46** that is activated cyclically by an electromagnet **47** each time data is presented to the storage block **10**. The timing shaft **45** is driven by a synchronous motor (not shown) of the type that would be available in the reader R or other basic mechanical apparatus.

The commutator **40** also includes valve means **48** provided by an open-sided bridging slot **49** in the operating surface **41** for controlling fluid communication between ports **36***c* and **36***d* of the reset pathway **36**. The location of slot **49** is such as to permit flow through pathway **36** at the end of each cycle.

Transducer 50 (FIGURE 2)

Signal fluid received by bore **44** is delivered through a flow rate limiting metering orifice **51** into an enclosed variable volume chamber **52**. A diaphragm or other movable wall **53** defines one end of chamber **52** and moves in response to flow into and out of the chamber.

The diaphragm **53** operates an electric switch **54** to generate an output signal in conductor C. The switch means **54** is shown as normally closed to provide a "mark" signal when no signal fluid is supplied to bore **44**. Obviously, the principles of the switch construction can be applied to a normally open switch if desired. The switch means **54** includes a substantially rigid electrical contact member **55** mounted adjacent the diaphragm **53** and an electrical contact member **56** that is operatively connected in a force transmitting relationship with the diaphragm **53** for bidirectional movement therewith through a range *m* by a biasing resilient leaf spring **57**. The movable contact member **56** is itself resilient and has an elongated contact surface **56***a* that is oriented at an angle α of about 45° to the direction of relative movement between the contact members **55** and **56**. The acute angle orientation permits limited relative sliding movement between the contact members at one extreme of the movement range *m* to assure complete bounce-free contact action and to permit a controlled length contact closure. Bounce of the contact is eliminated by the frictional dissipation of energy between the contact members and by permitting the storage of energy only in the moving contact member **56**. The length of contact closure is controlled by fixed-contact adjusting screw or stop **58** that positions the contact member **55** in opposition to return spring **58***a*.

The length of the "space" signal or contact open time is also made adjustable to permit accurate time-balancing of the "mark" and "space" signals. "Space" length adjustment is accomplished by limiting the movement range *m* by adjustable stop or limit screw **59** and permitting limited relative movement between the contact members **55** and **56** after the stop **59** has been reached. The stop **59** engages a point **57***a* on the contact supporting leaf spring **57** that is substantially coincident with the point of engagement between the spring **57** and the contact member **56**. The leaf spring **57** is mounted on one end in fixed end support **57***b* and normally flexes about point **57***c*. When spring **57** encounters stop **59** it becomes ineffective and further movement of the diaphragm **53** is opposed by the greater spring resistance of low mass spring contact **56** that acts against diaphragm **53** through a very short lever arm. This action has two beneficial effects. First, it softens the stopping force with the stop **59** to prevent bounce, and second it permits controllable distribution of the total transmitted energy between the low effective spring rate of spring **57** and the higher effective spring rate of the contact **56** itself. This latter effect permits the storage of some controlled amount of motion that must be returned and thus gives the bit controlled length, but with a minimum of stored energy and inertia effects.

Operation of the mechanism thus described is as follows. Prior to each operating cycle, all latches **20** are in their reset state and the jet from source **21** flows out conduit **23**. The commutator **40** is positioned to connect chamber **52** with atmospheric vent **38**, thus allowing switch means **54** to be closed. When the tape reader R generates pneumatic pulses in conduits **11** in accordance with a particular punched code read in parallel, it generates a short transmit cycle signal which is applied to magnet **47** to pick clutch **46** and initiate clockwise rotation of the commutator **40**. Pulses in conduits **11** set respective latches **20** causing flow out of associated sampling ports **33**. The slot **42** in commutator **40** first traverses the sampling port **33** of the pathway **31** associated with the start bit latch **15** which, as indicated above, is always in the "space" state. A fluid pulse is, therefore, transmitted to the transducer **50** through the slot **42**. The rate of fluid flow into chamber **52** is limited by restriction **51**, thus controlling the rate of leftward movement of diaphragm **53** and contact member **56**. The first motion of flexible con-

tact member **56** does not cause separation from rigid contact member **55**. Further movement, however, does cause separation to initiate generation of an electrical "space" signal. Continued movement brings the support spring **57** into contact with stop **59** and effectively reducing, but not eliminating, the flexibility of parts opposing further movement of diaphragm **53** to permit limited further movement thereof.

Slot **42** is rotated into communication with the next succeeding sampling port **33** at a predetermined time governed by the synchronous motor drive of shaft **45**. If a "mark" signal is called for, the sampling port will be at substantially atmospheric pressure, thus providing a vent for chamber **52**. Flow from the chamber **52** and diaphragm velocity is limited by restriction **51** and movement of the contact member **56** follows in reverse, the sequence spelled out above. Any remaining tendency to bounce is eliminated by sliding of contact portion **56***a* against rigid member **55**. The relative length of mark and space signals is thus controllable by stops **58** and **59** which determines the amount of limited arrested motion permitted at both ends of movement range *m*. Continued rotation of the commutator **40** brings the radially outward end of slot **42** into serial communication with each of the sampling ports **33** until all have been traversed. After a single revolution of the commutator **40**, clutch **46** will stop rotation, positioning slot **49** across ports **36***c* and **36***d* to communicate reset fluid manifold **13**, thus preparing the latches **20** to receive a second input.

Those skilled in the art will appreciate that I have provided a pneumatic data serializer employing pneumatic latches as storage elements to supply a pneumatic commutator with parallel data to be converted by commutation to serial data in the form of pneumatic pulses. It will also be understood that I have provided an improved fluid-electric pulse transducer for converting individual pulses into precise controllable squarewave electrical output pulses. While specific preferred structure has been shown herein for purposes of illustration, it will be understood that the principles of my invention are not limited thereto, and that various modifications can be made within the scope of this invention as set forth in the appended claims.

I claim:

1. Apparatus for converting data in parallel space-mark coded form having a fixed plurality of channels into serial electrical coded form comprising:

a plurality of bistable devices, each having a fluid output indicative of its existing operational state, there being one bistable device for each of the parallel channels and individually associated therewith to operate in its respective stable state in response to "space" and "mark" information in its associated channel,

a fluid-electric transducer for converting a fluid signal into an electric signal,

conduit means cooperable with said transducer and said fluid output of each of said bistable devices for providing individual communication therebetween, and

means operable to cause a predetermined timed sequential cooperation of said conduit means with each of said bistable devices.

2. Apparatus as defined in claim **1** wherein said fluid-electric transducer comprises:

a variable volume chamber having at least one movable wall and a fluid signal supply portion connected to said conduit means,

metering orifice means in said supply portion for limiting the rate of flow into said chamber,

a substantially rigid electrical contact member mounted adjacent said movable wall,

a low mass, resilient movable electrical contact member assembled in a force transmitting relationship with said movable wall for movement therewith between extremes of a range of movement, and resilient means supporting said movable contact member in position to engage said rigid contact member at one of said extremes,

one of said contact members having an elongated contact surface portion that is oriented at an acute angle relative to the direction of movement of said movable contact member to permit substantial relative movement between said contact members while they are in mutual engagement.

3. Apparatus as defined in claim **2** wherein said resilient support means comprise an elongated leaf spring fixedly supported adjacent one end thereof and connected at a first position along its length distal from said one end to said movable contact member for urging said movable contact member towards said movable wall, and further comprising

an adjustable stop positioned to engage said leaf spring substantially at said first position when said movable contact is in the other of said range of motion extremes.

4. Apparatus for converting data in parallel space-mark coded form having a fixed plurality of channels into serial electrical coded form, comprising:

a plurality of bistable pure fluid latches, each having a fluid output conduit for either supplying or not supplying fluid flow according to its existing operational state, there being one fluid latch for each of the parallel channels and individually associated therewith to operate in its respective stable states in response to "space" and "mark" information in its associated channel,

a fluid-electric transducer for converting a fluid signal into an electric signal,

conduit means cooperable with said transducer and said fluid output conduit of each of said pure fluid latches for providing individual communication therebetween, and

means operable to cause a predetermined timed sequential cooperation of said conduit means with each of said fluid latches.

5. A fluid-electric transducer responsive to a source of bi-level fluid information compirsing: conduit means fluidly connected to said source of fluid information,

a variable volume chamber having at least one movable wall and a fluid signal supply portion fluidly connected to said conduit means,

metering orifice means in said supply portion for limiting the rate of flow into said chamber,

a substantially rigid electrical contact member mounted adjacent said movable wall,

a low mass, resilient, movable electrical contact member assembled in a force transmitting relationship with said movable wall for movement therewith between extremes of a range of movement, and positioned to engage said rigid contact member at one of said extremes, and

one of said contact members having an elongated contact surface portion that is oriented at a small angle relative to the direction of movement of said movable contact member to permit substantial relative movement between said contact members while they are in mutual engagement.

6. A fluid-electric transducer as defined in claim **5** wherein said support means comprises an elongated leaf spring fixedly supported adjacent one end thereof and connected at a first position along its length distal from said one end to said movable contact member for urging said movable contact member toward said movable wall, and

an adjustable stop positioned to engage said leaf spring substantially at said first position when said movable contact is in the other of said range of motion extremes.

7. Apparatus for converting data in parallel space-mark coded form having a fixed plurality of channels into serial electrical codded form comprising:

a first plurality of bistable devices, each having a fluid output indicative of its existing operational state, there being one bistable device for each of the parallel channels and individually associated therewith to operate in its respective stable state in response to "space" and "mark" information in its associated channel,

individual flow pathways, individually fluidly connected to the fluid output of said bistable devices, each pathway terminating in an end portion that lies on a common circular arc,

a fluid-electric transducer for converting a fluid signal into an electric signal, and

a commutator rotatable about an axis coincident with the center of said circular arc and having conduit means therein for sequentially cooperating with said end portions of said pathways during rotation of said commutator, said conduit means having an outlet portion in fluid communication with said transducer for delivering the fluid flow received sequentially from said pathways to said transducer.

8. Apparatus as defined in claim 7 further comprising:

means for resetting said bistable devices to a common state comprising a fluid pathway for delivering a reset fluid signal to each of said bistable devices and valve means carried by said commutator and cooperable with said pathway for selectivity permitting flow of reset fluid to said bistable devices when said commutator is positioned in a predetermined angular position.

9. Apparatus for converting data in parallel space-mark coded form having fixed plurality of channels into serial electrical coded form comprising:

a data storage block having a plurality of bistable fluid latch flow control means formed therein, each fluid latch having a fluid output conduit communicating externally of said block, all of said fluid output conduits lying substantially in a straight line along one edge of said block,

signal input means for selectively setting at least some of said fluid latches individually according to "space-mark" data,

a distributor block having a plurality of input conduits,

a plurality of flow pathways corresponding in number to the output conduits of said storage block, formed in said distributor block and having inlets communicating externally thereof corresponding in position to the output conduits of said storage block, each of said pathways terminating in a sampling port positioned along a common circular arc, said sampling ports communicating externally of said distributor block and lying in a common plane,

a bore extending along the axis of said arc through said distributor block,

a commutator rotatable about said axis and having an operating surface lying substantially in the plane of said sampling ports, said commutator extending outwardly radially from said axis to beyond said circular arc and further including a radially extending open edged slot formed in said operative surface and extending between said bore and said arc to provide fluid communication between individual sampling ports of said distributor block and said bore, and

fluid-electric transducer means fluidly connected to said bore for converting fluid pulses supplied therefrom into electrical signals.

10. Apparatus as defined in claim 9 wherein

each of said fluid latches includes a reset conduit for resetting the associated latch to a common state,

said data storage block includes a manifold fluidly communicating with each of said reset conduits,

said distributor block includes a reset pathway having a supply portion continuously connected to a source of fluid flow and terminating in an outlet lying in the plane of said sampling ports and a delivery portion in fluid communication with said reset manifold and having an inlet lying in the plane of said sampling ports, and

said commutator further includes an open-sided bridging slot for connecting said outlet and inlet portions of said reset pathway when said commutator is in a single angular position relative to said distributor block.

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U.S. Cl. X.R.

200—83; 235—201