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Higgins

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[54] **ELECTRICAL ENCODING ARRANGEMENT FOR TYPEWRITERS HAVING SINGLE ROTARY PRINTING ELEMENT**

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[21] Appl. No.: **331,178**

Related U.S. Application Data

[63] Continuation of Ser. No. 3,782, Jan. 19, 1970, abandoned.

[52] **U.S. Cl.** **197/52;** 197/19; 250/227

[51] **Int. Cl.** **B41j 1/60**

[58] **Field of Search** ..... 197/16, 19, 52; 235/61 R; 250/223, 227

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[57] **ABSTRACT**

A typewrite assembly and attachment for typewriters of the kind having a single rotary printing element for simultaneously deriving encoded output electric signals representative of the characters being printed out by the typewriter in addition to the hard copy printout normally provided by such typewriters. The typewriter assembly and/or attachment comprises encoding means in the form of alternate light reflecting and non-or-minimally-reflecting stripes secured to a member which is operatively driven synchronously with the single rotary printing element of the typewriter for charactristically encoding each individual character imprinting movement of the single rotary printing element. Sensing means in the form of a fibre optic bundle operatively senses the characteristically encoded movements of the single rotary printing element and supplies pulsed light signals to a photo-electric converter for deriving serially encoded output electric signals representative of the characters being printed out by the typewriter. The encoding arrangement may be such that alternate light reflecting and non-or-minimally-reflecting stripes are formed on the single rotary element or may be attached to the drive cables or formed on the pulley wheels for the drive cables used in rotating the single printing element around two mutually orthogonal axes of rotation. Alternative sensor arrangements may employ capacitive, magnetic or inductive sensors for the markers formed on the single rotary printing element. Auxiliary signal generator equipment in the form of a line spacing signal generator, start of paragraph signal generator, etc are provided for use with the typewriter to enhance data handling capabilities of the overall system in which the typewriter is used.

18 Claims, 5 Drawing Figures

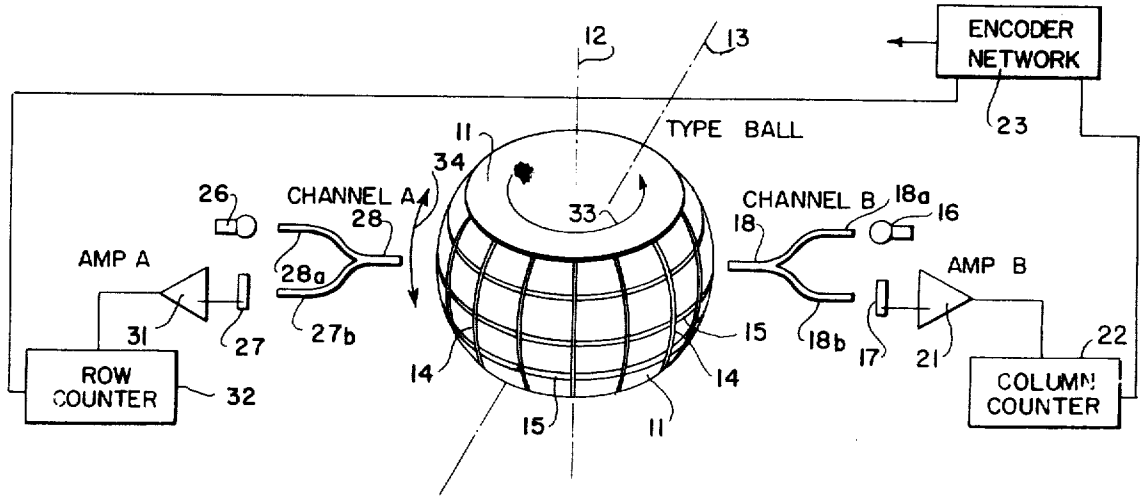
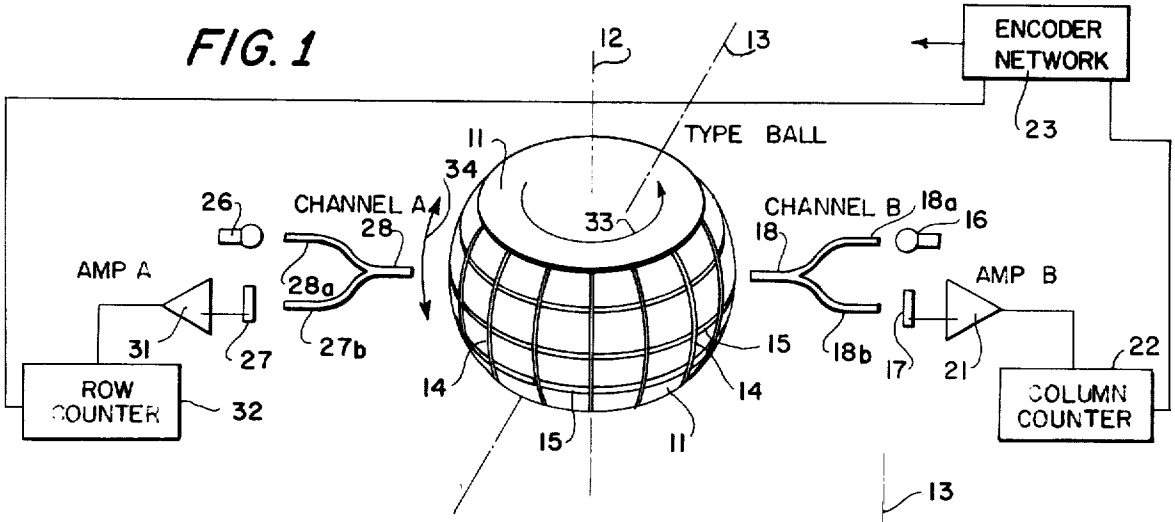


FIG. 1



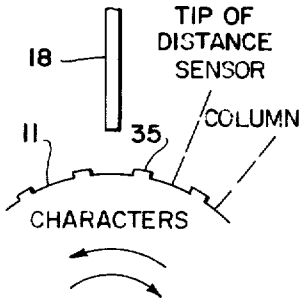


FIG. 3A

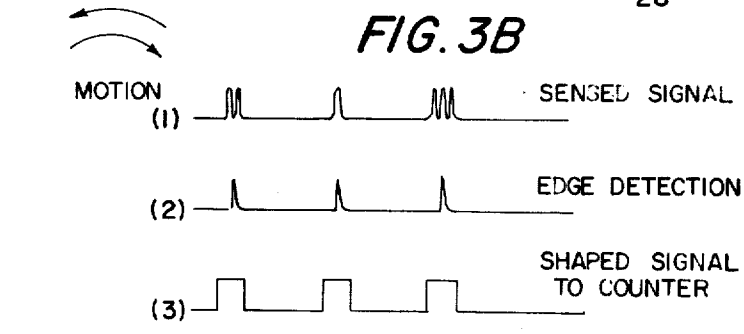


FIG. 3B

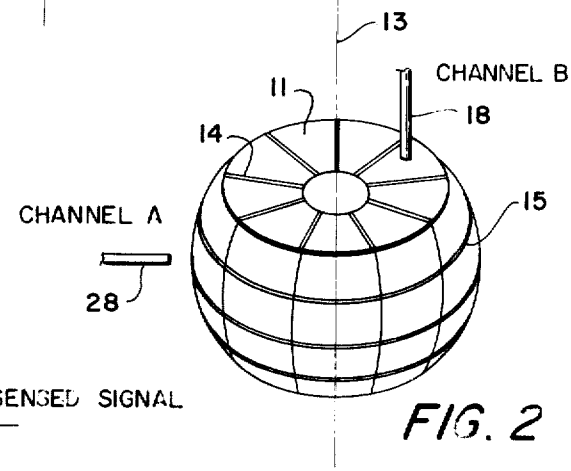


FIG. 2

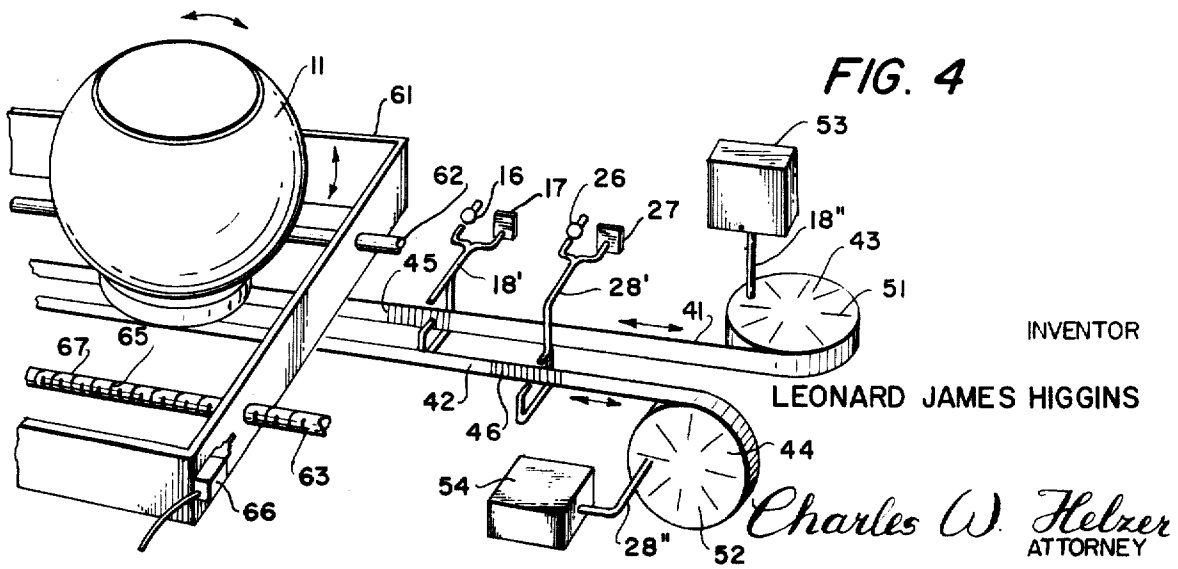


FIG. 4

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ELECTRICAL ENCODING ARRANGEMENT FOR TYPEWRITERS HAVING SINGLE ROTARY PRINTING ELEMENT

This is a continuation of application Ser. No. 3,782, filed Jan. 19, 1970, and now abandoned.

BACKGROUND OF INVENTION

1. Field of Invention

This invention relates to a novel encoding arrangement for typewriters of the kind having a single rotary printing element, and to typewriter assemblys including such an arrangement whereby the typewriter can produce encoded electric output signals suitable for use with an electronic data processing system simultaneously with the hard copy print out normally achieved with the typewriter.

More particularly the invention relates to the design of such typewriters and to attachments and component parts therefor which make it capable of producing hard printed copies of office data, business letters, etc. generated in the normal business routine of an office, and also capable of producing encoded electric output signals representative of such business information for supply to a central data processing facility either concurrently with the print-out of the hard copy, or at some subsequent point in time.

2. Statement of Prior Art

Electronic data processing has now been widely adopted by industry government, and education for record keeping purposes. While the central data processing equipment in the form of high speed computers, and related read-in and read-out equipment has the capability of accommodating immense amounts of data, the peripherial terminal equipment where such data is originally generated constitutes a weak link in the system. Existing computer data terminal equipment is extremely costly and requires special training in order to use the equipment. For a small business to enjoy the benefits of computer data processing, it must first accummulate its data on special forms, cards, etc which then must be physically transported to a data processing center where it is converted into machine readable-form suitable for use by the computer. Thereafter, the data is processed by the data processing center and the results mailed or otherwise communicated to the customer. The whole process is quite time consuming, costly and otherwise so involved as to restrict greatly computer data processing of the records of small businesses and the like. This same comment is equally applicable to the processing of records of small regional and district offices of larger businesses.

U.S. Pat. application Ser. No. 815,247-filed Mar. 14, 1969 for a "Keyboard-Actuated Apparatus and Attachment for Deriving Coded Electric Output Signals Representative of Characters to Be Recorded"- Leonard James Higgins, Inventor Describes and claims a low cost, highly reliable, keyboard-actuated apparatus for simultaneously printing selected characters and deriving encoded electric output signals which are representative of the characters being printed by the apparatus. The encoded electric output signals can be supplied directly to a central data processing computer through a dial tone receiver connection, direct wire connection, or temporairly recorded on a magnetic type recorder, etc for storage and subsequent processing by the computer at a convenient time. The encoding arrangement

can be embodied in the typewriter at the time of original manufacture or can be provided in the form of a low cost and reliable attachment for use on existing typewriters. It adapts the typewriter to derive the characteristic, encoded electric output signals simultaneously with the printing of the respective characters being typed on the typewriter and does not require any special training on the part of the typewriter operator other than that normally required for a typist. The arrangement described in application Ser. No. 815,247 is intended primarily for use with conventional typewriters of the kind having a plurality of key-actuated printing hammers that are selectively physically moved to a common printing position during operation. However, the arrangement may also be applied to typewriters of different design, and the present disclosure concerns the application of the novel encoding arrangement in a typewriter of the kind having a single rotary printing element (hereinafter referred to as a "golf ball" printing element).

SUMMARY OF INVENTION

It is therefor a primary object of the present invention to provide a novel encoding arrangement for typewriters of the single golf ball rotary printing element kind.

A further object of the invention is to provide such encoding arrangements either as a separate attachment for use on existing typewriters or for design into the typewriter assembly during original manufacture, as well as specially designed component parts such as encoded golf ball rotary printing elements, a line spacing signal generator, and the like for use in such combined electric signal encoding and hard copy print-out typewriters employing a single golf ball rotary printing element.

In practicing the invention, a typewriter assembly and attachment is provided for typewriters of the kind having a single rotary golf ball printing element for deriving coded output electric signals representative of the characters being printed out by the typewriter in addition to the hard copy print-out normally provided by such typewriters. The assembly and/or attachment comprises encoding means operatively driven synchronously with the single rotary golf ball printing element of the typewriter for characteristically encoding each individual character imprinting movement of the single rotary golf ball printing element with a unique and identifiable characteristic code. The encoding means may be in the form of a predetermined pattern of alternate light reflecting and non-or-minimally-reflecting areas or stripes formed on the golf ball printing element, the drive cables for the printing element, or the drive pulleys for driving the drive cables that in turn rotate the golf ball printing element around two mutually orthogonal axes of rotation to a desired angular orientation associated with a particular character to be printed out. Sensing means preferably in the form of a fiber optic sensor is operatively coupled to the encoding means for serially sensing the respective characteristic codes representative of the characters being printed out by the golf ball printing element. Coded signal deriving means in the form of a photo electric convertor is responsive to the pulsed light signals derived by the fiber optic bundle sensing means for producing serially-coded, output electric signals representative of the characters being printed out by the single rotary

golf ball printing element. The electric output signals thus derived are suitable for use with electronic computer data processing systems.

To facilitate practice of the invention, specially designed, single rotary, golf ball printing elements are provided having special markers formed thereon in the nature of mutually orthogonal latitude and longitude lines for characteristically encoding the respective different orientations assumed by the golf ball printing element in printing out different characters. The markings preferably are in the form of light reflecting surfaces that are observed and counted by the fiber optic sensor means. The invention also makes available auxiliary signal generator means in the form of a line-space signal generator that indicates the beginning of a line of data together with the spacing intermediate each character being printed out. In addition an auxiliary signal generator for indicating the start of paragraphs, etc may be included to enhance the overall data processing capabilities of a system in which the typewriter is included.

If desired, capacitive, magnetic, inductive or other forms of known sensors can be employed in place of the preferred fiber optic sensor arrangement described.

BRIEF DESCRIPTION OF DRAWINGS

Other objects, features and many of the attendant advantages of this invention will be appreciated more readily as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein like parts in each of the several figures are identified by the same reference character, and wherein:

FIG. 1 is a schematic representation of a single, rotary, golf ball printing element that has been specially scribed with encoding markers in accordance with the invention, and which utilizes a fiber optic read out sensing arrangement for reading out the encoding markers and deriving serially encoded electric output signals representative of the characters being printed out;

FIG. 2 is a perspective view of a different form of golf ball printing element fabricated in accordance with the invention and shows a different technique for read out;

FIG. 3A illustrates still a different manner of encoding the golf ball printing element which may be used with a fibre optic distance sensor or alternatively a capacitive, magnetic or inductive type of sensor in accordance with the invention;

FIG. 3B is a series of output electric signal wave shapes indicating the pulsed wave form nature of the encoded electric output signals derived by the embodiment of the invention shown in FIG. 3A; and

FIG. 4 is a perspective, schematic view of a gimbal supporting structure for a golf ball printing element showing drive cables for rotating the golf ball printing element about two mutually orthogonal axes to place the golf ball printing element in a particular angular orientation for printing or typing out desired characters, and illustrates a different means for encoding either the drive cables and/or the drive pulleys for the cables as well as the line spacing encoding and signal read out arrangement.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In FIG. 1, a single, rotary, golf ball printing element is shown at 11; however, the alpha-numeric characters normally arrayed around the peripherial surface of the golf ball printing element for rotation into printing position relative to a platen, have not been illustrated for convenience. The golf ball printing element 11 may be rotated about two mutually orthogonal axes of rotation (indicated by the dotted lines 12 and 13) by a suitable rotating mechanism not shown. For a detailed description of the construction and operation of a typewriter assembly having a golf ball printing element, and the manner in which the golf ball printing element, is angularly oriented so as to place it in printing position to print a particular alpha-numeric character, reference is made to U.S. Pat. No. 2,879,876 and 2,905,302 together with other similar patents and printed publications about typewriters of this kind.

During operation of the typewriter assembly the golf ball printing element 11 sequentailly is rotated about the mutually orthogonal axes 12 and 13 to place desired, different alpha-numeric characters in printing position relative to the platen of the typewriter. To detect the angular orientation of the golf ball printing element while thus rotated, marking means are provided in the form of an intersecting network of vertical column marks 14 and horizontal row marks 15. The intersecting network of column marks 14 and row marks 15 are arrayed in the manner of latitude and longitude lines for identifying any particular point on the surface of the golf ball printing element relative to a fixed point in space. As will be described more fully hereinafter, the intersecting orthogonal marks 14 and 15 preferably comprise highly polished light reflecting areas or stripes for reflecting back an interrogating light beam that is directed thereon from a suitable source of illumination.

Sensing means are provided to the arrangement shown in FIG. 1 for sensing or counting the number of vertical columns 14 and the number of horizontal rows 15 rotated past a fixed observation point during placement of the golf ball printing element at a particular angular orientation thereby conditioning it to print out a particular desired alpha-numeric character. The vertical columns 14 are sensed and counted by a suitable optical means for illuminating and reading out the verical columns. This optical means comprises a source of illumination 16 together with light transmitting means for directing light from the source of illumination 16 onto the vertical columns 14 together with light receiving means for receiving back light pulses reflected from the vertical columns 14 and directing the received light pulses onto the photo sensitive surface of a photo electric conversion device 17. The light transmitting and light receiving means preferably is comprised by a fiber optic bundle 18 having a light transmitting branch 18a and a light receiving branch 18b each having one end commonly positioned to illuminate and read back the vertical columns 14. The light transmitting fiber optic branch 18a has its remaining end positioned to be illuminated from the source of illumination 16 and the light receiving fiber optic branch 18b is positioned so that its remaining end images light pulses reflected back from the vertical column marks 14 onto the light sensitive surface of the photo electric conversion device 17. Pulsed electric output signals developed by the photo-electric conversion device 17, are supplied to coded electrical signal processing circuit means comprised by an amplifier 21, column counter 22 and en-

coder **23.** The signals are amplified and shaped in amplifier circuit **21** and supplied to, column counter **22** and thence to an encoding network **23** that supplies the signals to a central data processing computer through the medium of a direct connection, a dial tone receiver system, or to a magnetic recorder or the like for recording and subsequent supply to the central data processing computer at a more convenient processing time. The encoder network **23** is merely a conventional, logic gating network for sequentially gating out the output from column counter **22** to the data processing system.

In a similar manner, the horizontal rows **15** are interrogated and counted out by a second, separate, suitable sensing means comprised by a source of illumination **26,** a photo-electric conversion device **27,** and a fiber optic bundle sensor **28** having a light transmitting branch **28a** and a light receiving branch **27b** for supplying light pulses to the photo sensitive conversion device **27.** Pulsed electric output signals representative of the row count derived by the photo-electric conversion device **27** are supplied through coded electric signal processing circuit means comprised by an amplifier **31,** a row counter **32** and an encoder network **23** for supply to the data processing system.

The arrangement shown in FIG. **1** is intended for use with a golf ball typewriter of the kind which first rotates the golf ball printing element around one of its axes such as **12** in the manner indicated by the arrow **33,** and then subsequently rotates the element about the axis **13** in the manner shown by arrow **34.** During rotation about axis **12,** the column mark sensor **18** will count out the number of vertical column markers **14** rotated past the end of the fiber optic bundle **18** to derive at the output of the amplifier **21** a serially encoded, pulsed electric output signal similar to that shown in FIG. **3B(3)** and which is representative of the number of vertical column marks in the address of a particular character being printed out by the golf ball printing element. Thereafter, the typewriter assembly rotates the golf ball printing element around the orthogonal axis **13** to thereby angularly orient the golf ball printing element in a position required to print out a desired, particular alpha-numeric character. During this second rotation, the row counter **28** will count out the number of horizontal row marks **15** rotated past the end of the fiber optic sensor bundle **28,** and will derive at the output of the amplifier **31** a serially encoded, pulsed wave form output electric signal similar to FIG. **3B(3)** and which is representative of the row address of the particular character being printed out. This row address is then supplied to the row counter **32** and thence through encoder network **23** to the data processing system. The combination of the column marker address with the row marker address then provides to the data processing system a unique and identifiable address which is representative of the particular character being printed out by the typewriter at the particular angular orientation in question.

The intersecting network of vertical columns **14** and horizontal rows **15** may be formed on the peripheral surface of the golf ball printing element **11** by any suitable known means. For example, the characteristic marks forming the vertical columns and horizontal rows may be machined into the golf ball printing element during original manufacture and provided with a highly polished light reflecting surface. Alternatively, the highly polished and light surface may be electro deposited by an electrodeposition process, sprayed, painted, laminated and then etched or otherwise formed on the peripheral surface of the golf ball printing element by an suitable, known means or process. The above referenced U.S. Pat. application Ser. No. 815,247 describes a number of techniques for forming suitable light reflecting target stripes and which readily may be used in forming the intersecting column and row marks **14** and **15** on the golf ball printing element for use in the present system. The fiber optic sensors used to sense and count-out the intersecting network of vertical column marks **14** and horizontal row marks **15** may each comprise a fiber optic sensor of the type disclosed in U.S. Pat. No. 3,327,584 - issued June 27, **1967** for a "Fiber Optic Proximity Probe" - C. D. Kissinger, inventor, and for a more detailed description of the construction and operation of the fiber optic sensor **18** and **28,** reference is made to this U.S. Pat.

FIG. **2** of the drawings illustrate a modified form of the invention shown in FIG. **1** wherein the single, rotary golf ball printing element **11** has a quasi-spherical shape with a flattened head portion. The intersecting, orthogonally arranged light reflecting marks are comprised by a first set of radially extending spokes **14** formed on the flattened head portion, and rotatable about the first or vertical axis of rotation **12** of the golf ball printing element. The horizontally extending row markers **15** are similar to those employed with the golf ball printing element shown in FIG. **1.** By arranging the light reflecting marks in the manner shown in FIG. **2,** counting of the spokes **14** operates similar to the counting of the vertical column markers **14** in the FIG. **1** arrangement to derive an output count signal representative of the angular orientation of the golf ball printing element **11** about the vertical axis of rotation **12.** In other respects, the arrangement shown in FIG. **2** is constructed and operates in a manner similar to the FIG. **1** arrangement.

FIGS. **3A** and **3B** of the drawings illustrate a different technique for encoding and reading out the angular orientation of the golf ball printing element **11.** The arrangement shown in FIG. **3A** employs a fiber optic distance sensor such as **18** for sensing and detecting the raised characters (such as **35**) as they are rotated past the end of the distance sensor **18** during angular orientation of the golf ball printing element. In the illustration shown in FIG. **3A** it is assumed that the golf ball printing element is being rotated about its vertical axis **12** so that the raised characters **35** which are specially arrayed in a regular pattern on the peripheral surface of the golf ball printing element, can serve as column markers. In a similar fashion, a row counter fiber optic distance sensor **28** (not shown) can be positioned to sense and read out the specially arrayed, line of raised printing characters **35** which extend into the plane of the paper (and hence are not seen) as row markers. Since it is intended that the golf ball printing element first be rotated about the vertical axis **12** for proper column location, and thereafter be rotated about the horizontal axis **13** for proper row orientation, it is possible in this instance to employ only a single sensor **18** so long as measures are provided to assure that the end of the fiber optic distance sensor **18** is disposed opposite the mutually orthogonal, intersecting columns and rows of raised character printing elements **35** during rotation of the golf ball printing element. With either arrangement, the fiber optic distance sensor **18** will op-

erate in the manner described more fully in the above referenced U.S. Pat. No. 2,327,584 to develop serially encoded pulsed waveform, electric output signals which are representative of the characters being printed out by the golf ball printing element. The nature of these output signals is illustrated in FIG. 3B of the drawings.

Referring to FIG. 3B it will be seen that the output signals developed by the fiber optic sensor **18** in conjunction with its associated source of illumination and photo-electric convertor device, comprise a series of single or multi-spike pulsed electric signals such as those shown in FIG. 3B (1). From an examination of FIG. 3B(1) it is seen that there are a number of signal spikes produced by the fiber optic distance sensor **18** as the respective characters are rotated past the end of the sensor during angular orientation of the golf ball printing element. These signal spikes are due to the different nature of the characters being rotated past the tip of the distance sensor. For example, an A would produce a 2 spike pulse such as shown at the left-most position in FIG. 3B(1). An I would produce a 1 spike pulse as shown in the middle of FIG. 3B(1), and a M or W would produce a 3 spike pulse such as shown at the right-most position in FIG. 3B(1). The series of single and multi-spike signal pulses are processed by a suitable edge detector that may be included in the amplifiers **21** and/or **31** and which detects the leading edge of a single spike pulse or a multi-spike pulse. These leading edge signal pulses having a waveshape as shown in FIG. 3B(2), are then employed in a suitable signal shaping circuit to provide the desired square wave output signal pulses shown in FIG. 3B(3). The square waveshaped signal pulses are supplied to the column and row counters and encoder network **23** for use by the data processing system in the same manner as described with relation to FIG. 1 of the drawings.

While the encoding arrangements shown in FIGS. 1–3 have been described for use primarily with fiber optic sensors, it is believed obvious that other known sensing devices and techniques can be employed to detect and count out the angular orientation of the golf ball printing element. For example, the characteristic, intersecting set of column and row marks **14** and **15** could be formed from a magnetic marking substance and a magnetic sensitive detector employed to derive the output count signal. Similarly, in the arrangement described with relation to FIG. 3A, a capacitive sensing probe could be employed to sense the change in capacitance due to the raised characters **35** being rotated past the end of the probe. Alternatively, a change in inductance of an inductive pick-up due to the raised characters, could be employed to sense the column and row marks. Thus, it can be appreciated that while a fiber optic sensor arrangement is preferred, any known sensor means such as those using magnetic, capacitive or inductive signal generating schemes, could be employed in carrying out the present invention.

In the embodiments of the invention described above, it has been assumed that the single, rotary, golf ball printing element **11** is separately rotated first around one axis such as **12** and then around the orthogonally disposed axis. In certain golf ball typewriter designs, the angular orientation of the golf ball is not necessarily carried out about each axis of rotation by separate and distinct motions. Thus, it is entirely possible in such typewriters for some specific point (or character) on the peripheral surface of the golf ball printing element to follow some ill-defined, angular path in assuming a desired print-out orientation. As is described more fully in the above referenced U.S. Pat. Nos. 2,879,876 and 2,905,302 and other patents and printed publications relating to golf ball typewriters, the golf ball is generally angularly oriented through the medium of a set of drive cables or tapes such as those shown at **41** and **42** in FIG. 4 of the drawings. The arrangement shown in FIG. 4 is intended to be schematic in nature only, and does not illustrate in detail the mechanism for translating motion imparted to the drive cables **41** and **42** to the golf ball printing element **11** and which causes the golf ball to be rotated about mutually orthogonal axes simultaneously. For disclosure of such mechanisms, reference is made to the above noted U.S. Patents and the open literature. Briefly, however, it can be said that the drive cables **41** and **42** are driven through suitable pulley wheels **43** and **44** to cause the cables to be moved back and forth in the directions of the arrows and in turn cause the golf ball printing element **11** to be rotated about mutually orthogonal axes to a particular, desired angular orientation where it will print out a particular, desired alpha-numeric character.

In order to detect the particular, angular orientation of the golf ball printing element **11**, the drive cables **41** and **42** have characteristic markings shown at **45** and **46**, respectively, formed thereon in the manner described above in connection with the vertical column marks **14** and horizontal row marks **15**. Thus, the marks **45** and **46** may comprise highly reflective stripes arrayed between non-or-minimally-reflecting surfaces or stripes in a patterned configuration or coded arrangement wherein the code corresponds to a particular alpha-numeric character being printed out. For a more detailed description of the manner of so marking the drive cables **41** and **42** with suitable reflecting, encoding stripes **45** and **46**, reference is made to the disclosure in the above identified co-pending U.S. application Ser. No. 815,247.

In order to read out the encoding markers **45** and **46** respectively, suitable, fiber optic bundle sensors **18'** and **28'** are employed. The fiber optic bundle sensor **18'** and **28'** may be identical in construction and operation to the corresponding numbered elements shown in FIG. 1. However, due to the possibility of background noise generation should the drive cables **41** and **42** be translated or vibrated back and forth relative to the tip of fiber optic bundles **18'** and **28'** it is preferred that a dual-sided, read out, fibre optic sensor be employed. With such dual-sided fibre optic sensors, the fibre optic bundles **18'** and **28'** will be divided into four branches wherein two of the fiber optic branches are employed to illuminate marks formed on both sides of the drive cables or tapes **41** and **42**, and the remaining two fiber optic branches are employed to read out the two sides of the cables or tapes, respectively. By this arrangement, vibration of the drive tapes **41** and **42** in a direction co-axial with the ends of the fiber optic sensors, will result in the production of compensating signals from the dual sided sensors with reduced background noise signal generation.

As an alternative to reading out the separate drive cables or tapes **41** and **42**, it is possible to form suitable encoding marks such as shown at **51** and **52** on the respective drive pulley wheels **43** and **44** for driving the cables **45** and **46**. With such an arrangement, separate,

single sided fiber optic sensors **18''** and **23''** together with their associated light source and photo-electric converter shown generally at **53** and **54**, respectively, may be employed to read out and count the respective encoding marks **51** and **52** on the drive pulley wheels **43** and **44**. With either of the arrangements shown in FIG. **4**, it is necessary to include a suitable logic circuit in the encoder network **23** to assure separation of serially produced, pulse wave form signals resulting from translation of the drive cables **41** and **42**, or the drive pulley wheels **43** and **44**, respectively, in the event such translation occurs concurrently. This can be achieved with a suitable memory network or the like for temporarily storing and subsequently reading out to the computer one of the concurrent pulse trains and which is activated only under conditions where concurrent translation is encountered.

From a study of the above referenced U.S. Pat. No. 2,879,876, and the like, it can be demonstrated that the single, rotary, golf ball printing element **11** is supported within suitable gimble supports (not shown) that in turn are mounted on a gimbal supporting structure **61**, and the gimbal supporting structure **61** is translated linearly along a set of guide rods **62** and **63** as a line of characters is being printed out by the typewriter. Thus, it will be appreciated that the linear translation of the gimbal supporting carriage **61** (and hence golf ball printing element **11**) serves to insert spacing between the various characters of a line of type being printed out. In order to detect this spacing, a series of spacing markings shown at **65** is formed on at least one of the guide rods **63**, or a similar member of the typewriter assembly for appropriately marking the length-wise travel of the golf ball printing element. The spacing marks **65** may comprise highly reflective stripes, or the like similar to the marks **14** and **15**, and are sensed by a suitable fiber optic, spacing mark sensor **66** mounted on and movable with the gimbal supporting structure **61**. With this arrangement, as the gimbal supporting structure **61** (and hence golf ball printing element **11**) move laterally along the platen of the typewriter in printing out a line of type, the spacing mark sensor **66** will derive a spacing-mark signal that can be supplied to the central data processing computer to show the spacing between the individual characters being printed out. In order to indicate the return of the golf ball printing element to start a new line of print, suitable start-of-line encoding markings such as shown at **67** may be formed at a particular point on the guide rod **63** in order to derive start-of-line encoded output signals. The placement of the start-of-line encoding marks can be made to be adjustable with the margin adjustment of the typewriter for any particular format with which the assembly is used. The spacing marking, fiber optic sensing device **66** may be similar in construction and operation to one of the row or column mark sensors **18** or **28** as described previously in connection with FIG. **1** of the drawings, and includes its own light source and photo-electric converter together with amplifying and signal shaping circuitry.

From the preceeding description, it will be appreciated that the present invention provides a means for encoding and subsequently reading out characteristic markings on the golf ball printing element or its drive members of a typewriter having a single, rotary, golf ball printing element, and which are read out during operation of the typewriter to produce serially encoded electric output signals representative of the characters being typed. It is believed obvious that such characters would also include punctuation marks such as periods, commas, semi-colons and the like in addition to the alpha-numeric characters normally reproduced by such typewriters. Inclusion of a line spacing-marking signal generating arrangement together with the start of line encoding will provide substantially all of the data required to properly process the communication at a central data processing center. If desired, an auxiliary signal generator such as that described in the above referenced U.S. Pat. application Ser. No. 815,247 may be employed to indicate start of a new paragraph or other special format arrangements such as tabular listing, etc. The inclusion of such an auxiliary signal generator would serve to enhance the overall data processing capability of a system including the novel encoding arrangement made available by the invention. The novel, electric signal encoding arrangement for typewriters of the single rotary, golf ball printing element type, may be used either as a separate attachment to an existing typewriter, or may be incorporated into the typewriter assembly at the time of original manufacture thereof. In addition, specially designed component parts are made available to enhance the data processing capability of typewriters incorporating the novel electric signal encoder feature.

Having described several embodiments of a novel, electric encoding arrangement for typewriters having single rotary printing elements, constructed in accordance with the invention, it is believed obvious that other modifications and variations of the invention are possible in the light of the above teachings. It is therefore to be understood that the changes may be made in the particular embodiments of the invention described which are within the full intended scope of the invention as defined by the appended claims.

What is claimed is:

1. A typewriter for producing both hard-copy printout of data recorded with the typewriter and coded electric output signals representative of the characters being printed out, said typewriter assembly being of the kind having a single rotary printing element, encoding means driven synchronously with the single rotary printing element for encoding each individual character printing movement of the single rotary printing element with a unique and identifiable code, said encoding means comprising serially arrayed alternate light reflecting and minimal reflecting code marks physically arranged in predetermined sequential patterns representative of each individual character, a single electro-optic light responsive sensing device for each orthogonal direction of rotation of said rotary printing element, each of said signal light responsive sensing devices having a single light path coupled to said encoding means for serially sensing all of the respective code marks in sequence, and respective coded electric signal processing circuit means responsive to each of the single light responsive sensing devices for deriving serially coded electric output signals representative of the characters being printed-out by the single rotary printing element and suitable for use with electronic data processing systems.

2. A typewriter assembly according to claim **1** wherein the encoding means comprises at least two separate sets of similar encoding marks formed on opposite sides of a member movable synchronously with

the single rotary printing member, and each of the light responsive sensing devices comprises a dual-sided sensing device for simultaneously sensing the dual set of encoding marks from opposite sides of the movable member.

3. A typewriter assembly according to claim 1 wherein each of the single electro-optic light responsive sensing devices comprises at least a source of light, light transmitting means forming a single light path for directing light from said source of light onto the predetermined pattern of light reflecting and minimally reflecting code marks as the same are moved serially past the light transmitting means, light receiving means for receiving back light pulses reflected from the code marks and directing the received light to a light sensitive member in said single electro-optic light responsive sensing device, said light sensitive member comprising a single photo-electric conversion element having a light sensitive surface that converts the received light pulses into corresponding serially-coded pulsed electric output signals representative of characters being printed-out by the typewriter.

4. A typewriter assembly according to claim 3 wherein the light transmitting means and the light receiving means comprises a fibre optic bundle having light transmitting and light receiving branches each having one end commonly positioned to illuminate and read-back, respectively, the pattern of light reflecting encoding marks, said light transmitting fibre optic branch having its remaining end positioned to be illuminated by the source of light and said light receiving fibre optic branch having its remaining end positioned to image light pulses received from the pattern of light reflecting marks onto the light sensitive surface of the photo-electric conversion element.

5. A typewriter assembly according to claim 4 wherein the encoding means comprises at least two separate sets of similar encoding marks formed on opposite sides of a member movable synchronously with the single rotary printing member, and the fibre optic bundle includes separate light transmitting and light receiving branches for each set of encoding marks.

6. A typewriter assembly according to claim 4 wherein the characters printed by the typewriter are alpha-numeric characters and the assembly includes a movable structure for moving the single rotary printing element during the printing out of a line of characters, spacing-marking means mounted adjacent said movable structure, spacing mark sensing means movable with said movable structure for sensing the spacing marks on said spacing marking means, and spacing mark signal coupling circuit means for deriving output electric marking signals representative of the spacing between characters being printed out by the typewriter assembly, said spacing marking means including specially coded beginning of line markers which result in said spacing mark sensing means producing coded electric output signals indicative of the start of a new line of characters being typed.

7. A typewriter assembly according to claim 1 wherein said encoding means comprises a set of orthogonal marks having light reflective surfaces formed on the periphery of the single rotary printing element in the form of latitude and longitude lines whereby the angular orientation assumed by the single rotary printing element in printing-out a particular character results in rotating a unique pattern of markings past separate observation points for the vertical and horizontal planes, separate single electrooptic light responsive sensing devices having a single light path optically coupled to the respective markings for each observation point, said devices each comprising a fibre optic bundle having light transmitting and light receiving branches each having one end commonly positioned to illuminate the reflective orthogonal markings on the surface of the single rotary printing element and to receive back light reflected from the markings, respectively, the light transmitting fibre optic branch having its remaining end positioned adjacent a source of illumination for directing light onto the reflective markings and the light receiving fibre optic branch having its remaining end positioned to image received back light pulses onto the light sensitive surface of a photo electric converter device.

8. A typewriter assembly according to claim 7 wherein the single rotary printing element has a quasi-spherical shape with a flattened head portion and wherein one set of orthogonal light reflective marks are in the form of set of radially extending spokes formed on the flattened head portion and rotatable about a first axis of movement and the remaining set comprises a set of horizontally extending rows of light reflective marks rotatable about a second axis of movement, and the two separate single electro-optic sensing devices view and count the radial spokes and the horizontal rows, respectively.

9. A typewriter assembly according to claim 4 wherein the encoding means is formed by a series of alternate light reflecting and minimally reflecting marks formed along the length of respective ones of a set of two drive cables used to rotate the single rotary printing element to a particular angular orientation related to a particular character being printed out by the typewriter.

10. A typewriter assembly according to claim 9 wherein the encoding means comprises at least two separate sets of similar characteristic encoding marks formed on opposite sides of the drive cables movable synchronously with the single rotary printing member, and the fibre optic bundle is dual sided and includes separate light transmitting and light receiving branches for each set of encoding marks.

11. A typewriter assembly according to claim 14 wherein the encoding means is formed by a series of alternate light reflecting and minimally reflecting marks formed on the drive pulley wheels for a set of drive cables used to rotate the single rotary printing element to a particular angular orientation related to a particular character being printed out by the typewriter.

12. A typewriter attachment for a typewriter of the kind having a single rotary printing element for printing alpha-numeric characters and including a laterally translatable structure for translating the single rotary printing element during the printing out of a line of characters, said attachment comprising spacing marking means formed on and movable with said translatable structure and a pattern of light reflecting and minimally reflecting marks spaced along the axis of translation of said translatable structure, and spacing mark sensing means positioned adjacent to and light path coupled to the spacing marking means and comprising a fibre optic device having light transmitting and receiving branches for respectively illuminating and receiving back light pulses from the spacing marks, and

a single photo-electric conversion device having the received spacing mark light pulses directed onto the light sensitive surface thereof for converting the light pulses into corresponding characteristic coded pulses electric signals representative of the spacing between characters being printed out by the typewriter.

13. A rotary printing element for a typewriter having sets of orthogonally arranged light reflective encoding marks formed on the surface thereof separately from and in addition to the normal alpha-numeric characters appearing on the rotary printing element to form a grid of latitude and longitudinal lines for identifying points on the surface of the printing element during rotation of the rotary printing element about mutually orthogonal axes to a particular angular orientation representative of a particular character to be printed by the rotary printing element, the set of light reflective orthogonal encoding marks being arranged in the form of intersecting vertical columns and horizontal rows.

14. A rotary printing element according to claim **13** wherein the rotary printing element has a quasi-spherical shape with a flattened head portion and wherein the set of orthogonally arranged marks are in the form of a set of radially extending spokes formed on the flattened head portion and rotatable about a first axis of movement and a set of horizontally extending rows rotatable about a second axis of movement.

15. An attachment for use with typewriters of the kind having a single rotary printing element for deriving coded electric output signals representative of the characters being printed-out by the typewriter in addition to the hard copy printed-out normally provided by such typewriters, said attachment comprising encoding means for attachment to movable members of the typewriter which are driven synchronously with the single rotary element for encoding each individual character imprinting movement of the single rotary printing element with a code, said encoding means comprising serially arranged alternate light reflecting and minimal light reflecting code marks physically arranged in predetermined sequential patterns representative of each individual character, single electro-optic light responsive sensing device for each orthogonal direction of rotation of said rotary printing element, each of said single light responsive devices having a single light path coupled to said encoding means for serially sensing all of the respective characteristic code marks in sequence, and coded electric signal processing circuit means responsive to the respective single light responsive sensing devices for deriving serially-coded electric output signals representative of the characters being printed-out by the single rotary printing element and suitable for use with data processing systems.

16. A typewriter attachment according to claim **15** wherein each of the single electro-optic light responsive sensing devices comprises at least a source of light, light transmitting means forming a single light path for directing light from said source of light onto the predetermined pattern of light reflecting and minimal light reflecting code marks as the same are moved serially past the light transmitting means, light receiving means for receiving back light pulses reflected from the code marks and directing the received light to a light sensitive member in said single electro-optic light responsive sensing device, said light sensitive member comprising a single photo-electric conversion element having a light sensitive surface that converts the received light pulses into corresponding serially coded pulsed electric output signals representative of characters being printed-out by the typewriter.

17. A typewriter assembly attachment according to claim **15** wherein the light transmitting means and the light receiving means comprises a fibre optic bundle having light transmitting and light receiving branches each having one end commonly positioned to illuminate and read-back, respectively, the pattern of light reflecting encoding marks, said light transmitting fibre optic branch having its remaining end positioned to be illuminated by the source of light and said light receiving fibre optic branch having its remaining end positioned to image light pulses received from the pattern of light reflecting encoding marks onto the light sensitive surface of the photo-electric conversion element.

18. A typewriter assembly according to claim **17** wherein the encoding means comprises at least two separate sets of similar characteristic encoding marks formed on opposite sides of a member movable synchronously with the single rotary printing member, and the fibre optic bundle is dual-sided and includes separate light transmitting and light receiving branches for each set of encoding marks.

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