United States Patent

Whetstone

[15] **3,647,962**

[45] **Mar. 7, 1972**

[54] **KEYBOARD ENCODING**

[72] Inventor: **Albert L. Whetstone**, Southport, Conn.

[73] Assignee: **Science Accessories Corporation**, Southport, Conn.

[22] Filed: **July 30, 1970**

[21] Appl. No.: **59,449**

[52] **U.S. Cl.** ....178/17 C

[51] **Int. Cl.** H04l 17/12

[58] **Field of Search** ....178/17 C, 17 D, 17 R, 18, 79; 325/106, 107; 340/365

[56] **References Cited**

UNITED STATES PATENTS

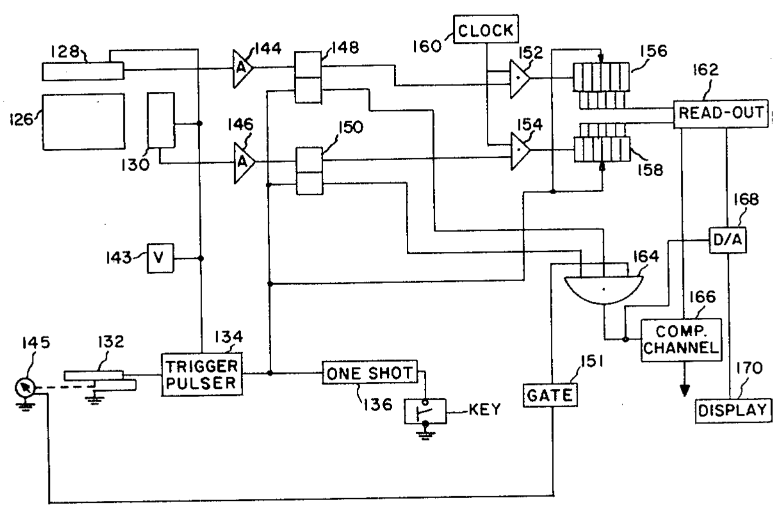
3,568,183	3/1971	Snell	178/17 C
3,176,263	3/1965	Douglas	178/18
3,134,099	5/1964	Woo	178/18

Primary Examiner—Kathleen H. Claffy
Assistant Examiner—Horst F. Brauner
Attorney—Frank R. Trifari

[57] **ABSTRACT**

This invention relates to a keyboard encoding device for converting the data represented by a key in a keyboard to a digital representation. The device employs a plurality of keys each individually operable to provide an acoustic shock wave in the form of a spark. Receptors arranged about the perimeter of the keyboard respond to the leading edge of the shock wave. The time period between generation of the spark and reception thereof by the shock wave receptor is digitized by means of a counting device responsive to the initiation of the spark and to the receipt of the shock wave by the receptor. Since each key is uniquely locatable with respect to the receptor, each key will produce a spark at a location which will take differing amounts of time to reach their receptor. The various digitization of these times are indicative or representative of the information attributed to each key respectively.

8 Claims, 8 Drawing Figures



Patented March 7, 1972 3,647,962

4 Sheets-Sheet 1

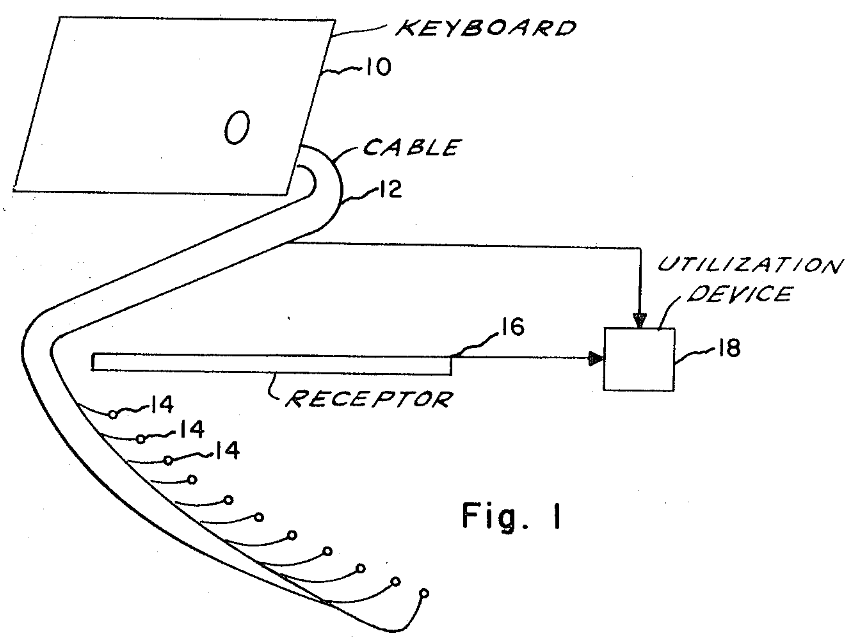


Fig. 1

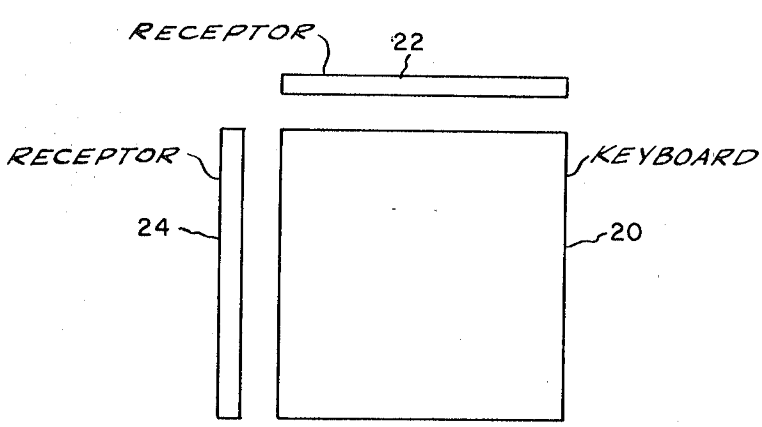


Fig. 2

INVENTOR.
ALBERT L. WHETSTONE

BY

AGENT

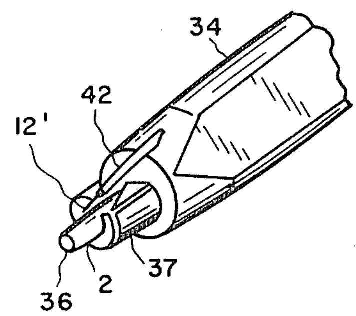


Fig. 2A

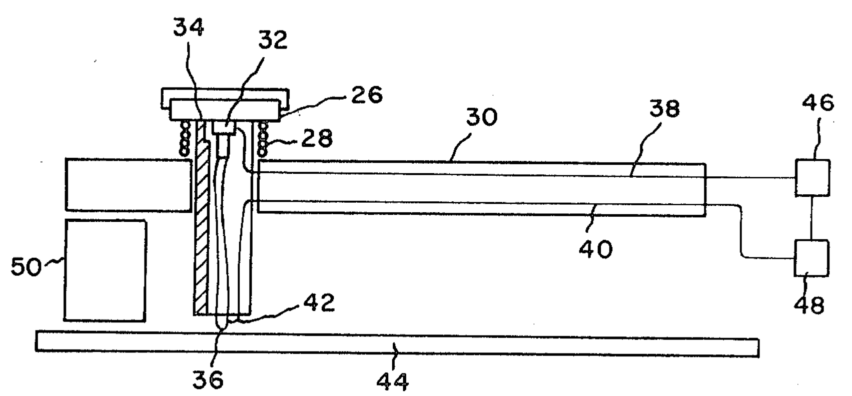


Fig. 3

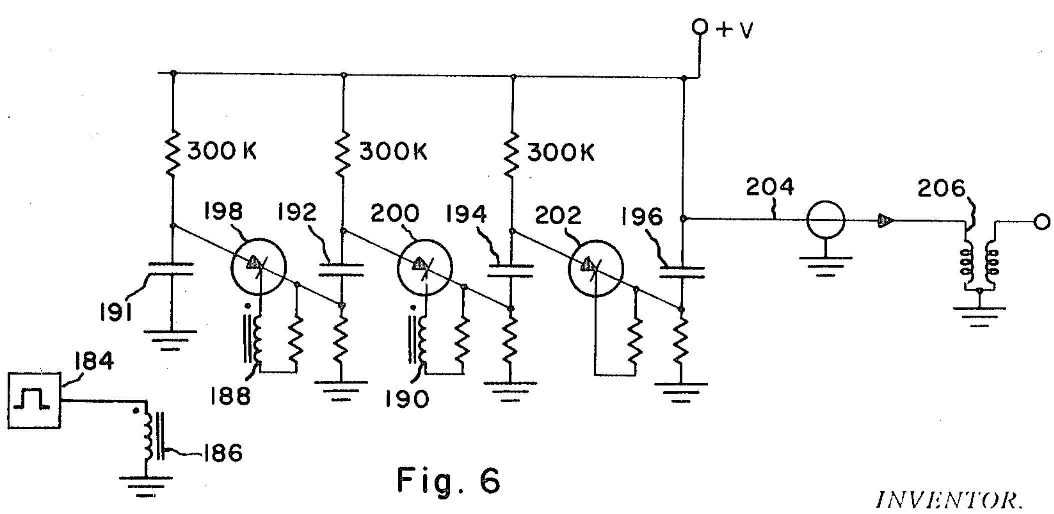


Fig. 6

INVENTOR.
ALBERT L. WHETSTONE
BY
AGENT

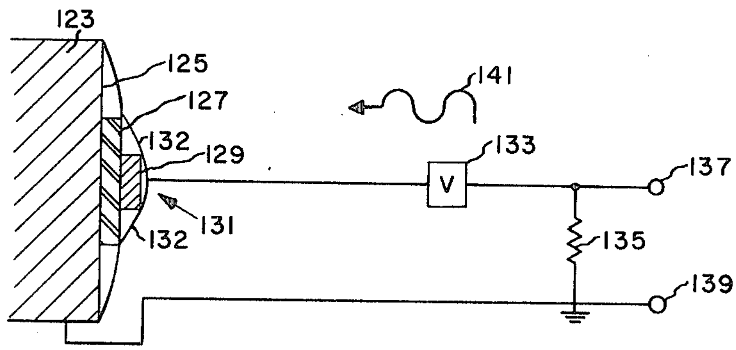


Fig. 3A

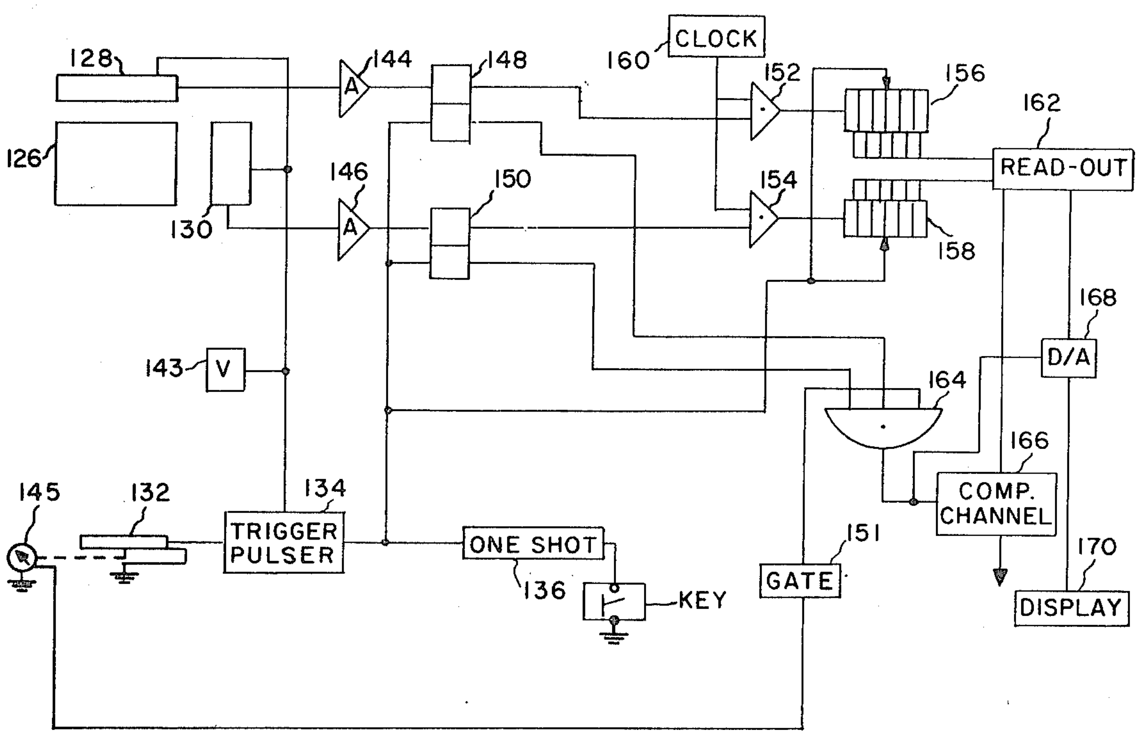


Fig. 4

INVENTOR.
ALBERT L. WHETSTONE

BY
[signature]
AGENT

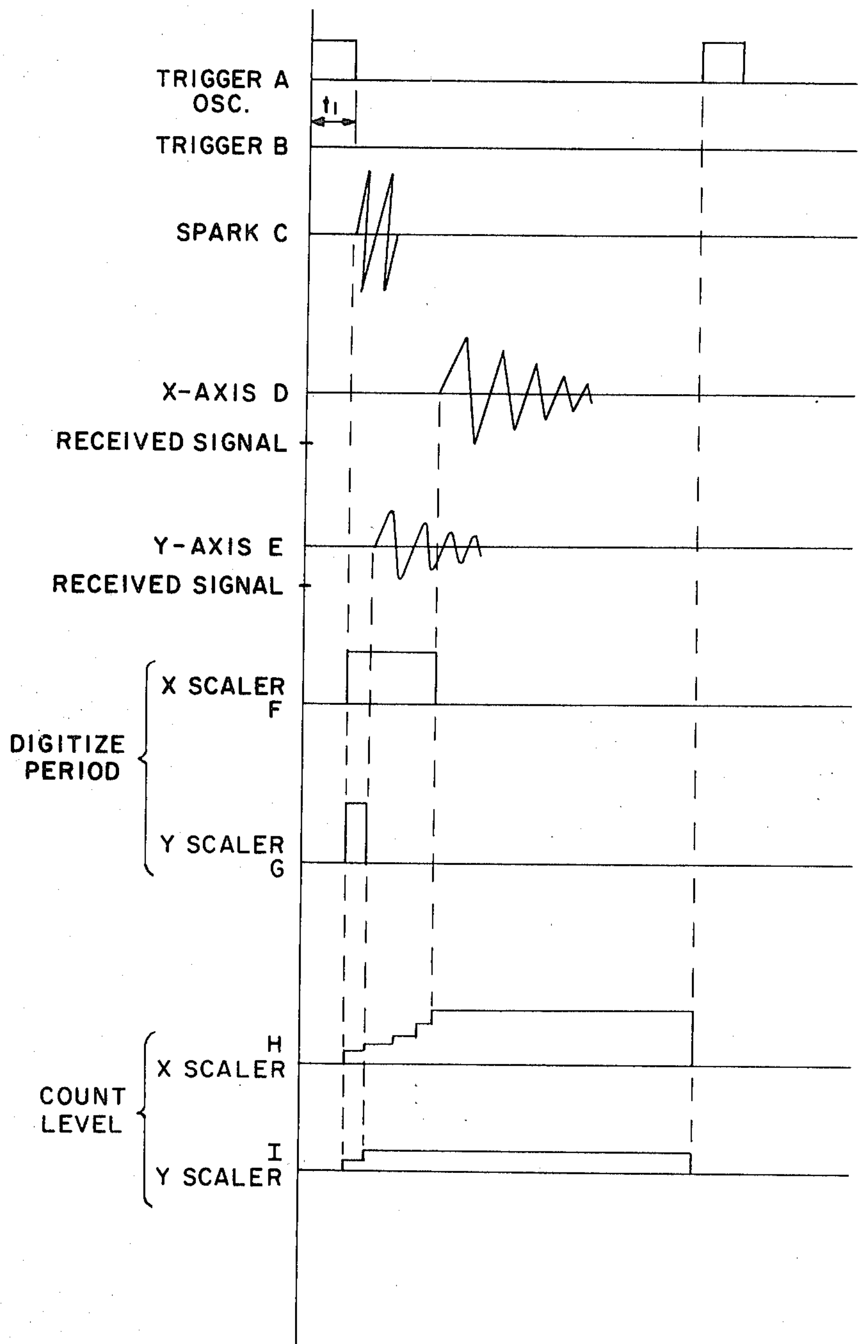


Fig. 5

INVENTOR.
ALBERT L. WHETSTONE
BY
AGENT

KEYBOARD ENCODING

This invention relates to encoding devices and more particularly to keyboard encoding devices using acoustic shock waves as time displacement representations.

Prior art keyboard encoding devices employ complex matrix networks and the like for providing unique identifiable digital locations for the respective keys. The difficulties with such arrangements lies in their expense, complexity, and the need for a large amount of wiring.

It is the prime object of this invention to provide an improved keyboard encoding device.

It is a further object of this invention to provide a keyboard encoding device employing a plurality of keys with the need for only a single digitization output line.

It is a further object of this invention to provide a keyboard encoding device utilizing acoustic spark generated wave fronts.

Forgoing objects are effected by means of a device having a plurality of keys, each key individually actuatable, with a first means coupled to each of the keys and responsive to their actuation for providing an acoustic shock wave preferably in the form of a spark. Each spark production point is uniquely located with respect to a fixed point, the location of the spark generating point identifiable with respect to the key actuated. Each generated acoustic shock wave produces a response in a device which initiates an accumulation of a digital quantity. A receptor located at a fixed point responds to the leading edge of the acoustic shock wave and terminates the operation of the accumulation device, thereby providing a digital representation of the actuated key. The receptor may be located along a single axis, with the keys arranged diagonally with respect to the plane of the receptor such that each key occupies the requisite differing location with respect to the receptor. Alternatively, a standard keyboard could be used, with each of the keys actuating a spark at a production point located along the diagonal in the manner described above. In a further alternative, a standard keyboard can be employed with two receptors, thereby eliminating the need for any special arrangement of key or spark production points. In this latter embodiment, each key and spark production point can be structurally integral, since the use of two dimensional receptors will result in unique digitization of the location of each individual key. Logic circuitry for sampling and reading the data and for production and responding to the production of the spark is employed.

The forgoing objects and brief description of the invention as well as further objects and other variations or embodiments of the invention will become more apparent with reference to the appended specification and accompanying drawings,

FIG. 1 represents the keyboard and a separate set of spark generating points,

FIG. 2 represents a keyboard and two axial receptors,

FIG. 2A, a spark generating point construction,

FIG. 3 represents a cross-sectional view of the receptor and an integrally structured key and spark generating point,

FIG. 3A represents the structure of the spark receptor mechanism,

FIG. 4 shows a logic diagram for providing sample signals for a two dimensional arrangement,

FIG. 5 a waveform diagram of the elements of FIG. 4,

FIG. 6 is a schematic of a spark generating circuit.

Referring to the drawings, FIG. 1 represents a keyboard **10** which may be of the standard alphanumeric format having a cable **12** providing separate electrical signals indicative of each energized key respectively coupled through said cable **12** to a plurality of sparking points **14** located along a diagonal line with respect to the plane of the receptor **16**. The nature of the receptor will be explained in more detail below. To the output of the receptor **16** is coupled a utilization circuit **18**, which also will be explained in more detail below. As is evident from the drawing, energization of a key on the keyboard **10** will result in a spark being produced at the appropriate spark generating point **14** along the diagonal. A shock wave thus generated will proceed in radial fashion until striking the receptor **16**. It will be evident that the first point to strike the receptor **16** will be along a tangential line with respect to the radials produced by the acoustic shock wave as it approaches the receptor, or in other words the direction of radial transmission from a spark generating point to the receptor will be orthogonal with respect to the receptor. Utilization device **18** responds to both the initiation signal appearing along cable **12** and the receptor signal appearing from the receptor **16** so as to provide a digital indication of the time delay between first and second signals. Since each spark generating point is locatable at a different position with respect to the receptor **16**, each sparking point representative of a different key will provide a different time of travel of shock wave, and therefore a different digitalization in the utilization device **18**. Referring to FIG. **2** the arrangement shows a keyboard **20** positioned directly between a pair of orthogonally arranged receptors **22** and **24**. The keys may be arranged in standard fashion about the keyboard **20**, much as in the arrangement of an ordinary keyboard input. Since the coordinate array is two dimensional, each key will produce a unique two dimensional coordinate through the combination of the receptors **24** and **22**. In regard of this latter arrangement, FIG. **3** shows a cross-sectional view of a single key. The device operates upon pressure of the key **26** which is spring biased by means of a suitable spring **28** against the surface **30**.

Within the key structure are located a pushbutton type of switch **32** which is fixed to the upper portion of the key interior **34** and a stylus point **36**. Stylus point **36** and the switch **32** occupy a hollow shaft portion within the inner portion of the switch **26**. Pressure of the switch **26** will cause the stylus **36** to press upon the snap action switch **32**, thereby closing a circuit to the lines **38** and **40** which will result in a spark being generated between an electrode **42** and the stylus **36** as shown on the drawing. The lower plate **44** showing a means to apply the upper pressure to the stylus **36** to close the switch **32**. The closing of the switch will generate a pulse in a trigger circuit **46**. This pulse will control, through the high-voltage pulsing circuit **48**, the spark to be generated at the electrode **42**. The detail of the tip is shown by FIG. 2A. The electrode **42** may be a tungsten whisker **12** affixed within the tubing by means of an electrically conductive epoxy adhesive and is conductively joined to the wire **40** at one end; the opposite end of the whisker is spaced from the conductive stylus point **36** to form a spark gap.

Immediately surrounding the stylus point **36** in the tip area of the stylus **34** is a cylindrical collar attached to the housing and having an open notch in its cylindrical surface positioned opposite the end of the whisker **12**. The purpose of this collar is to direct the spark which is transmitted from the whisker to the conductive casing of the ink cartridge. The use of barium titanate for the collar material has been found to be particularly advantageous because this material will cause the spark to fire in the same direction each time the voltage pulse arrives at the end of the whisker, and will reduce spark erraticity and consequently will reduce the amount of energy required to fire the spark. Furthermore, the notch is used to direct the shock wave since the spark generated will run along the notch and thereby provide a clear path for the wave to travel to the coordinately placed receptors **22** and **24**.

By way of example, the brass tubing can be 0.062 inch O.D. and the tungsten whisker can be 0.006 inch in diameter and 0.178 inch in length. The notch may be V-shaped with the open end of the V corresponding to the free edge of the collar and being 0.031 inch; the dimension of the depth of the V can also be 0.031 inch. It should be understood of course that these measures and dimensions are given by way of example only and that other dimensions, and notch shapes, may work equally as well.

A receptor **50** is positioned at the edge of the active area and responds to the leading wave front of the spark produced by the electrode **42** upon pressure of the key to provide the secondary pulse indication therefrom. The digitizing device responds to activation of the pulse indication line **38**, indicating the depression of the switch **26**, and a pulse indication from the receptor **50**, indicating a receipt of the pulse generated by the spark electrode **42**, to provide the time spaced pulse sequence necessary for the digitization of the unique location of the key **26** with respect to the receptor **50**. As explained heretofore, a single receptor can be used with individually locatable spark generating points, or a pair of receptors can be used as shown in FIG. **2** with the keyboard switch integral therewith.

The microphone units may be any form of acoustic transducer constructed so as to produce a substantially uniform magnitude output pulse in response to the incidence at any point along the microphone length of a sound shock wave front. A preferred form of microphone structure is indicated at FIG. 3A, showing a cross-sectional view of a microphone used in FIG. **1** and as shown therein is constructed of a bar length of any type of metallic base structure **123** such as aluminum. A layer of insulating polyester film **127** such as mylar is mounted to the surface **125**. A metal layer **129** such as copper is mounted to the insulating film **127**. A final layer of a polyester film **131** such as mylar, metallized on the external surface, is affixed to the base structure **123** and encloses the conductor insulator sandwich. A high-voltage source **133** of, for example, 500 volts is coupled to one of the layers **129**, and through a limiting resistance **135** to the base portion **123** and the metallized film **131**. The output is taken across the resistance **135** via terminals **137** and **139**. In operation, a sound wave **141** approaching the surface of the metallized film **131** causes movement of the film **131** relative to the metal layer **129** particularly within the sensitive region **132**. Since the capacitive effect is directly dependent upon the spacing between layers **129** and **131**, the movement will have the effect of varying the capacitance and therefore the output across terminals **137** and **139**. If the microphone is operated at constant A, then in accordance with the standard relationship for a capacitor:

$$Q=CV$$

$$V=Q/C, \text{ and assuming } Q \text{ constant,}$$

$$dv=Q\,dc/C^2$$

$$dv/v=dc/c$$

the output voltage will be a direct function of the capacitance change.

Referring now to FIG. 4, the two dimensional graphical data device is shown. The data surface **126** is bordered by X- and Y-microphones **128** and **130**. The stylus **132** represents a key position and is triggered by a trigger pulser **134** which is any form of conventional trigger generator. Both microphones and trigger pulser is powered by a voltage source **143**. For low-energy level sparks the generator can store an energy level of, for example, 10^{-3} joules for subsequent discharge through the spark gap. The energy produced can be higher but the level thereof should be controlled by safety factors. The trigger pulses can be energized any number of ways, such as the one-shot trigger **136** producing single sparks and energizable upon pushing the key. The one-shot **136** may be of a conventional variety.

The X-Y microphones **128** and **130** are respectively coupled to high-gain band-pass amplifiers **144** and **146**. Since the spark shock wave produces a fast rise time electrical impulse upon impinging on the microphone, the band-pass amplifiers will allow only the fast rise time portion of the electrical pulse to pass while blocking out all noise signals outside the band. To insure rapid operation, the amplifiers include threshold discriminators which provide an output pulse with steep leading edges in response to the input thereto exceeding a predetermined level.

The outputs of the respective amplifiers **144** and **146** are coupled to the respective inputs of a conventional bistable flip-flop network **148** and **150**. One output of each flip-flop is gated through gates **152** and **154** into X-channel and Y-channel counters or scalers **156** and **158**. The gates **152** and **154** respectively receive a clock input from a clock pulse generator **160**. The counter outputs are coupled to a readout unit **162** which may be any conventional form of interim storage device or transfer register.

The external source initiation of a trigger signal passing through the key (FIG. 5A) acts to trigger a pulse from pulser **134** (FIG. 5B) and initiate a spark (FIG. 5C). The trigger signal is also conducted simultaneously to each of the flip-flops **148** and **150** and acts to reset the scalers **156** and **158**. The effect of the trigger signal on flip-flops **148** and **150** is to set each flip-flop in a state permitting the AND-gates **152** and **154** coupled thereto to pass clock pulses from the clock source **160**. The scalers each begin to accumulate a digital count. (FIG. 5F and 5G; FIGS. 5H and 5I). The count continues to accumulate until an appropriate signal is received at the microphone units **128** and **130** (FIG. 5D and 5E). The leading edge of the respective coordinate signal received acts to reset the state of the appropriate flip-flop **148** and **150** and thereby block the AND-gate **152** and **154** coupled thereto; holding the flow of clock pulses and ceasing the scaler accumulation. The period between trigger pulses is sufficient to allow the received signals to damp out. The scaler reset operation is effected on the leading edge of the trigger pulse (FIG. 5A) and the unblocking of the AND-gates on the trailing edge.

The complimentary outputs of flip-flops **148** and **150** are respectively coupled to an additional AND-gate **164**. This latter gate is coincidentally energized only during the period after the count accumulation is complete but before the reset period when both flip-flops **148** anD **150** are in the reset state. This provides a "data ready" indication which can be utilized for transferring the accumulated count to an appropriate output.

As shown, the gate **164** can energize a computer channel **166** which can receive the data from the readout unit **162**, or a digit to analog conversion unit **168** which can convert the digitization to a series of analog voltages for display on a cathode-ray screen **170**. The latter can be a storage unit, thereby allowing continuous readout and permanent screen storage for observation.

Referring to FIG. 6, a preferred form of the trigger circuitry is illustrated for providing a voltage magnitude sufficient for a spark generation.

A source of pulses **184** supplies a transformer primary **186** coupling pulses through to secondaries **188** and **190**. The network itself consists of a series of capacitors **191**, **192**, **194**, **196** each series connected between pairs of resistors, excepting capacitor **191**, which is connected between a resistor and ground. A source of voltage +v, of for example 500 volts, is coupled to each line. Each line is connected to an adjacent line by a thyristor **198**, **200**, **202**. The last capacitor **196** is coupled through a cable **204** to a saturable transformer **206**, and from there to the stylus electrodes.

In operation, each of the thyristors are nonconducting and each capacitor is charged up to v. The appearance of a pulse from the source **164** will, through transformer action, switch the thyristor **198** by applying a positive potential to the gate electrode, thereby rendering the thyristor conductive. The flow through thyristor **198** clamps the lower plate of capacitor **192** at +V, thereby driving the upper plate to V+V or 2V. The thyristor **200**, also rendered conductive, clamps the lower plate of capacitor **194** at +2V, thereby driving the upper plate 2V+V or 3V. A transformer secondary could be employed at the last thyristor **202**, however by proper designing of potentials, the last thyristor can self-saturate due to the forward impression thereon of a 3V potential difference. With a 500-volt source, and utilizing thyristors type 2N4443, that situation will occur.

The final voltage across capacitor **196** is conducted along the cable **204** and through a step-up transformer **206**. The transformer **206** is preferably of the saturable core type and guards against excessive overloading at the spark generating electrode, thereby providing a degree of safety factor.

Since certain changes and modifications can be readily entered into in the practice of the present invention without departing substantially from its intended spirit or scope, it is to be fully understood that all of the forgoing description and specification be interpreted and construed as being merely illustrative of the invention and in no sense or manner as being limiting or restrictive thereof.

What is claimed is:

1. An encoder comprising a plurality of individually actuatable keys, first means coupled to each of said keys and responsive to the actuation of any said key for providing a shock wave at a location with respect to a fixed point, said location uniquely identifiable with respect to the key actuated, second means responsive to production of said acoustic shock wave to begin accumulation of a digital quantity, and third means positioned at said fixed point and responsive to said shock wave for terminating the operation of said second means, said second means thereby providing a digital representation of said actuated key.

2. The combination of claim 1 wherein each of said keys are arranged diagonally with respect to the plane of said third means.

3. The combination of claim 1 wherein said third means includes first and second shock wave receptors, orthogonally arranged with respect to each other, and said plurality of keys positioned between said receptors.

4. The combination of claim 1 wherein said first means includes switching means coupled to a key and responsive to activation thereof for assuming a first condition and to deactivation thereof for assuming a second condition, a set of electrodes positioned in proximity with said key, and a pulsing circuit coupled to said switching means and said electrodes and responsive to said first condition for providing a spark at said electrodes said spark providing said acoustic shock wave.

5. An encoder comprising a plurality of individually actuatable keys, first means coupled to each of said keys and responsive to actuation of any of said keys for providing an acoustic shock wave at a location with respect to a fixed point, said location uniquely identifiable with respect to the key actuated, a source of pulses, a digital counter, gating means connecting said pulse source to said counter, second means coupled to said gating means and responsive to production of said acoustic shock wave to couple said source of pulses to said counter, thereby beginning a digital accumulation therein, and third means positioned at said fixed point coupled to said gating means and responsive to the leading edge of said acoustic shock wave for providing a signal to said gating means for uncoupling said source of pulses from said counter, thereby preventing further digital accumulation therein, said counter thereby containing a digital representation of said actuated key.

6. The combination of claim 5 wherein each of said keys are arranged diagonally with respect to the plane of said third means.

7. The combination of claim 5 wherein said first means includes switching means coupled to a key and responsive to activation thereof for assuming a first condition and to deactivation thereof for assuming a second condition, a set of electrodes positioned in proximity with said key, and a pulsing circuit coupled to said switching means and said electrodes and responsive to said first condition for providing a spark at said electrodes said spark providing said acoustic shock wave.

8. The combination of claim 5 wherein said third means includes first and second shock wave receptors orthogonally arranged with respect to each other, said plurality of keys positioned between said receptors, said gating means including first and second gates each respectively coupled to a receptor, said counting means including first and second counters each respectively coupled first and second gates, each of said gates further including means coupling said source of pulses thereto.

* * * * *