

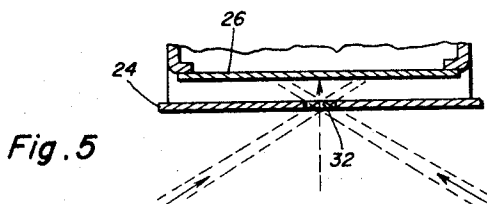
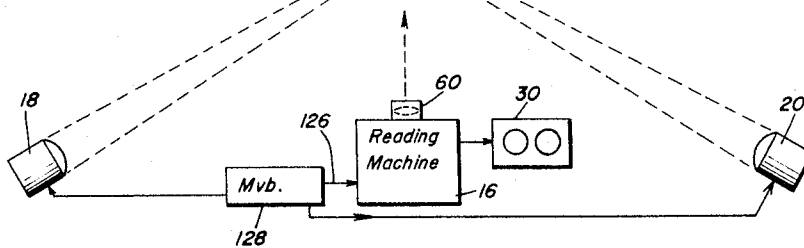
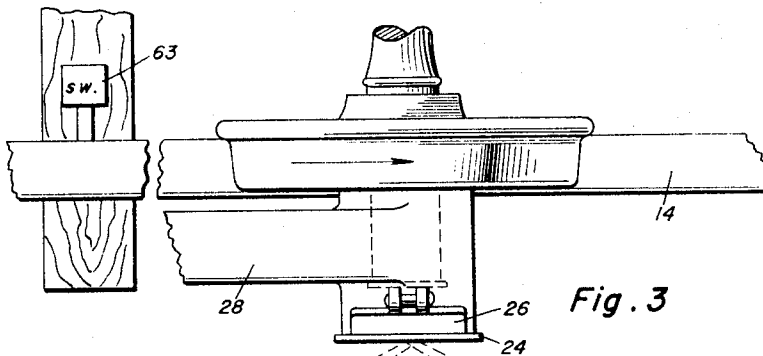
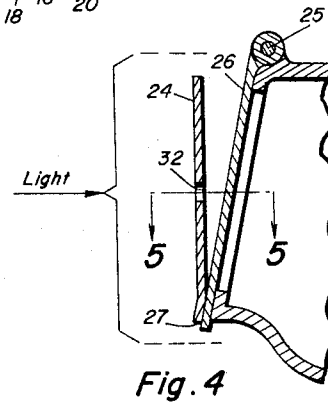
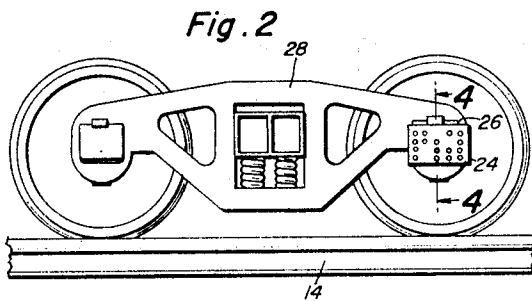
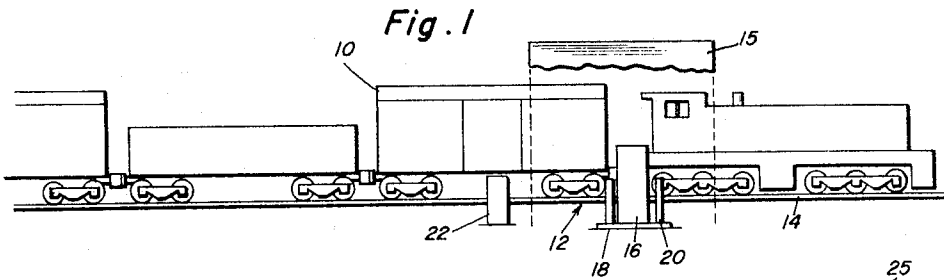
Oct. 4, 1966

J. RABINOW ET AL
RAILWAY CAR IDENTIFIER

3,277,283

Filed March 22, 1962

5 Sheets-Sheet 1



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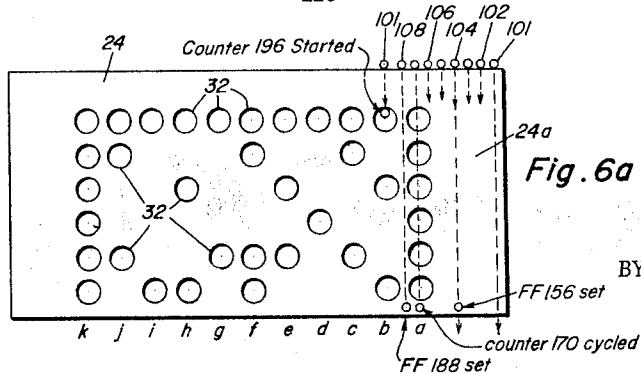
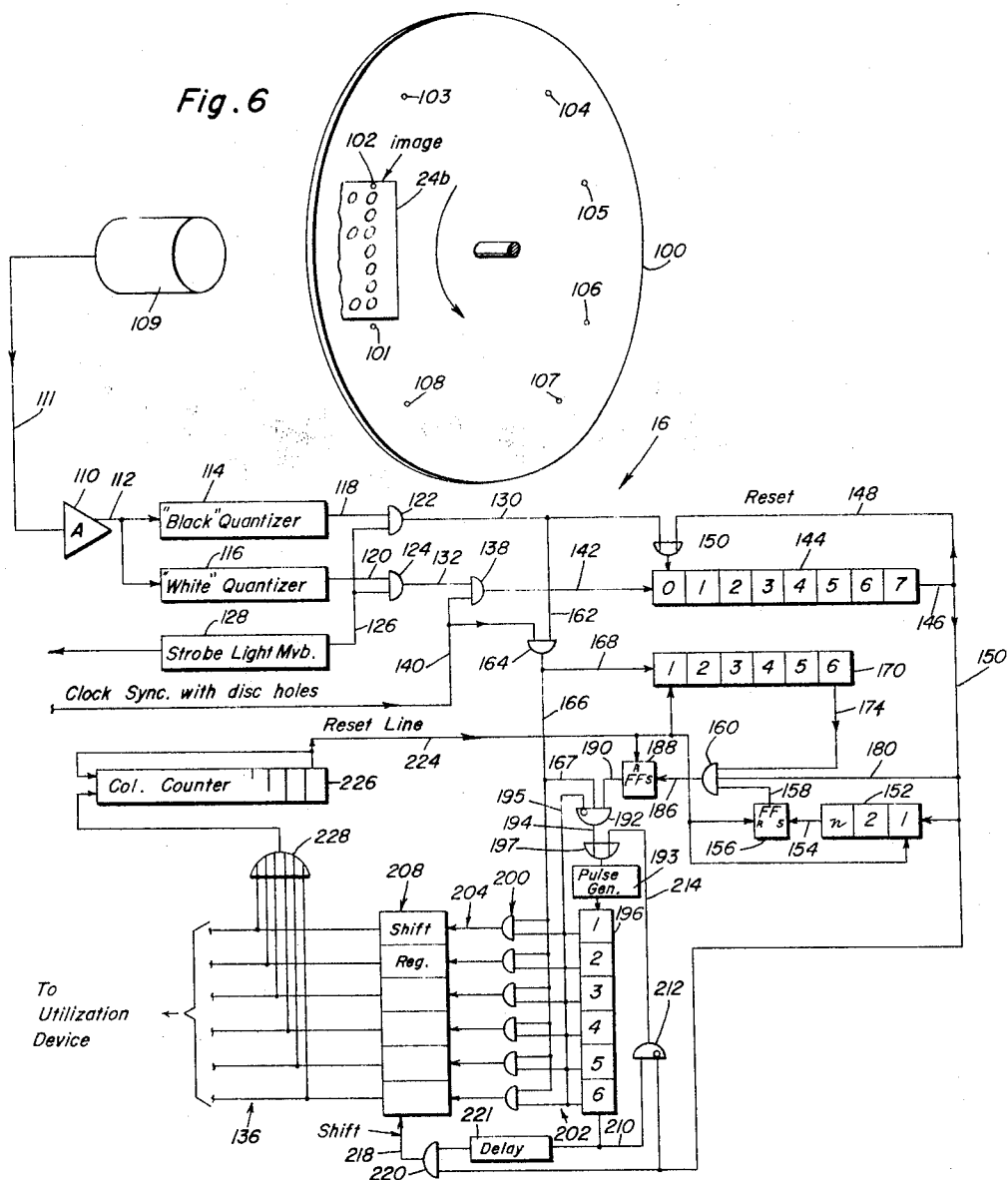
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5 Sheets-Sheet 2



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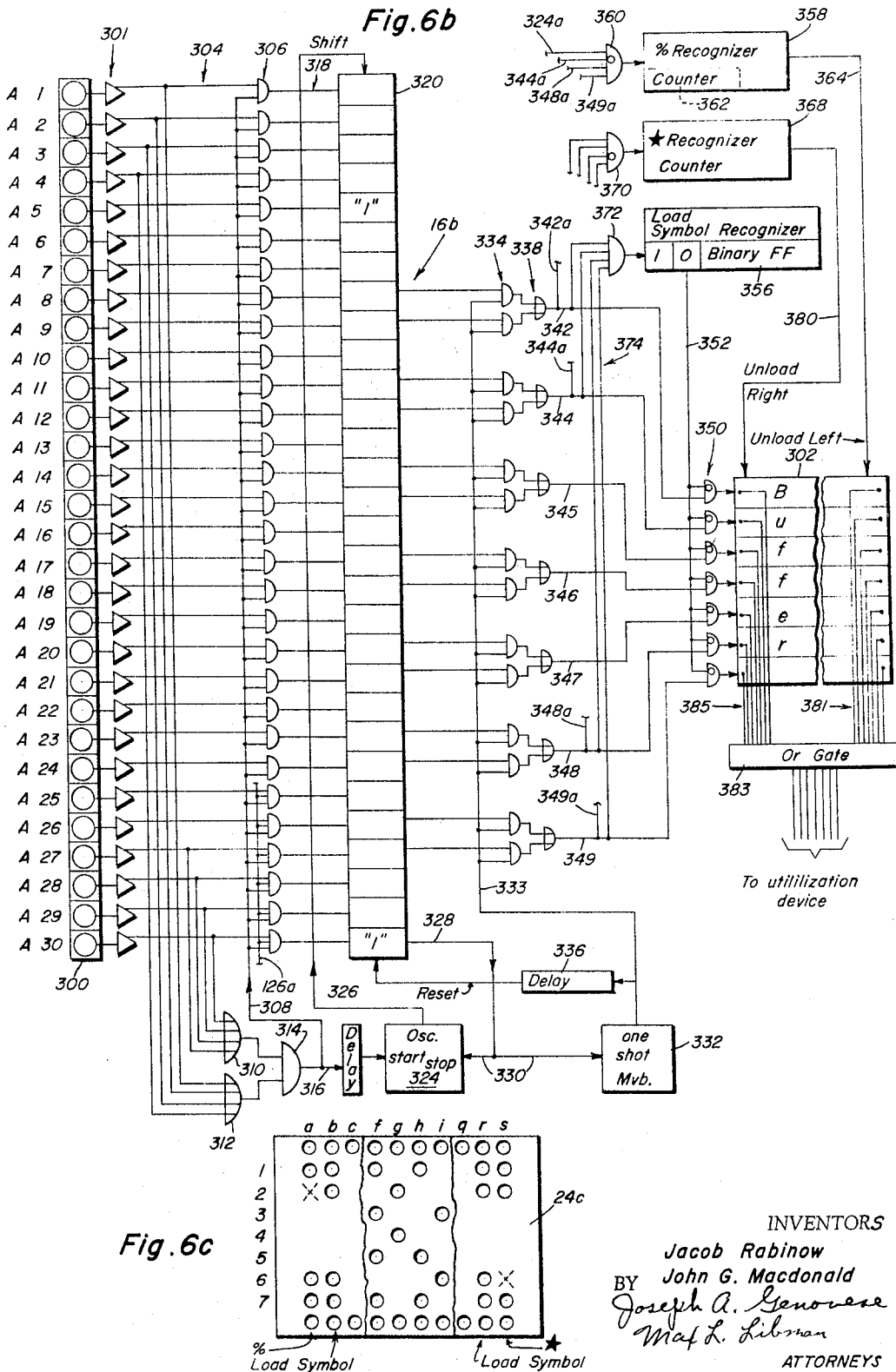
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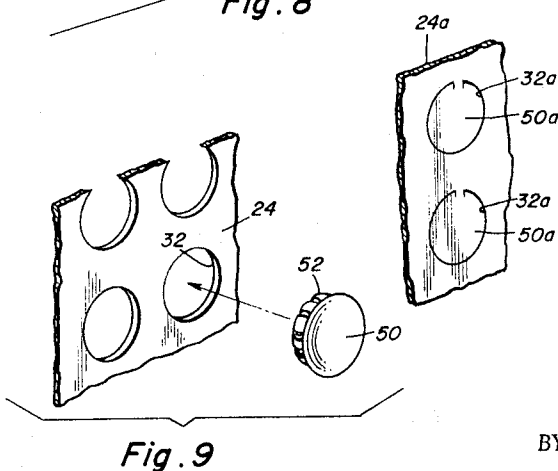
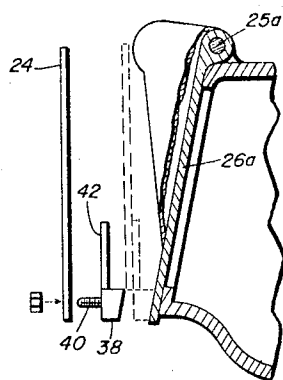
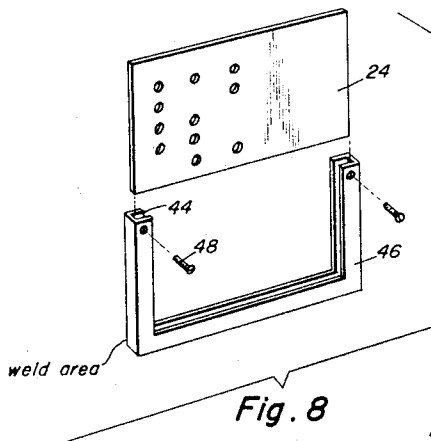
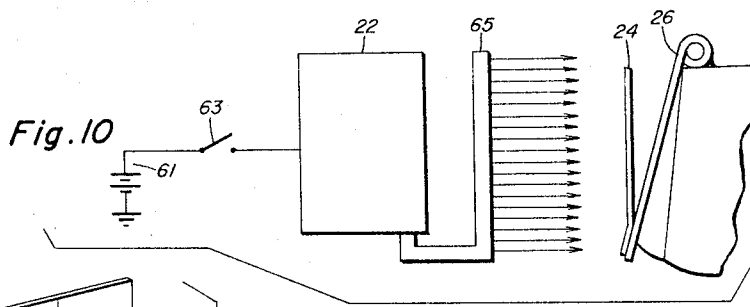
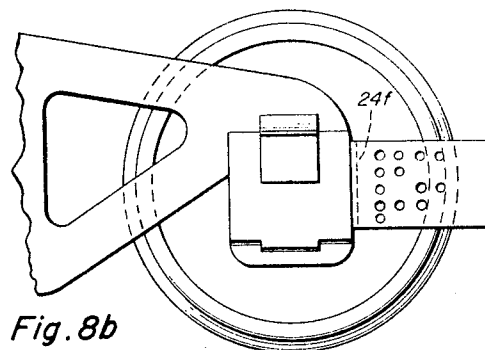
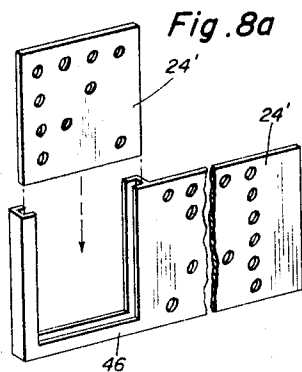
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5 Sheets-Sheet 4



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5 Sheets-Sheet 5

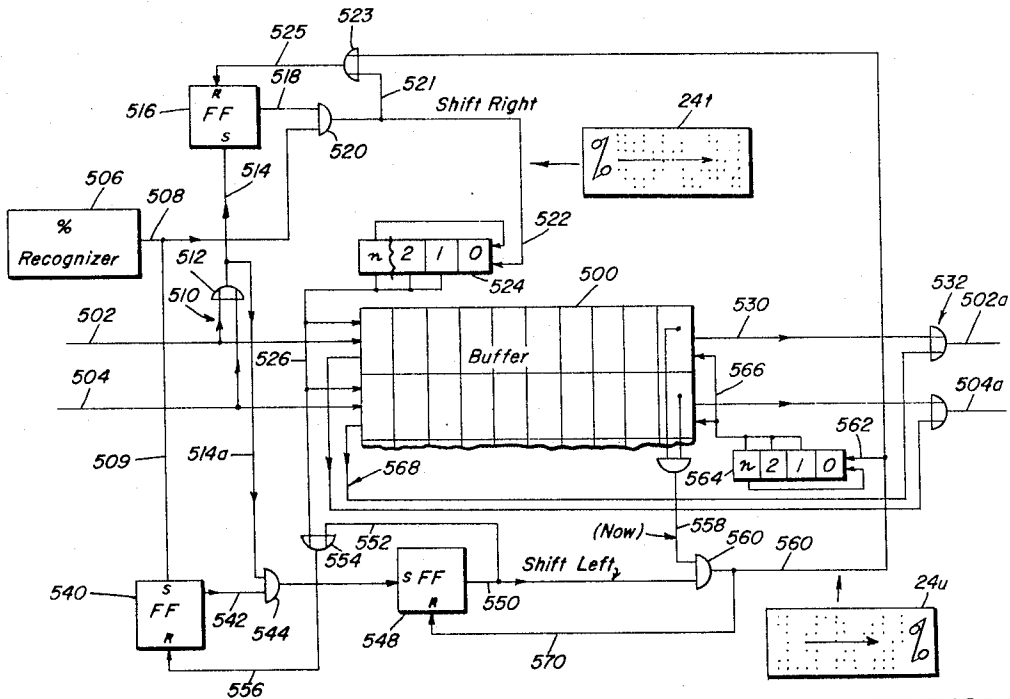
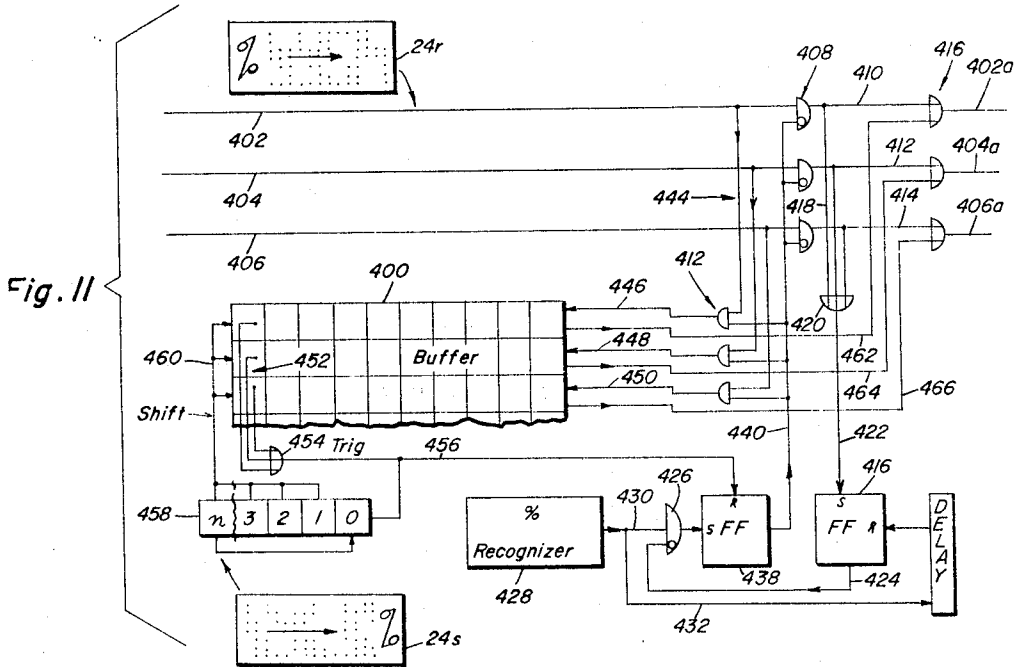


Fig. IIa

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1

3,277,283 RAILWAY CAR IDENTIFIER

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6 Claims. (Cl. 235—61.11)

This invention relates to a system for detecting and recording information carried by objects while they pass a check point. Although the detection system disclosed herein can be used with many moving objects such as trucks, automobiles, boats, packages, etc., it is especially useful with rail cars. Thus, the following description pertains to identification of rail cars, and recordation of data relating to them, their cargo, destination, etc., but it is understood that the principles of the invention apply to other moving objects.

Identification and recordation of railway car-identifying (or other) data have been long standing problems in the railroad industry. For example, the Ivey Patent No. 422,790, of 1890, and the Schierberg Patent No. 784,595, of 1905, disclose automatic devices for recording information relating to railway cars as they pass a checkpoint. As the art developed, numerous patented inventions have presented different solutions to the same problem. As technology progressed, modern techniques were used in an effort to provide a satisfactory system for identifying rail cars. For instance, the Ernst et al. Patent No. 2,956,117, of 1960, discloses the "Telefilm" freight car identification system which uses a television camera combined with radar equipment and a photographic film processor to make a record of the identifying letters and numbers on the sides of freight cars as they pass a checkpoint.

An object of the present invention is to provide a railway car identification system which overcomes serious difficulties encountered in prior systems, some of which are discussed below.

There are many freight cars in this country. The number is so large that the success of any system will depend on how little modification is required of each of these freight cars. Ideally, there should be no modification of any of the cars (as in Patent No. 2,956,117), and special reading machines should be developed to read the printed characters on the sides of the cars. Unfortunately the cost of television-radar-photography systems is high. Further, the lettering on cars becomes so weathered and dirty after a short time that it is often difficult even for a human to read the characters. Another problem is this: where the eyesight of a human being is able to quickly servo to the number on the car no matter where it is located (high, low, etc.), this is quite difficult for any presently conceivable reading machine.

The present invention relies on an automatic reading technique, but does not attempt to identify the printed characters already on the cars. Instead, by very inexpensive means, the identification characters of a car are reproduced in code on the car, and the code is machine-read to overcome the above problems. It is true that our system necessitates a code but it can be formed on or in a panel made only of a flat plate. Although the panel may be made smaller, a panel approximately 8 inches by 12 inches appears to be desirable.

The presently used practice for identifying railways cars is to have a human checker at a check station read the characters on the sides of the cars as they pass slowly through the check station. The necessary data concerning the cars are ordinarily recorded and processed in an office. This is not only a slow, expensive method, but the human-error is quite high. A system such as disclosed in Patent No. 2,956,117 is faster. That patent states that the

2

system is effective with train speeds as high as 35 miles per hour. A feature of the present invention is that the cars may be identified accurately at any speed that the train is capable of attaining.

Railway cars often sway, especially when the rail bed is poor. The trucks of the cars are subject to sway due to the same cause, but the amplitude is far smaller than that of the car bodies on which the identification numerals are ordinarily printed. To reduce the cost of the reading machine equipment and avoid having to examine the entire side of a car, it would be advantageous to have the railway car identification at a reasonably uniform place on every car, and have it insensitive to the more acute swaying. Accordingly, a further object of the invention is to provide railway car identification means, preferably as a panel on a part of the truck which ordinarily does not sway violently, and which is reasonably uniformly spaced from the rails of the track, both vertically and horizontally. A preferred location for our panel is on the journal box or its cover because these boxes contain the ends of the car axles, and railway car wheels have a reasonably uniform diameter; e.g., 28 to 33 inches. Furthermore, there is ordinarily no appendage or device on the outer side of these covers since they must be opened periodically for inspection and lubrication. Those journal boxes which are sealed, contain covers which are not usually opened and these, also, can be used to support our code panel. Alternatively, the cover itself can be used as the carrier of the code.

The fact that the identifying characters are in code is an advantage for machine reading, leading to considerable simplification of the reading machine, as opposed to reading machines which are required to identify the alphanumeric characters.

Railway cars become quite dirty in normal use. This is, as discussed before, one of the acute problems in attempting to directly read the characters on the side of the car. By having a comparatively small code panel at a predetermined place on each car, it becomes practical to clean the panel automatically when the cars approach or are in the check station. It would be impractical to attempt to wash or otherwise clean practically the whole side of a car when it is moving at high speed in order to aid the reading machine in identifying the printed characters on the sides of the cars. But, when the code is on a small panel at a predetermined height within a small tolerance, we can clean the panel, for instance, by water, steam, air, etc., with or without detergent or other cleaning agents. In our system this may be done automatically as the cars approach a reading machine located at the check station. Furthermore, the panel can have a coating (or be made entirely of) material which sheds water and dirt. "Teflon" is a satisfactory material for this purpose.

Machine reading by optical means such as suggested by the present invention, can encounter difficulties if the code is hidden or disturbed by accumulations of ice and dirt. The above cleaning procedure will overcome this difficulty. In addition, one of the preferred ways of establishing the code is to use a substantial plate, for instance a metal plate with or without a dirt repelling surface. The code is made of holes through the plate. The holes can be of any shape such as polygonal, elliptical, round, etc. Round holes have a slight advantage over other shapes, because they have no dirt-accumulation corners. If the holes are approximately one-half or three-quarters of an inch in diameter it is highly unlikely that they will become filled with ice or dirt. However, in those embodiments where a cleaning device is used, the holes will be cleaned prior to each reading. Using holes to establish the code has other advantages. For instance, the holes can always be made to appear (to a reading machine) to

be darker than the front surface of the panel even when the panel appears to be "black." By using sufficient light, even ordinary "black" surfaces will reflect enough light to distinguish the holes which reflect no light because there is no surface to reflect light.

There is always a possibility that sunlight and other sources of illumination may be a cause of spurious signals. It is our intention that the reading machine station would normally be covered by a shelter so that it either totally bridged the cars as they pass through the station, or at least, the shelter could be made in sections which approach the train from both sides so that extraneous light can be excluded as far as possible. Another method (to be used with or without the shelter) is to use stroboscopic lights of high intensity which are operated in synchronism with the reading of the codes. Because of the short pulse duration of such light, its intensity can be made very high to override ambient illumination. Still another way to minimize ambient light problems is to take advantage of the fact that the stroboscopic light has a sharp rise and fall while the ambient illumination is, in general, of a steady nature. If the photocell amplifiers of the code panel reading machine are suitably designed, only rapidly varying lights will be picked up, and slow changing lights can be neglected. These rapidly-changing lights can be made with such fast rise times that the modulation of the light by the motion of the identifying panel will appear slow by comparison.

Since it is important to read the codes properly, we have a further precaution against improper readings caused by spurious light reflections. By directing the wanted light onto the panel at an angle, the panel is made to form a shadow-mask for the area directly behind the code holes being read. Thus, the background behind the code holes will always be darker than the front-surface area of the panel adjacent to the code-holes being read.

Although we shall emphasize the reading of codes which identify rail cars, it is understood that any data in addition to or in place of car-identity data can be read. For instance, the data may relate to destination, cargo, ownership, routing, etc.

Other objects and features will become apparent in following the description of the illustrated forms of the invention.

FIGURE 1 is a diagrammatic side view of a railway train passing through a check station equipped with apparatus in accordance with the invention.

FIGURE 2 is a side elevational view of a typical railway car truck having a code panel attached thereto.

FIGURE 3 is a diagrammatic top view of the check station of FIGURE 1 with the shelter omitted and showing a single journal box, wheel, and car-identification panel.

FIGURE 4 is an enlarged sectional view taken on line 4—4 of FIGURE 2.

FIGURE 5 is a sectional view taken on line 5—5 of FIGURE 4.

FIGURE 6 is a diagrammatic view showing a typical reading machine for one of our code panels.

FIGURE 6a is a view of our code panel.

FIGURE 6b is a schematic view showing a modification of the code-reading machine.

FIGURE 6c is an elevational view of a panel used to help explain the operation of the machine of FIGURE 6b.

FIGURE 7 is a diagrammatic exploded sectional view showing a modification of the means for attaching a code panel to a journal box cover whose construction is different from that of FIGURE 4.

FIGURE 8 is an exploded perspective view showing a further modification.

FIGURE 8a is a perspective view showing a modification of our code panel.

FIGURE 8b is a front view of a part of a car truck showing an alternate way to mount a code panel on a journal box.

FIGURE 9 is a fragmentary exploded perspective view showing a plug for one of the code holes in the panel of FIGURE 6.

FIGURE 9a is a fragmentary perspective view showing a code panel with different means to form the code.

FIGURE 10 is a side view showing our code panel cleaning device and its controls.

FIGURES 11 and 11a show alternate reading machine buffers.

Summary of system

FIGURE 1 shows a train 10 passing through a wayside check station 12 near track 14. The check station can have a shelter 15 which bridges, or partially bridges the train to both protect reading machine 16 and exclude, as far as possible, spurious light. Optical reading machine 16 has light sources 18 and 20 on each side thereof to illuminate code panel 24 on a train car at the time of reading. Cleaning device 22 can be considered at the check station or in advance thereof. FIGURE 2 shows a code member or panel 24 attached to the journal box cover 26 of typical railway car truck 28. As the train passes through check station 12 the code of panel 24 is cleaned by device 22 (when a cleaning device is used as a part of our system) and illuminated by light sources 18 and 20. While panel 24 is illuminated, the reading machine 16 reads out the code, and the code is recorded by a printer, a punched paper tape recorder, a magnetic recorder, radio or telephonic transmitter, etc.

Code device and mounting

One configuration of code panel 24 (FIGURE 6a) is a flat durable plate with columns of holes 32 formed therein. Each vertical column (a-k) represents a single character or other data. An area at the top or bottom of the panel may be reserved for conventional alphanumeric characters which correspond to the individual columns so that a person unfamiliar with the code can read the panel information. To aid the operation of the reading machine, the leading edge area 24a and the first column "a" can contain a code which produces a signal that reading machine 16 recognizes as a "begin to read" signal. Another column of the panel may contain a check number for the reading machine to assure that the machine has read the panel information properly. For forward-or-backward reading of the code, columns "a" and "k" can each contain "begin-to-read" signal codes, with information as to the direction of reading which is used by reading machine 16. We prefer to use a parity check digit in each column as is common in computer technology. "Begin-to-read" signal codes, parity checks, and check number codes are conventional, as are the facilities in reading machines to recognize these codes. In the embodiments of our invention which use marks (not shown) on a panel instead of holes, the holes 32 would simply be replaced with marks. It is to be clearly understood that the size and shape of panel 24 and the arrangement of the code may be varied. For instance, instead of a six bit code as shown in FIGURE 6a we could use a code having a larger or smaller number of bits, e.g., FIGURE 6c. We have shown nine vertical character columns "b"- "j" and here again, this number may be increased or decreased.

Most journal boxes have their covers slightly tilted (see FIGURES 4 and 7) with a hinge 25 at the top. Thus, by securing the lower edge portion 27 of panel 24 to the lower part of the journal box cover with the code area of the panel vertical, the panel will stand off from the front surface of the journal box cover but not enough to interfere with the normal opening and closing of the journal box. The physical connection of panel 24 with the journal box cover can be made in numerous ways, one of which is to weld or braze the lower edge 27 of panel 24 to the cover. Another is to use brackets, bolts, etc. The fact that the code area of the panel stands off from the

journal box cover 26 provides us with an important reading feature.

As shown in FIGURES 1, 3 and 5 the lamps 18 and 20 are located to the left and right respectively of the reading machine. By masking and/or using vertical columnating lenses or the equivalent, the lamps project a narrow beam of light onto the outer face of panel 24 as the truck 28 moves through the reading station. The optical axis of the reading machine coincides with the cross-over point of the light beams (see FIGURE 5) so that the reading machine optics "see" the unlighted background immediately behind the typical code hole 32. Thus, the front surface of the panel 24 serves as a shadow mask for the background of the reading machine optical system when the illumination sources 18 and 20 are at an angle to the face of the panel 24 substantially as shown. And, by having the front face of the panel 24 reflective (galvanized, stainless steel, plated with reflective material, painted, coated with light Teflon or other non-wetting (chemically material, etc.) and the background behind holes 32 unlighted, there will be a considerable light-to-dark ratio between the holes and the front surface of the panel. To further this end, the panel 24 may be made of hollow-core construction thereby increasing the thickness. In the simpler form, though, a heavy-duty single thickness metal plate is considered practical, especially if it is approximately $\frac{3}{16}$ or $\frac{1}{4}$ of an inch thick (or thinner with a roll or flange at its edge) so that it cannot be easily bent.

FIGURE 4 shows the lower edge portion 27 of the plate at an angle to the major area thereof. The lower edge 27 can be brazed or welded, bolted or otherwise secured to the lower part of the journal box cover. Another method of attaching panel 24 to the journal box cover is shown in FIGURE 7. Cover 26a is of a slightly different design from cover 26. The hinge structure 25a projects forwardly a considerable distance. In all cases of which we are aware, the hinge structure 25a does not project forward far enough to prevent panel 24 from being mounted vertically. However, to increase the standoff distance, we can supply a standoff bracket 38 which is welded, clamped, brazed, bolted etc. to the lower edge of the journal box cover 26a. Panel 24 could then be attached to the front face of the bracket 38 by any means, for instance by using studs 40 and nuts and providing holes in the lower edge portion of the panel. For additional support vertical backing strips 42 may be provided on the standoff bracket 38.

FIGURE 8 shows another modification where the panel 24 is fitted into the ways 44 of a mounting bracket 46. In this instance the bracket is a frame whose lower edge is fastened to the journal box cover. After (or before) the panel 24 is slid into the ways 44 bracket may be fastened to the journal box cover. When the panel 24 is slid into the ways 44 it may be fastened in place by any means, for instance by the bolts 48. It is understood that the bracket 46 is given by way of example only and that other frame-type brackets could be used. This form of mounting has the advantage of being able to easily remove the panel and replace it with another containing code information in addition to the car-identification, e.g., the ultimate destination, kind of cargo, the consignee, etc. A modification (FIGURE 8a) has a two-piece panel 24' with the parts adjacent, and the one having the car number permanently attached to, or formed with frame 46; but the other containing the various data, removable. Although we discuss "metal" panels, other materials (or combinations) can be used. For example, the panel can be made of pressed fibreboard or plastic, particularly plastic laminate. Where a part of the code panel is disposable (FIGURE 8a) it is preferred that the disposable part be made inexpensive, e.g., fibreboard, treated cardboard, etc. If desired, the full field of the disposable part of the panel could be punched, and the code established

by plugging or covering (with adhesive tape) selected holes.

Each of the illustrated code panels (described above) are shown attached to the journal box cover. This is a good place to attach the code panel, but not the only location possible. FIGURE 8b shows a code panel with a flange 24f at one edge which is attached to the side edge of the journal box or its cover. In a like manner, the panels of FIGURES 7, 8, 9, etc. could be secured to the side of the journal box or to a predetermined part of the truck of a car.

Each car will have at least one panel with a code unique to the car. However, normally, two panels would be used for each car, one for each side. This means that only one reading machine is necessary at each station, but two reading machines can be used to check each other. The panels may have their codes uniquely formed at a manufacturing plant, just as automobile license plates have numbers uniquely formed at a central plant. But, since it may be more expensive to punch unique codes in the panel for each car and dispatch them to the site of the rolling stock, the full field of the panel may be punched or otherwise formed with the holes 32 and then the code set up by filling all the undesired holes. We can use any kind of plug for this purpose, for example plug 50 having a reflective outer surface to match the surface of panel 24 and resilient prongs 52 arranged as a skirt so that the plugs need only be pushed in the holes 32 and allowed to automatically lock in place. Plugs, and particularly the type of plug 50 shown in FIGURE 9, are merely one of many methods for masking the undesired holes in order to set up a code peculiar to a given car.

It is simpler at the point of installation to furnish panels with knock-outs. These are incompletely punched discs 50a (FIGURE 9a) in panel 24a, that are removed to form the desired code of holes 32a. The knock-outs can be the same as in electrical boxes and can be removed the same way as an electrician removes them from electrical boxes. Thus, installation in the field can be simplified by attaching panel 24a in place and then removing selected discs 50a (or removing the correct discs 50a and then securing the panel to the rail car).

Cleaning and reading devices

Cleaning machine 22 (FIGURES 1 and 10) can be a commercially available steam or liquid cleaner operated with or without a cleaning agent. Such machines are extensively used for cleaning automobile engines, tires, etc.; and they are usually valve-controlled. We can use an equivalent, solenoid valve, controlled by a circuit 61 having a switch 63 (FIGURES 3 and 10) so located that its operator is actuated by the flange of a car wheel as a train car approaches the reading station. Thus, the code panels will be cleaned by the fluid discharged from the nozzle 65 of machine 22, just prior to reading. We can use a photocell circuit in place of circuit 63 and switch 61, but this is not as simple as the wheel-operated switch.

Reading machine 16 can be comparatively simple because the information of each panel 24 is already in a code which need only be transposed to corresponding electrical signals to be recorded by a suitable recorder 30, such as a conventional paper tape punch. However, the reading machines (FIGURES 6 and 6b) have several features making them particularly effective for our purpose. One is strobing the light sources 18 and 20 with the reading of the panels 24. Another is that the machines read the codes independently of the speed of the panel; and they provide considerable flexibility for left-to-right or right-to-left reading and/or data processing.

FIGURE 6 shows a scanning disc 100 rotated by a motor (not shown) and having a plurality of scan apertures 101, 102, 103 . . . 108 which examine the image of a typical panel 24. The optical system 69 of machine 16 (FIGURE 3) forms an image of panel 24 on disc 100, and the motion of the rail car furnishes one component of scan motion. Disc rotation forms the other component

of scan motion. Photocell 109, e.g., a photomultiplier, is located behind disc 100, and its output on line 111 is amplified at 110 to provide output signals on line 112 to "black" and "white" quantizers 114 and 116. The outputs on lines 118 and 120 from the quantizers correspond to the "black" and "white" information, i.e., when a scan aperture "sees" a code hole 32 or the surface of panel 24 respectively. We use the terms "black" and "white" only as a convenience, it being understood that we will be dealing with dark and light greys most of the time. Pending application Serial No. 115,165, filed on June 6, 1961, describes a scanning system (for printed letters and numbers) which is essentially the same, up to the quantized signals on lines 118 and 120.

And gates 122 and 124 have lines 118 and 120 as respective inputs, and line 126 as the other input of each. Line 126 conducts rapid strobe signals from multivibrator 128 (or the equivalent), one of whose purposes is to strobe light sources 18 and 20 (FIGURE 3). Thus, gates 122 and 124 are interrogated when panel 24 is illuminated, i.e., during the illumination periods of the high intensity sources 18 and 20. The frequency of multivibrator 128 is great enough so that gates 128 and 124 are interrogated (by the strobe pulses) many times during the time that it takes a scan hole (e.g., 102) to traverse one hole 32 of the image 24b (FIGURE 6). The output signals on lines 130 and 132 from gates 122 and 124 are processed by the remaining circuitry (FIGURE 6) to provide outputs on lines 136 to recorder 30 or any other utilization device. There are six lines 136 to provide concurrent outputs which correspond to the data of each column-position of panel 24, although we could easily have a serial output on a single line to take the place of lines 136.

Consider panel 24b of FIGURE 6 to be the image of panel 24 of FIGURE 6a as it is being scanned. FIGURE 6a shows how the panel is traversed by successive apertures 101, 102, etc. as the panel image moves to the right. When aperture 101 scans the reflective leading edge area of panel 24, there will be successive outputs on line 132, each corresponding to the movement of a hole 101 across the leading edge area 24a of panel 24, in sync with the very rapid strobe pulses passing gate 124. But there will be no "black" signals, line 130. The "white" outputs are gated at 138 with a clock signal on line 140 in sync with the rotation of disc 100, to provide "white" outputs on line 142 which operate counter 144. The counter has a number of stages to correspond to the width of panel 24, taking the speed of disc 100 into consideration. When counter 144 is stepped to the end, there is a signal on line 146 fed back over line 148 and Or gate 150 to reset the counter. Line 130 ("black" signal) is also Or gated at 150 to reset the counter 144 if a hole 32 is detected anywhere in a vertical scan (shown by dotted lines in FIGURE 6a). To make certain that we are scanning the leading edge area 24a of panel 24 we required "n" completely white scans before doing anything else. In practice "n" can be about five to thirty scans (depending on the speed of the rail car), but we have shown only four scans (FIGURE 6a (represented by scan apertures 101-104 inclusive and their traces shown by dotted lines). The "completely white" scans are represented by outputs from counter 144 on lines 146, 150, which are counted by counter 152 of "n" stages. When counter 152 steps to the "n"th stage, the output on line 154 sets flip flop 156. The flip flop 156, when set, provides a standing signal on line 158 to And gate 160. This gate will be further described later. Up to this point, we have detected the panel 24 by scanning the area 24a with "n" successive scans, and have then set flip flop 156. The next requirement is that we detect a column of holes 32, i.e., the first column adjacent to area 24a. We do this as follows, although there are many ways to do the same thing.

The "black" signals on line 130 are conducted over

line 162 to And gate 164 whose other input is the clock signal (synchronized with the image-scan rate of holes 101, 102, etc.) on line 140. The output of gate 164 is conducted on line 168 to counter 170 to count the holes 32 ("black" signals) in the first column (column "a") of the panel 24. Since we show six holes in column "a," counter 170 has six stages with an output line 174 from the last stage to gate 160. Thus, we have a circuit which provides signals on lines 158 and 174 to gate 160 when there are "n" white scans and then six "black" pulses corresponding to the fully punched column "a." As will be described later (FIGURE 6b) column "a" cannot only represent a "start" code but can also designate whether the car (panel) is moving left-to-right or right-to-left with respect to the reading machine. But gate 160 will still be unsatisfied because line 180 (its remaining input) has no signal. Line 180 is connected to line 150, and therefore, it conducts each "all white scan" signal, none of which has any effect on gate 160 until we have "n" white scans (the traces of apertures 101-104 in FIGURE 6a), and the detection of six holes 32 (trace of scan aperture 106 in FIGURE 6a). When this is followed by an "all white scan" (trace of scan aperture 108 in FIGURE 6a) representing inter-column spacing in panel 24, gate 160 is satisfied, to provide an output on line 186 which sets flip flop 188. The output of flip flop 188 is conducted on line 190 to And gate 192, another of whose inputs is the information signal ("black") over lines 166, 167. The output of gate 192 on line 194 starts pulse-burst generator 193 through Or gate 197 to operate counter 196 whose frequency is a function of the speed of disc 100 and the pitch of holes 32. The counter 196 is stepped six times to sequentially interrogate gates 200 in time with the movement of a scan hole, e.g., 102, across the image 24b (further described later). For now (see FIGURE 6a), after flip flop 188 is set, ring counter 196 will be started when a scan aperture (101 again in FIGURE 6a) detects the first hole 32 of a column. Each of the information columns of panel 24 begins with a hole 32, and the counter 196 is prevented from being recycled by a second "black" (hole 32) in any column by feeding back an inhibit signal over line 195 from the stages of counter 196 to an inhibit terminal of gate 192.

Once the beginning of each column of holes 32 of panel 24 is detected (by starting ring counter 196), read-out of the successive columns is very simple. FIGURE 6 shows a group of And gates 200 with lines 202 from the stages of ring counter 196 providing one input to each And gate at a rate compatible with the speed of disc 100, either by design of counter 196 or by gating the sync pulses on line 140 to start the counter. The other input to all of the gates 200 is line 166 which conducts the "black" pulse signals corresponding to holes 32. Thus, gates 200 are sequentially interrogated by the outputs of the successive stages of counter 196, thereby providing outputs on the gate output lines 204 corresponding to the information content of the column of holes 32 being scanned. Lines 204 are load lines for shift register 208 which stores binary ones and zeros corresponding to the scanned column of panel 24. Once started, the ring counter 196 will be recycled by a signal fed back over line 210, through inhibit gate 212, and over line 214. The inhibit signal for gate 212 is the "all white scan" signal on line 150, whereby the counter 196 will continue to cycle until the clear space between columns is detected. Thus, register 208 will be loaded an indefinite number of times (with the same information for a single column b, c, d, etc.) until the clear space between columns is detected, at which gate 212 becomes inhibited. We do this to impose no limitation on the speed of the car (horizontal motion of panel 24).

When the counter 196 stops cycling, register 208 is shifted by a shift signal on line 218 to provide the previously mentioned outputs on lines 136 to recorder 30. The

shift signal on line 218 can be obtained by gating (at 220) the "all white scan" signal on line 150 with the counter shift signal on line 210, delayed as at 221 for proper timing. This will prevent register 208 from shifting during the time that area 24a is scanned (because counter 196 will not be cycling to provide a signal on line 210 at that time).

When all of the information columns of holes 32 are examined, it is necessary to prepare the reading machine for the next panel 24. A reset signal on line 224 is used for this purpose, and as shown, line 224 is connected to the reset terminals of flip flops 188 and 156, and counters 170 and 152. Any suitable means can be used to provide the signal on line 224, for example, a column counter 226 which is stepped each time that there is an output on any of the lines 136. Or gate 228 with which all lines 136 are connected will serve this purpose.

Once a panel 24, 24', etc. is attached to a car, there is no practical way to assure that a particular edge (24a) will always be the leading edge. We could transmit the code as read, relying on the utilization device to transpose the data when necessary. Another solution to this problem is to have separate "start" signals (columns "a" and "k") at both edge areas of the panel and rely on logic circuits in the reading machine to transpose the code (when necessary) after reading. Accordingly, the reading machine 16b (FIGURE 6b) has a buffer 302 and a capability to load the buffer left-to-right or right-to-left (not shown) or to always load in the same direction and unload in a selected direction (shown). This feature will be described later, but we emphasize that it can also be used on the output of reading machine 16. (See also FIGURES 11 and 11a.)

A typical practical panel 24c (FIGURE 6c) has any number of vertical columns of data, for instance columns a-s inclusive. The top and bottom bits (holes) of each column are optical sprockets used to normalize the data in the reading machine. They are not part of the information defining the car, cargo, destination, etc. These data are contained in columns c, d, e . . . q, each having seven bits, numbered 1-7 inclusive to the left of panel 24c. Columns "a" and "s," then, are seven-bit codes and these define two edges of the panel which we will call "left" and "right" simply for identification. Columns "b" and "r" are "load" symbols which are useful in a machine which transposes the data of a code panel before transmitting the data to a utilization device. "Load" symbols are not essential, as described later.

Machine 16b (FIGURE 6b) has scanner 300 made of a vertical row of thirty solid-state photocells A1-A30, although this number is arbitrarily selected. The output of each cell is amplified at 301 by a quantizing amplifier whose "black" and "white" (hole 32 or "no hole") outputs are conducted on lines 304. Each line 304 is an input to an And gate 306, there being one gate for each photocell-amplifier combination. If we wish to strobe gates 306 in sync with lights 18 and 20, strobe line 126a (the same as line 126 in FIGURE 6) is used as an input to each gate 306, and the gates are three-entry gates. Otherwise, we will use two-entry And gates 306 gated by the final input on line 308 which occurs when any cell of an upper group, e.g., cells A1-A4 and any cell of the lower group, e.g., cells A27-A30 concurrently detect code holes. The geometry of panel 24c is such that for cells for both groups to simultaneously detect holes, the holes must be the sprockets. We know when two sprockets of one column are detected by Or gating (at 310) the amplified outputs of cells A1-A4; Or gating (at 312) the amplified outputs of cells A27-A30; and And gating (at 314) the results. Load signal line 308 is connected to the output line 316 of And gate 314. Thus, when there is coincidence at gates 306 (a "black" signal on a line 304 and a "load" signal on line 308) there will be a resulting output signal on the corresponding gate output line 318. Lines 318 are inputs

for the shift register 320 having one stage for each photocell. Consequently, the "image" of column "a" code of panel 24c will be stored in register 320.

For the moment, assume that the panel is moving to the left meaning that the data in column a is the first that is stored in the register 320. This code is a directional shift code which is later used to shift out the data stored in register 302 in one direction, while the coded signal of column s (opposite end of the panel) signifies that register 302 must be unloaded in the opposite direction. These codes, though, are not used until all of the character information data are extracted from the panel.

Returning now to the register 320 having the data of column a stored therein, the next step is to normalize the data by shifting it down until the lower sprocket represented as a "black" signal (binary one), reaches the bottom stage of the register. We can shift down (or up) by using the delayed signal on line 316 to start an oscillator 324 whose output is fed over line 326 as shift pulses for register 320. When a binary "one" reaches the bottom stages, its signal is conducted on lines 328, 330 to stop the oscillator.

The signal on line 330 actuates a one shot multivibrator 332 whose output duration on line 333 is long enough to interrogate a set of And gates 334. The signal on line 333 is convenient to reset register 320, so it is delayed at 336 (to allow the gates 334 to be interrogated) and fed to the reset terminal of register 320. Gates 334 are two-entry And gates whose inputs are the signal on line 333 and selected output lines of the stages of register 320. The illustrated scanner has two cells for each information position 1-7 where panel 24c can have a hole or an imperforate area. Since we illustrate a seven-bit code, there are fourteen gates 334 with the outputs of pairs Or gated at 338. Thus, after register 320 is normalized, the pairs of And gates 334 are interrogated to see which associated pairs of photocells are "seeing" holes in panel 24c. The gate pairs which are detecting holes provide outputs (binary ones) on their respective output line 342, 343 . . . 349. These lines form inputs to a group of inhibit gates 350 which pass no signals to register 302, unless the inhibit signal on line 352 is removed. The inhibit signal is not removed until a specific "load" code (column b or r in FIGURE 6c) is recognized by recognizer 365.

Hence, the code of column a (or s) of panel 24c reaches gates 350 but is not stored in register 302. However, it is recognized by code recognizer-counter 358 made of inhibit gate 360 which triggers a counter 362 to provide shift pulses on line 364 to shift out register 302 from right-to-left. Column a code is represented as a % symbol while column s is represented by some other symbol such as an asterisk. But the asterisk is recognized by recognizer-counter 368 to provide left-to-right shifting of register 302. The way that the % code is recognized is as follows: lines 342a, 344a, 348a and 349a are connected to lines 342, 344, 348 and 349. Lines 342a, 348a and 349a are inputs to gate 360, and line 344a is an inhibit input. Thus, to satisfy gate 360 there must be holes at the first, sixth and seventh position of column a of panel 24c, and there must not be a hole at the second position (otherwise its corresponding signal on line 344a will inhibit gate 360). This will prevent a spurious "black" shadow from triggering the recognizer 358. Recognizer gate 370 operates the same way (but the connections to the gate are difficult), so as to recognize the asterisk symbol in a similar manner.

Although recognition of symbol % will shift out the register, it is presumed to contain no information, so shifting will have no consequence. Now assume that the panel 24c moves a little to the left with respect to the scanner, and the photocells see the vertical space between columns a and b. This will have no effect because "load" line 308 has no signal. As the panel 24c moves farther to the left column b (previously mentioned

"load code") will come into the field of view of scanner 300, and again initiate the read cycle. The data of column *b* will be loaded in register 320, normalized, and gated at 334, 338 over lines 342-349. But now the code of column *b* is recognized by satisfying gate 372 whose inputs are established by lines 374 connected to lines 342, 344, 348 and 349 which correspond to the first, second, sixth and seventh vertical position of column *b*. The output of And gate 372 is conducted to the binary flip flop 356, stepping it to the "one" stage so that the standing signal on line 352 to gate 350 is removed to thereby open gates 350. Thus, the "load" code of column *b* is loaded into register 302. The nature of a binary flip flop is such that the signal from stage "one" will continue until the flip flop is again pulsed (by recognizing the second "load" code of column *r* after the character data of columns *c*, *d*, *e*, etc. are loaded in register 302 in the same way that the code of column *b* is loaded into register 302). Recognition of the second "load code" (column *r*) steps the signal from the "one" stage of flip flop 356 to the "zero" stage to which line 352 is connected. The final step is the recognition of the asterisk code of column *s* by recognizer 368. Its output signal on line 380 shifts out register 302 in a given direction, over lines 381 through Or gate 383 to the utilization device. Lines 381 are Or gated with register output lines 385 which are used when register 302 is unloaded in the opposite direction.

We have elected to gate the "load" symbols (columns *b* and *r*) into register 302 because they can be used to define the ends of the data relating to a panel 24, 24', etc. when the data is processed by a utilization device. However, we can just as easily exclude these codes from register 302 if the particular utilization device 30 has no need for them. They can be excluded like we exclude the % and asterisk codes. We can omit the load symbols of columns *b* and *r* and use only the left and right edge codes in columns *a* and *s* to fulfill all of the functions of these and the codes of columns *b* and *r*. We can also omit both "load" codes and one of the edge codes, with the remaining edge code, e.g., column *a*, always signifying a specific end (front or back) of the coded data of the panel. This variation is shown in FIGURES 11 and 11a, which also show the use of single direction or bi-directional buffers with machine 16 or 16b.

By having the coded information arranged in columns, each defining a character, the panels can be made much shorter than if the code data were serially arranged. Many more characters can be compressed in the same horizontal space. As a further space-conservation measure we can omit all of the machine-control codes from the panel except one (% symbol in FIGURES 11 and 11a) and still provide properly oriented output signals for the utilization device. Thus, almost the entire area of the panel may be used for data-defining codes.

FIGURE 11 shows a single-direction buffer 400 (magnetic core, flip flop, etc.) of only three levels, but it is understood that in practice buffer 400 will have as many levels as required for the code of the panel. Lines 402, 404 and 406 are output lines conducting code data, and would correspond to lines 136 (FIGURE 6) or lines 342-349 (FIGURE 6b). Thus, buffer 400 can be added to machine 16 or used in place of buffer 302 in a vertical-row-photocell scanning machine similar to machine 16b.

The panel can pass through the reading station in one of two possible directions, for instance as shown by panel 24r and 24s, depending on the direction of vehicle motion. Assume that the % code signifies "end of data." When the panel passes through the reading station with the symbol following the code data (24r) buffer 400 is bypassed and the code data passes gates 408, over lines 410, 412 and 414, through Or gates 416 and to the utilization device (not shown) over lines 402a, 404a and 406a.

As described below, when panel 24r is moving in the assumed direction, the remainder of the circuit of FIG-

URE 11 will not be effective. As the code data is conducted on lines 410, 412 and 414, flip flop 416 is set by signals on lines 418 (Or gated at 420) and line 422, but this has no effect. The output line 424 of the flip flop merely provides an inhibit signal on gate 426 (mentioned again later) so that when the % code recognizer 428 recognizes the % code (following the code data as at 24r), the signal from recognizer 428 on line 430 is inhibited by gate 426. Flip flop 416 is reset shortly thereafter by the signal on line 432 conducted over delay line 432 to the reset terminal of flip flop 416. Thus, the described results are obtained.

Now consider the case where the code symbol (%) enters the reading station ahead of the columns of code data (panel 24s). In this case we buffer the code message and read it out in reverse order. Code recognizer 428 (like those in FIGURE 6 or 6b or made in other ways) provides a signal on line 430 before flip flop 416 is set (by definition, the "end of message" (%) code precedes the data of panel 24s). Thus, the signal on line 430 passes gate 426 which is not now inhibited, and sets flip flop 438. The output signal on line 440 of flip flop 438 has the effect of diverting the code data into buffer 400 as follows: the signal on line 440 inhibits the line-gates 408, and provides one input to each And gate 442. The only other input to gates 442 is on the respective lines 444 connected to the lines 402, 404 and 406. The outputs of gates 442 are on the buffer-load lines 446, 448 and 450. Thus, the character-defining codes are loaded into the buffer 400 in the order of examination, i.e., column nearest % symbol first until the register is loaded.

When the code data is fully loaded, the last stage (or any selected stage) of each level is interrogated by lines 452 which are Or gated at 454 to provide a trigger signal on line 456 which triggers ring counter 458 and resets flip flop 438 (preparing the control circuitry for the next panel 24r or 24s). The number of stages of counter 458 corresponds to the number of stages of buffer 400, and each time that counter 458 steps a shift pulse is conducted on line 460 to step (unload) the buffer 400. As the buffer is unloaded, the stored data is conducted on lines 462, 464 and 466 (last stored character first) to lines 402a, 404a and 406a by way of Or gates 416.

FIGURE 11a shows a buffer 500 which can be used with machines like those at 16 or 16b, in place of the buffer (and controls) of FIGURE 11. The difference is that buffer 500 stores all of the data as received (panel oriented as at 24t or 24u), but unloads in the direction necessary to transmit the data in proper order, assume 24t to be "proper." In brief, the way this is done is to remember whether the code symbol (%) preceded or succeeded the code data stored in the buffer 500, and then unload the register according (left-to-right, or right-to-left).

Code data lines 502 and 504 (only two of the buffer levels shown for simplification) load buffer 500. First assume that the panel is oriented as at 24t, meaning that the character-code data is conducted on lines 502 and 504 before % code recognizer 506 provides a signal on line 508. Lines 510 (Or gated at 512) continually interrogate lines 502 and 504 for code data, so that the output of gate 512 on line 514 will set flip flop 516. The output line 518 of flip flop 516 is And gated at 520 with the % symbol recognition signal on line 508. Consequently, if the % symbol is recognized before character-data on lines 502 and/or 504, gate 520 will not be satisfied. But if the data comes first, followed by the % symbol, the gate 520 will be satisfied, providing an output signal on line 522 (resetting flip flop 516 over line 521, Or gate 523 and line 525) and primarily signifying that buffer 500 must be shifted out "to the right." This is accomplished by having the signal on line 522 trigger a ring counter 524 whose outputs are conducted as shift pulses on line 526 to one end of buffer 500. This unloads the

buffer over lines 530 and 531 which are Or gated at 532 to lines 502a and 504a.

Now assume that the panel is oriented as at 24u. The fact that the % symbol precedes the character data is remembered in the following way. The % recognition signal on line 508 is conducted on line 509 to set flip flop 540. It will not now pass gate 520 because flip flop 516 is not set.) The output line 542 of flip flop 540 is And gated at 544 with line 514a from Or gate 512 (described before). Thus, if (and only if) the % symbol is recognized before the character code data, gate 544 provides an output on line 546 to set flip flop 548 which (a) resets flip flop 540 (by a feedback signal on lines 550, 552, Or gate 554 and line 556) and (b) provides a "shift left" signal on line 550. The shift signal line 526 (for "right" shifting) is Or gated with line 552 to reset flip flop 540 which would be momentarily set by the % symbol recognition at the end of the 24t mode.

We know the direction to unload buffer 500 by the standing signal on line 550, and the only other information necessary is timing. Since the panel can be moving at any speed, as before, timing is obtained from the buffer itself. When it becomes loaded a signal on line 558 from the last stages of the buffer coincides at gate 560 with the "shift left" signal on line 550, thereby providing a signal on lines 560, 562 which triggers ring counter 564. The output pulses of counter 564 on lines 566 unload buffer 500 to the left so that the last-stored character is unloaded first over lines 568 which are Or gated at 532 to the transmission lines 502a and 504a.

The trigger signal on line 560 is fed back on line 570 to reset flip flop 548 to prepare it for subsequent use. Also, line 560 is Or gated at 523 with the reset line 521 for flip flop 516. The reason for this is that this flip flop will be set by the character-data signal on line 514 in the 24u mode even though the flip flop 516 will have no effect on the operation.

We have elected to show reading machines 16 and 16b having different scan systems because each has inherent advantages. The disc scanning can be coupled with the "double white" system disclosed in application Serial No. 115,165 which enables the reading machine to locate the panel within a wide range of vertical tolerance. Even if we used one or two additional photocells for finding the panel image (vertically) the number of photocells in the scan-disc embodiment would still be small. But, disc scanning requires a moving part and a motor. The vertical row of photocells 300 can be made as tall as desired to provide any amount of vertical tolerance, and this kind of scan system has no moving parts. But it is more expensive, requiring more photocells, gates and a large register 320.

These and many other changes and modifications may be made without departing from the protection of our claims. For example, the code panels need not be a separate part attached to an object, e.g., a vehicle. They can be a portion of the object itself where manufacturing expedience permits. Our entire description deals with a stationary reading machine (at a reading station) and moving objects to be read. It is a mere reversal of parts to have the reading machine movable and the objects stationary. By mounting a reading machine on a vehicle, stationary (or relatively moving) objects having panels 24 (or the equivalent) can be read.

Only brief mention was made of using two reading machines at each reading station, one on each side of the track, highway, etc. What is said herein about "two" reading machines applies equally to a single reading machine having two examination devices (scan means) with one on each side of the vehicle, but both feeding their outputs into one set of electronics (processing circuits for the scanner outputs). When two reading machines are used, our system acquires considerable flexibility. For instance, the codes can be arranged in the

same direction (as at 24v or 24s in FIGURE 11) on each side of the vehicle. In such an arrangement both reading machines would always read out the codes in the same manner, and the outputs of the respective reading machines could be compared as a reading-accuracy check either before or after the code data is transmitted to a utilization device. By having the optical system of one machine higher than the other, we can automatically increase the vertical tolerances for reading. By having the code on the opposite sides of the vehicle facing in opposite directions, e.g., as at 24r and 24s respectively, the reading direction of one reading machine will be correct and the other incorrect for each reading. This has an important practical advantage, because no matter what direction the vehicle moves, we know that one reading machine is reading in the proper direction, and we do not have to rely on a buffer to rearrange the data or do this at the utilization device. Instead it is a simple matter to inhibit the output of the reading machine which identifies the code in the undesired (backward) direction. Mere recognition of the % symbol (in our examples) as preceding or succeeding the code data will provide a signal (like that in FIGURES 6b, 11 or 11a for example) by which to inhibit one machine or the other. Obviously, both codes (forward and backward) could be transmitted, and the correct one selected later.

We claim:

1. Apparatus to read coded information from a vehicle while the vehicle is in motion, wherein the coded information is embodied in a panel having a plurality of apertures and imperforate areas defining the coded information, means for attaching said panel to the vehicle at a predetermined position, means for illuminating said panel, said illuminating means being arranged to direct light rays onto said panel at an angle to the plane of said panel such that the reflected rays are at an angle to an optical axis normal to the plane of said panel thereby enhancing the apparent optical contrast between said apertures and said imperforate areas, optical reading means separate from the vehicle to sense and read said coded information from the panel, said optical means having a field of view approximately coincident with said optical axis, and means for rendering said optical reading means insensitive to spurious light during the reading of said coded information.

2. Apparatus of claim 1 wherein said panel has more than one section, and said mounting device detachably supports one of said sections so that it can be removed and replaced with a different section having different coded information with the result that some of the total coded information remains on the vehicle while others are altered by removal and replacement of one panel section.

3. Apparatus of claim 1 wherein the apertures and imperforate areas forming said coded information are arranged in vertical columns horizontally spaced from each other thereby leaving vertical strips of imperforate panel between said vertical columns, and means associated with said optical reading means for detecting said inter-columnar strips and for developing control signals to control the processing of the information signals extracted from said columns by said optical reading means.

4. Apparatus of claim 1 wherein said panel attaching means include a mounting device which supports said panel in a position such that at least the major portion thereof is spaced from the surface of the vehicle therebehind so that the panel area adjacent to each aperture forms a shadow mask for the area directly behind each aperture as viewed along said optical axis, to thereby further enhance said apparent optical contrast.

5. Apparatus of claim 4 wherein said panel has more than one section, and said mounting device detachably supports one of said sections so that it can be removed and replaced with a different section having different coded information with the result that some of the total coded information remains on the vehicle while others

15

are altered by removal and replacement of one panel section.

6. Apparatus to read coded information from a vehicle while the vehicle is in motion, wherein the coded information is embodied in a panel having a plurality of apertures and imperforate areas defining the coded information, means for attaching said panel to the vehicle at a predetermined position, means for illuminating said panel, optical reading means separate from the vehicle to sense and read said coded information from the panel, and means to pulse said illuminating means at a predetermined frequency for rendering said optical reading means insensitive to spurious light during the reading of said coded information.

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