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(71) Applicant
Snipe Computers Limited

(Incorporated in United Kingdom)

Babbage House, 18 Whitefield Road, New Milton, Hants. BH25 6DF

(72) Inventor
Colin Victor Fellowes

(74) Agent and/or Address for Service
Withers & Rogers,
4 Dyer's Buildings, Holborn, London EC1N 2JT

(56) Documents cited
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Selected US specifications from IPC sub-class G06K

(54) Bar-code reader

(57) A bar-code reader for use in, for instance, retail outlets or libraries, is coupled to a data collection device by ultrasonic means. The reader is in the form of a wand (10) having a light emitter (16) and a light sensitive receiver (20) at one end and an ultrasonic transmitter (22) at the other end. Battery power is saved by operating the light emitter (16) in a pulsed mode during a quiescent state of a control circuit, and only switching to continuous operation when the white lead-in portion of a bar code is detected. Ultrasonic coupling of the wand (1) to the data collection device allows cordless operation, and, if required, several wands can be so coupled to the same device.

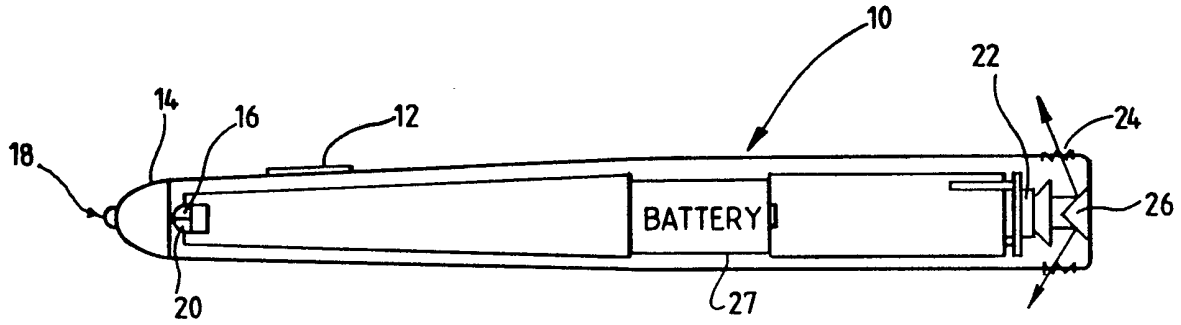

Fig.1.

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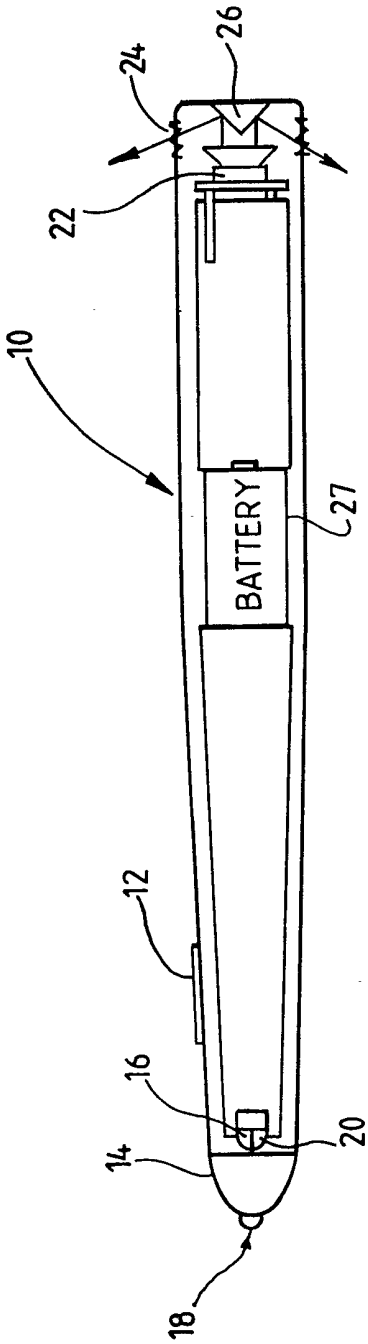

Fig.1.

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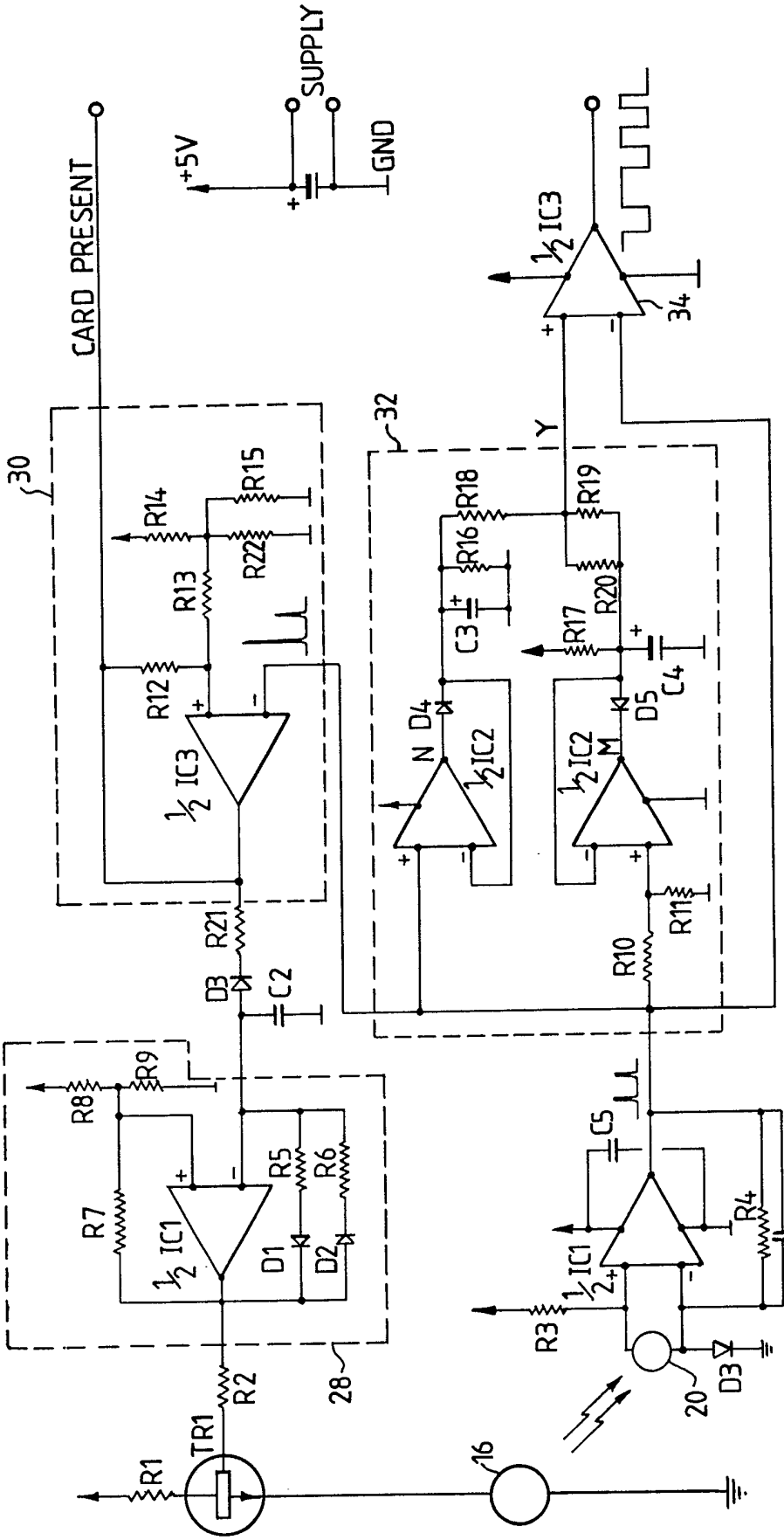

Fig.2.

SPECIFICATION

Bar code reading system

This invention relates to a data collection system and to optical reader therefor, more particularly though not exclusively, a bar code reader.

Data collection systems are widely used in libraries, shops and supermarkets and many other applications, for example, to record the movement of stock or when the system is linked to the case register, to automatically prepare a customers bill. Indentification of the stock item and/or other relevant information is applied thereto in the form of a bar code; a sequence of black bars on a white background. After a white lead-in portion, the bars and spaces have differing widths to represent in accordance with a predetermined code, the relevant information.

The bar code is read by passing over the bar code a reader usually in the form of a so-called "wand" or pen having at one end, optical elements for generating a beam of light which is reflected to a greater or lesser extent depending upon whether the beam impinges upon the white background or a black bar, onto a light sensitive element forming part of a control circuit for generating an electrical bar code image signal.

These signals may be connected either directly to a central processing unit or to a portable data collection terminal incorporating a memory in which data is stored temporarily prior to being read into a processing unit, for example, at the end of a shift.

In either case, the wand or pen requires a cable connection not only to provide signal transmission paths, usually in both directions enabling return signals to provide confirmation that accurate data has been received, but also for the supply of power to the control circuit for driving the optical elements. An infra-red laser diode such as normally used in bar-code readers requires a relatively high current of the order of 40 mA.

One object of the invention is to provide a bar code reader that is truly portable, requiring no hard-wired connections to the data collecting terminal or CPU.

According to one aspect of the present invention, I propose a bar-code reader, preferably a wand or pen, in which the bar code image signal is used to drive a transmitter, conveniently an ultra-sonic signal generator, whereby the bar-code image signal is transmitted to a data collection device which may be either a portable device or form part of a CPU or terminal.

One advantage of ultra-sonic signal generators is that they present high impedance requiring only small currents and so are ideally suited for use in battery operated devices.

Conventional bar code readers in the form of hand held wands or pens cannot be battery powered due to the relatively high currents required by the infra-red laser diode, and hence the size of the batteries necessary to provide an acceptable working life.

With the object of avoiding this problem I now propose a bar code reader wherein the control circuit is operable preferably only following activation of the bar-code reader in readiness for use, to switch on light emitting means at intervals and to compare the signal generated by light sensitive means on which reflected light impinges, with a predetermined reference value. When the sampled signal exceeds the reference value for a predetermined time conveniently selected to correspond with the so-called white lead-in portion of the bar-code, the light emiting means is switched on permanently or at least until the output of the light sensitive means reverts to its quiescent level for a continuous period whereupon the control circuit is reset.

By virtue of sampled switching at a mark-space ratio typically of 10% or any other convenient relatively small fraction, the effective power consumption in the quiescent state once the reader has been activated is only a fraction of the power consumed in continuous operation. Since full power is required only when the treader is actually in use, the useful life of the batteries is considerably extended. The present invention therefore enables a wand or pen to be of manageable size and still have a reasonable useful life.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows schematically a wand or pen for reading a bar code;

Figure 2 is a diagram of a control circuit incorporated in the wand or pen of Fig. 1.

Referring first of all to Fig. 1, the wand or pen 10 which is activated by a button or switch 12, has at the pointed end 14 thereof a light source 16 arranged to direct a beam of light out through a lens 18 onto a surface bearing a bar code. Light is reflected back through the aperture 18 and impinges upon a light sensitive receiver 20 connected in output pulses which are converted by a control circuit (not shown) on printed circuit board 21. The central circuit, which is described below with reference to Fig. 2, converts output pulses generated by the receiver 20 into a bar code-image signal used to drive an ultrasonic transmitter 22 disposed at the other end of the pen and protected by a gauze screen 24. The transmitter comprises a piezo-electric crystal generator emitting signals at say 40 KHz, that are reflected by the conical surface 26 to radiate in all directions. These signals are received by a data collection device or terminal which may be portable and preferably of such a size as to be carried in the pocket of an operator.

Typically the wand has a range of about 8ft. which is sufficient for most purposes. Accuracy can be confirmed by virtue of the fact that a typical bar code and hence the bar code image signal includes a check sum digit or element, so that an intelligent terminal may be adapted to produce feedback, for example, in the form of an audible signal, to indicate that accurate information has been received.

The light source 16 and receiver 20 both of which are of a solid state construction and usually sensitive in the infra-red band are connected in the bar-code reader control circuit as shown in Fig. 2, the source, an infra-red laser diode, being driven by a transistor TR1, the base of which is connected to an oscillator 28 producing in the quiescent (i.e. activated) state a pulsed output signal having a mark/space ratio of about 10% whereby the transistor TR1 conducts and the laser diode is switched on at intervals for example, for 1 millisecond every one hundreth of a second (i.e. 10% of the time). When in continuous operation the diode consumes in the region of 40 milliamps. By comparison the power consumed in the quiescent state is one tenth full power.

In this state, unless the wand is directed towards a reflecting surface little light is incident upon the receiver so that the output of the amplifier to which the receiver is connected, is in the form of a series of short pulses. The pulses are applied to one input of a comparator 30 producing an output when the pulses exceed a reference voltage determined by the ratio R14 to R22, and corresponding to a pulse produced when light is reflected by a white portion of the bar code, so that the oscillator 28 is switched on permanently when the comparator 30 output is maintained for a period determined by capacitor C2 and resistance R21. This period is selected so as to correspond to the so-called white lead-in portion of the bar code so ensuring that full cover is consumed only when a bar code is being read.

Two operational amplifiers, to each of which the receiver output pulses are applied, together form a current following device 32. The resistors R10, R11 prevent operational amplifier M from ever reaching the voltage level as applied to operational amplifier N. Operational amplifier M is able, therefore, to prevent extraneous variations in the white level (high) from affecting the averaging performance of the current follower. This produces at one input of a comparator 34 a signal representing the mean level of the receiver output. This is compared with the receiver output which is applied to the other input of the comparator so that the comparator 34 output goes high when received output exceeds the mean level and *vice versa* to produce a square wave output which is an electrical representation of the bar code and is referred to as the bar-code image signal. It is this signal that drives the piezo-electric crystal generator producing an ultra-sonic bar-code image signal for transmission to the data collecting device.

The sampled switching technique described above and by which the power requirement is reduced to about 10% of full power in the quiescent state, has other advantages in the context of a data collection system wherein a number of bar-code readers are required to transmit data to their respective data collection devices at the same time and in the same vicinity.

As described the light source is turned on for one millisecond every one hundredth of a second. If the receiver does not "see" a reflection therefore the ultra-sonic generator transmits a pulse signal having a mark of 1×10^{-3} seconds and a space of 9×10^{-3} seconds. Both the pulse and repetition are fixed in time (length) and due to the tolerance of components or by design different fixed times may be obtained to give an identifiable signature for each wand.

For a nominal mark space ratio of 10% and with a 10% tolerance limit on components various mark/space combinations are possible. Taking the upper and lower tolerance limits and the nominal value and when transmitting at 40 kHz these combinations are:

36 ± 1	326 ± 1	@	-10% limit
40 ± 1	360 ± 1	@	0% limit
44 ± 1	396 ± 1	@	$+10\%$ limit

A bandwidth of $\pm$ cycle is required to ensure no crossover. Hence, nine different combinations are possible while maintaining minimum power consumption, and it will be appreciated that a greater number of combinations could be produced if required.

An intelligent receiver of the ultra-sonic transmitted data can therefore be programmed to learn the "signature" of a particular wand (this being achieved by a manually requested function on the receiver) and thereafter accept data only from that wand until it is reset.

CLAIMS

1. A bar-code reader having light sensitive means, a control circuit coupled to the light sensitive means for producing a bar-code image signal corresponding to the signal generated by the light sensitive means when a bar code is scanned, and a transmitter coupled to and operable to be driven by the control circuit for emitting into space a signal corresponding to the bar code image signal.

2. A reader according to claim 1 in the form of a battery powered cordless wand, and

wherein the transmitter is an ultrasonic signal generator.

3. A reader according to claim 1, further comprising light emitting means coupled to the control circuit for irradiating a bar code, and wherein the control circuit is arranged to have a battery saving quiescent state during which the light emitting means is driven for short time intervals periodically, and an activated state in which the light emitting means is driven continuously.

4. A reader according to claim 3, wherein the control circuit is arranged to change from its quiescent state to its activated state when the signal generated by the light sensitive means exceeds a predetermined level for a predetermined time.

5. A reader according to claim 4 wherein the control signal is arranged to revert to its quiescent state when the signal generated by the light sensitive means falls to a quiescent level for a continuous period.

6. A reader according to any preceding claim wherein the control circuit includes means for generating a reference signal representative of a mean level of the signal generated by the light sensitive means, and a comparator coupled to receive the reference signal on one input and the instantaneous signal generated by the light sensitive means on another input, the signal present at the output of the comparator constituting the bar-code image signal.

7. A reader according to claim 3, wherein the mark-to-space ratio of energisation of the light emitting means during the quiescent state of the control circuit is substantially 10%.

8. A reader according to claim 2, wherein the ultrasonic transmitter is located at the end of the wand which is remote from the light sensitive means.

9. A reader according to claim 8, wherein the wand has a casing which has an aperture adjacent the transmitter.

10. A bar-code reading system comprising at least one wand as defined in any of the preceding claims, and a remote data collection device.

11. A bar-code reader constructed and arranged substantially as hereinbefore described and as shown in the drawings.

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