# United States Patent [19]

**Vargo**

[11] **3,745,354**

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[54] **DETECTOR FOR READING BAR CODES ON MOVING ARTICLES AND HAVING IMPROVED SIGNAL-TO-NOISE RATIO**


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[52] **U.S. Cl.** ..... **250/219 D**, 250/223 R, 250/209, 235/61.11 E

[51] **Int. Cl.** ..... **G08c 9/06**

[58] **Field of Search** ..... 250/219 D, 219 DC, 250/219 DD, 208, 209; 333/70; 235/61.11 E



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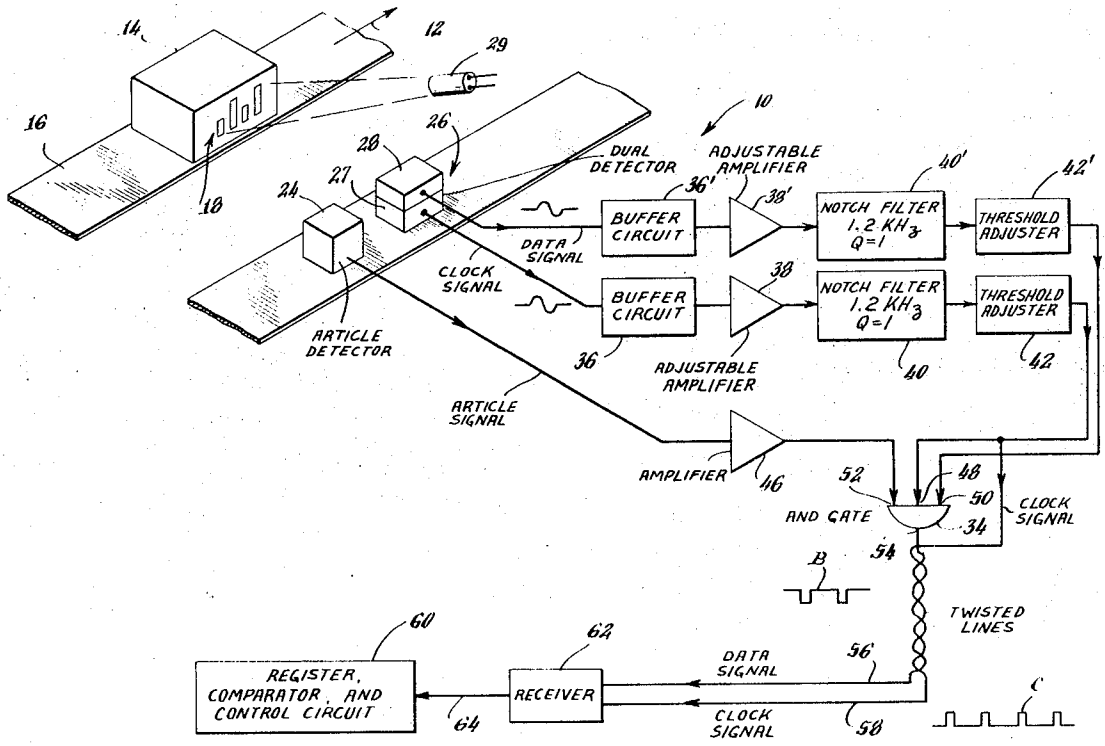
[57] **ABSTRACT**

A detection system is provided of the type used for reading bar coded indicia on articles passing on a moving conveyor and for emitting a corresponding output signal to be used in subsequently manipulating the articles. To reduce noise in the output signal and so to provide an improved signal-to-noise ratio and more accurate manipulation of the articles in response to the code, the detection system is arranged to be selectively responsive not only to the frequency characteristic of the spacing of the coded bars, relative to their speed of passage, but also similarly responsive to the frequency characteristic of the width of the bars in the code. This predetermined detection frequency is established in the coded indicia by giving each individual bar a uniform width dimension, preferably equal to the spacing between adjacent bars. The detector includes a notch filter passing this predetermined frequency so that wide band noise and spurious signals developed at other frequencies will be eliminated from the output signal.


**4 Claims, 2 Drawing Figures**



2 Sheets-Sheet 1

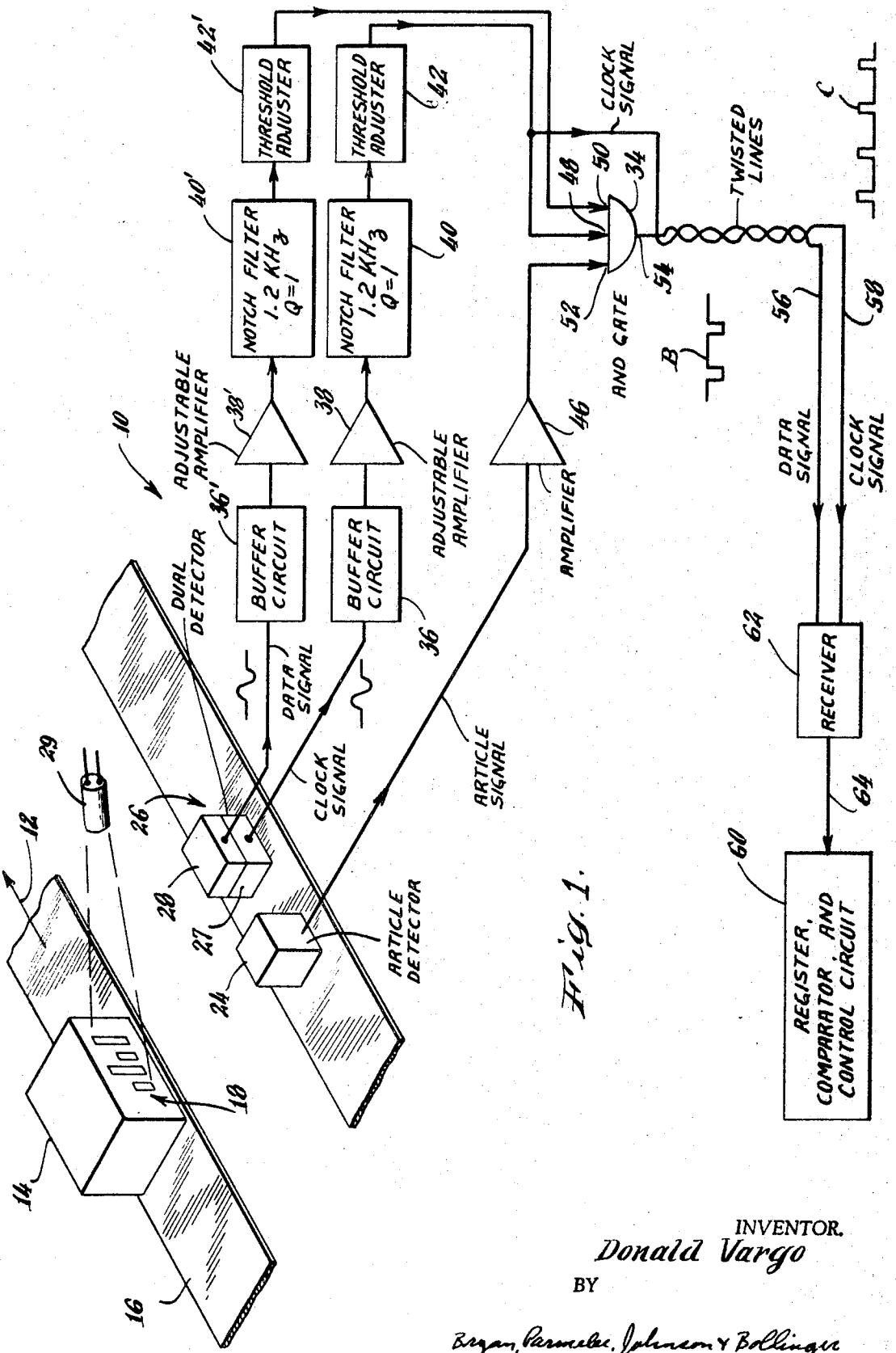



Fig. 1.

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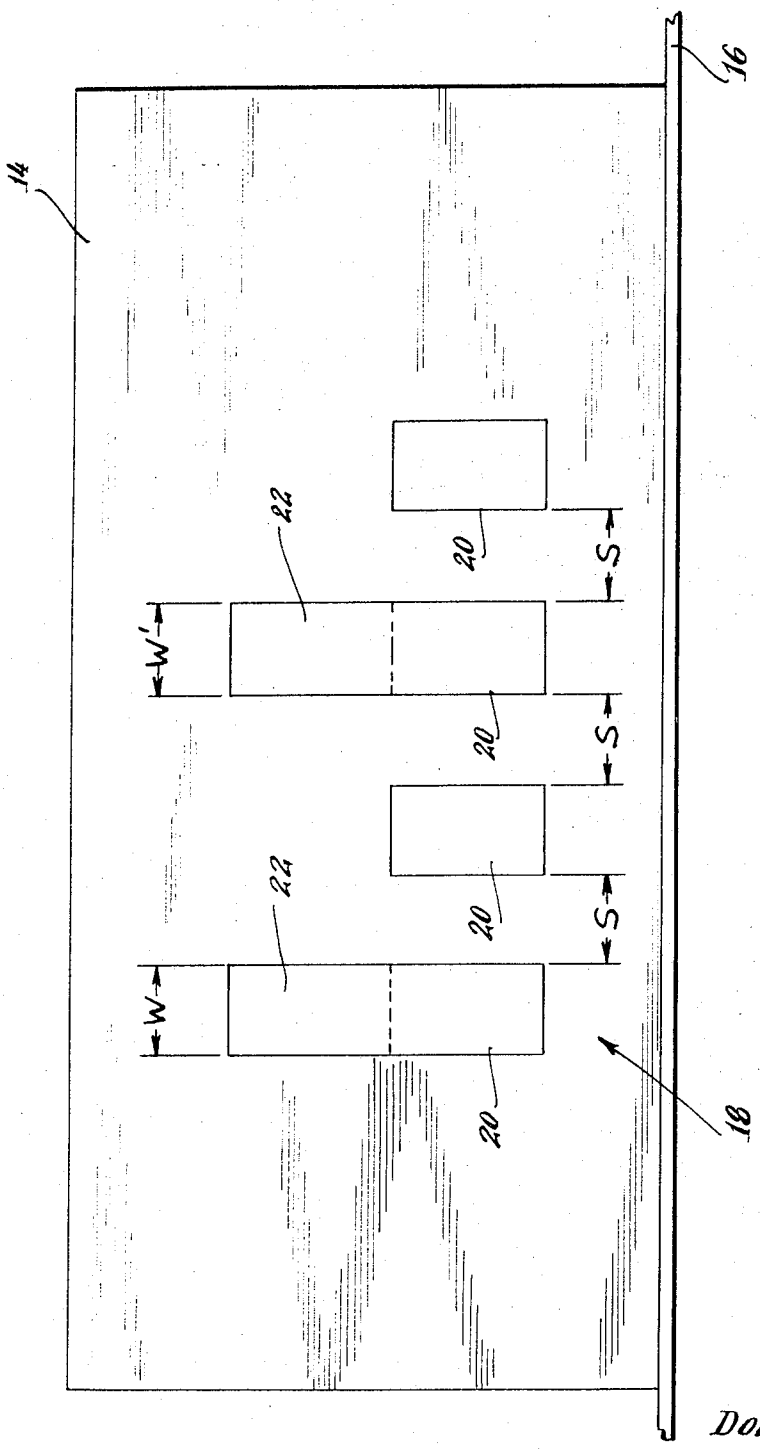


Fig. 2.

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# DETECTOR FOR READING BAR CODES ON MOVING ARTICLES AND HAVING IMPROVED SIGNAL-TO-NOISE RATIO

## BACKGROUND OF THE INVENTION

The present invention relates to the field of object identification in which a code is placed upon an article so that, when the article passes down a conveyor line, the code may be read by a scanning system and the article thereby identified. This identification can be used for control of the article as it passes diverting stations on the belt, for inventory purposes, or the like.

Although various types of codes have been used for this purpose, one of the more commonly used codes is a so-called bar code. A bar code is one having bars positioned transversely to the direction of motion of the article (or transversely to the direction of motion of the scanner itself if the scanner moves) and having information encoded therein in binary fashion by the presence or absence of a code or data bar in each of a series of evenly-spaced positions. As the article moves down a conveyor belt, the detector examines each possible code position and determines whether or not indicia are present.

In carrying out the examination, the determination of those positions on the article in which a code indicium might be found can be based upon periodically-timed readings of the surface of the article as it passes the detection station, noting the presence or absence of a marking in each time period, or upon the use of a parallel second bar code, above or below the code carrying the information, the second bar code having indicia adjacent each possible data bar position, thus indicating when the related code should be read. The second code is ofter referred to as a "clock code," and its indicia as "clock bars."

Code indicia have usually been formed with visible inks and detected by means of optical detectors sensitive to visible wavelengths. Magnetic inks and detectors have also been used. Codes have also embodied use of luminescent inks, visible when subjected to ultraviolet light, as is referred to in the present invention.

The practical use of such codes for article identification, however, is limited by the ability of detectors to discriminate between the indicia and their background. If the threshold sensitivity of the detector is not sufficiently great, the signal can be lost in spurious background signals and noise when light is reflected from the spaces between the bars into the detection system, or, even more serious, when material upon which the luminescent code is printed itself contains a brightener which is subject to excitation upon being exposed to the same ultraviolet illumination.

## SUMMARY OF THE INVENTION

In order to improve signal-to-noise ratios and enhance the sensitivity of detection, the present invention utilizes a phenomenon intrinsic to bar codes but heretofor unobserved and unused.

It is, of course, realized that a given spacing of the bars in the code in conjunction with a given speed of scanning establishes a frequency of detection (bars per second) which can be used for timing purposes. It has not been noted, however, that a single bar itself, having a predetermined width, will also be detected as a single cycle of predetermined frequency, when considered in conjunction with the speed of travel of the belt upon



which the coded articles ride. By utilizing and combining these two factors in a bar code having bars of predetermined uniform width, preferably equal to the spacing between bars so that a single detection frequency is produced for both single and multiple bars, the present invention enables one to use a sharply defined filter that will detect and pass only signals with a frequency corresponding to the desired data, and substantially eliminate unwanted background noise. The particular filter used is known as a notch filter and preferably has a Q of 1 to minimize transients.

Utilization of the frequency characteristic of bar width is not limited only to the information of the code, but can be applied as well to the clock code if one is used. The resulting signal can then be used for control or other purposes.

## DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial schematic and partial block diagram of the present invention; and

FIG. 2 is an enlarged side elevational view showing the arrangement of the code.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates the invention as applidd to the detection of codes containing both data and clock bars, and shows the overall detection station, a portion of the conveyor belt with an article thereon passing the detection station, and the circuitry associated with the detection station and including the notch filter.

The detection station, generally indicated by the numeral **10,** is positioned adjacent a conventional moving conveyor belt **16.** The belt is depicted carrying article **14** in the direction shown by the arrow **12.** Article **14** has thereon the data and clock code, generally shown by the numeral **18,** and more specifically shown in FIG. **2.** Code **18** includes a series of vertical clock bars **20** uniformly spaced in the horizontal direction and a series of data bars **22.** Data bars **22** will by their presence or absence in the spaces immediately above the clock bars **20** serve to convey coded information. Thus, as shown in the example of FIG. **2,** there are four clock bars **20** and so there are four positions in which there may be the presence or absence of data bars **22.** The four positions provide $2^4$, or 16 possible combinations of present and absent data bars **22.**

The bars are indicated in FIG. **2** as being of a width W and the clock bars are spaced apart from one another by a distance S which, preferably, is the same as width W. It can be seen then, that if the clock bars pass a detector looking through a scanning slit at the bars passing at a given constant speed, the detector will sense the presence of a bar and then the absence of a bar sequentially and will receive a square wave signal of a frequency corresponding to the number of bars that pass the scanner per second. Because of detector characteristics and circuit response characteristics, the square wave is usually rounded off close to a sinusoidal shape of the same frequency as it passes through the circuitry. It turns out, however, that a single bar of this same width such as one of the bars **22** of the data code, will produce one cycle of the same frequency. Accordingly, it is possible to utilize highly selective frequency sensitive circuitry that will pass only signals of frequency corresponding to the bar coded data and

thereby enhance the signal-to-noise ratio, but still enable a single data bar to be accurately detected.

Detection station **10** includes two types of detectors, an article presence detector **24** and a dual code bar detector **26.** Article presence detector **24** is simply a photodetector positioned adjacent conveyor **16** and adapted to detect the presence or absence of a passing article **14.** Once it detects the leading edge of the passing article **14** it actuates circuitry, as will be described below, to make the dual detector **26** operative. Once the article has passed by the article presence detector, the code detecting unit is deactivated so that no false data signals will be transmitted.

The dual code bar detector **26** includes clock bar detector **27** and, above it, data bar detector **28.** Each of these detectors is a photodetector, such as a photomultiplier tube, with a limited vertical field of view appropriate to look at either the passing data bars alone, or the passing clock bars alone.

Preferably the data bars and clock bars are made of a luminescent material, which radiates visible light energy upon being subjected to ultraviolet light. Therefore, an ultraviolet light source **29** is provided adjacent the detectors directing the ultraviolet light toward the conveyor belt and so upon the bars **18** on article **14.**

Clock bar detector **27** receives one pulse of energy for each clock bar **20** passing in front of it. This signal, substantially sinusoidal in shape, appears at the output of detector **27,** and passes through a buffer circuit **36,** and adjustable amplifier **38,** a notch filter **40** and a threshold adjuster **42,** and is applied to one input **48** of an AND gate **34.** Similarly the signal from data bar detector **28** passes through buffer circuit **36'**, adjustable amplifier circuit **38'**, notch filter **40'**, threshhold adjuster **42'**, and is applied to a second input **50** of AND gate **34.** A clock signal is received, of course, for every possible code position whereas a data signal is received only for each of the marked code positions.

As has been mentioned, the circuits of both the clock bar detector **27** and the data bar detector **28** include a notch filter. Being a notch filter, the band of frequencies passed is very narrow and can be considered to include essentially only the center frequency. The filter preferably has a Q of **1,** meaning that in one cycle the same energy comes out of the filter as goes into it, thus eliminating transients and slow damping effects which might otherwise continue into the time when the next data position is being examined. The center frequency of the notch filter is selected according to the spacing and width of the bars relative to the speed of the article on the conveyor belt. For example, if bar width and spacing are equal and article speed is such that 1,200 bars pass the detector per second, then the appropriate notch filter is one which has a center frequency of 1.2KHz.

The signal from the article presence detector **24** passes through amplifier **46** to a third input **52** of AND gate **34.** Thus, when there is coincidence of: the presence of an article, the presence of a clock signal, and the presence of the data signal, there will be an output signal emanating from output terminal **54** of AND gate **34,** which signal is carried to subsequent circuitry over output lead **56** as a signal as shown in insert B with reverse polarity compared to the inputs to AND gate **34.**

Output lead **56** is twisted together with another lead **58** which carries the clock signal as shown in insert C. Therefore, any noise picked up by leads **56** and **58** will be present equally in each lead. The leads **56** and **58** are connected to a decoding receiver **62** which derives a difference signal from those carried by leads **56** and **58,** and thereby cancels out any noise picked up. The output of receiver **62** is carried by line **64** to a circuit **60** having register, comparator and/or control functions and which may be used to control the passage of articles **14** in their future course on belt **12,** or to inventory the articles into particular types or classes, or for other purposes.

It will be noted that, if desired, the clock signal and the article detector signal may be eliminated and use made only of the data signal. This is a matter of design preference taking into account the uses to which the detector is put.

It should be understood by those skilled in the art that various modifications may be made in the present invention without departing from the spirit or scope thereof as described in the description and defined in the appended claims.

What is claimed is:

**1.** Detection apparatus for detecting the presence or absence of information in data code bar positions aligned with clock bars adjacent thereto, both data and clock bars appearing on articles moving at uniform speed relative to the detection apparatus and being formed with predetermined uniform widths, and having uniform spaces between bars equal to said uniform widths, thereby providing for every clock and data bar a predetermined detection frequency related to the speed at which the bars are scanned, the detection apparatus comprising:

first scanning means for scanning across the data bars to thereby retrieve the data of said bars and to produce data signals corresponding to the presence of said bars and having said predetermined frequency;

second scanning means for scanning across the clock bars synchronously with the scanning of said first scanning means and to produce clock signals as each data bar position is scanned, said clock signals having said predetermined frequency;

first bandpass filter means receiving said data signals and passing essentially only said predetermined frequency;

second bandpass filter means receiving said clock signals and passing essentially only said predetermined frequency; said first and second bandpass filter means being notch filters with a Q of **1;** and

coincidence means for comparing signals from said first and second filter means.

**2.** Apparatus as defined in claim **1** wherein said clock and data bars are a luminescent material and said apparatus includes means for irradiating said bars with ultraviolet light.

**3.** In a method for detecting the presence or absence of information in the data code bar positions aligned with clock code bars adjacent thereto, both clock and data bars being found on articles moving past a dual detector at uniform speed, wherein the dual detector simultaneously scans across the clock bars and data bars to retrieve the information of the data bars and, through associated circuitry, transmits said data for control or accounting purposes, the improvement which comprises:

forming said clock bars and data bars with a predetermined uniform width, the space between said clock bars being uniform and equal to said prede-

termined width thereby providing for every bar a predetermined detection frequency related to the speed at which said detector scans across a bar;

scanning across said data bars to produce a data signal corresponding to the presence of said data bars and having said predetermined frequency;

simultaneously scanning across said clock bars to produce a clock signal having said predetermined frequency;

separately filtering said data and clock signals simultaneously, with sharply defined bandpass filters having a Q of 1, passing essentially only signals of said predetermined detection frequency; whereby an improved signal to noise ratio results and sensitivity of detection is increased for each signal; and

comparing said filtered data and clock signals in coincidence means.

**4.** The method of claim **3** wherein said clock and data bars are formed from luminescent material and said bars are irradiated with ultraviolet light during scanning.

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