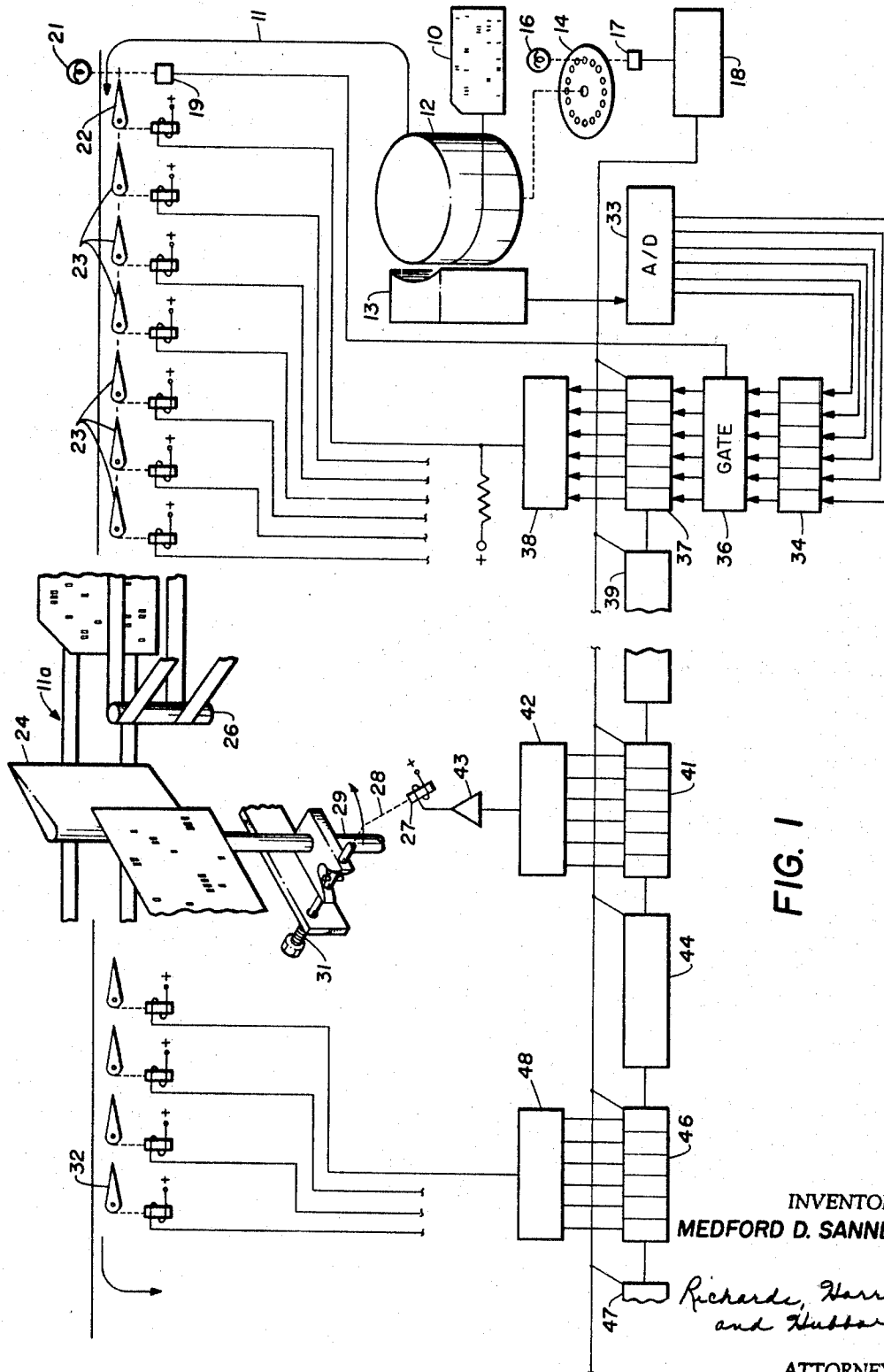


Filed June 19, 1967

# DOCUMENT SORTING APPARATUS

2 Sheets-Sheet 1



Aug. 12, 1969

M. D. SANNER

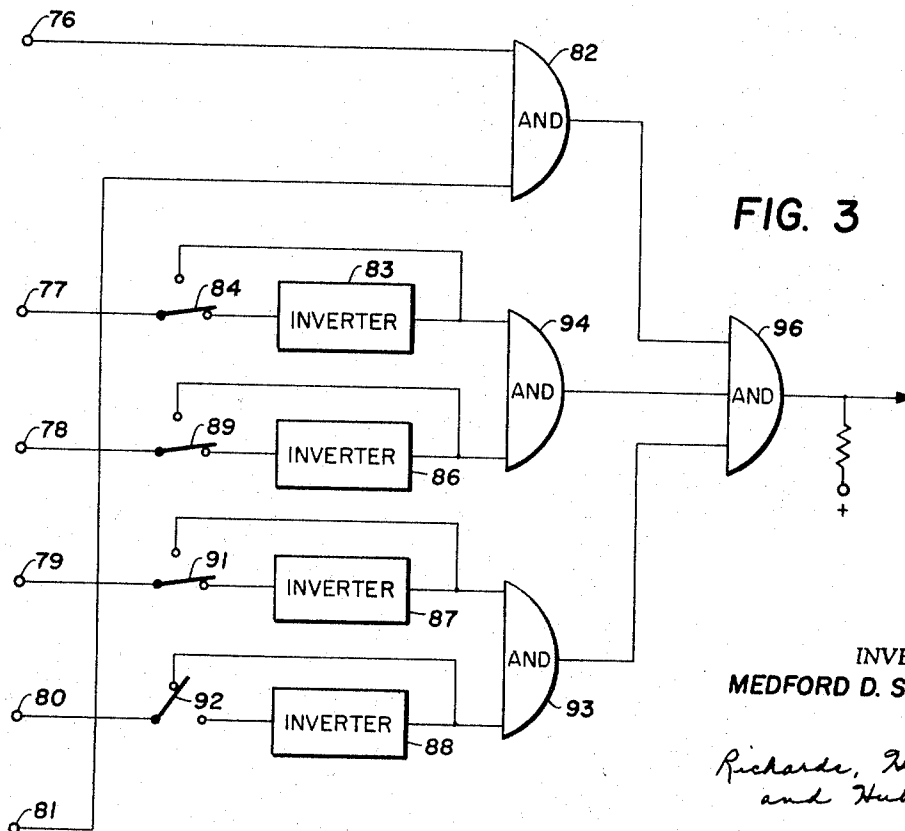
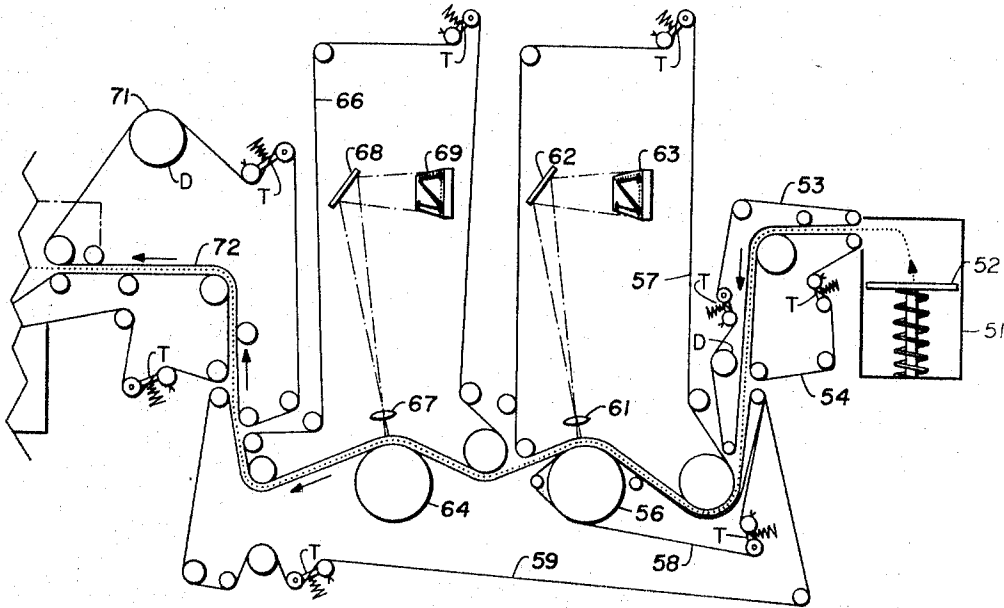
3,460,673

DOCUMENT SORTING APPARATUS

Filed June 19, 1967

2 Sheets-Sheet 2

FIG. 2



INVENTOR  
MEDFORD D. SANNER

*Richards, Harris  
and Hubbard*

ATTORNEY

1

3,460,673

## DOCUMENT SORTING APPARATUS

Medford D. Sanner, Irving, Tex., assignor to Recognition Equipment Incorporated, Dallas, Tex., a corporation of Delaware

Filed June 19, 1967, Ser. No. 647,012

Int. Cl. B07c 5/344

U.S. Cl. 209—73

9 Claims

### ABSTRACT OF THE DISCLOSURE

Apparatus for sorting documents having a code imprinted thereon including a plurality of stacker pockets and a document reading drum for generating a binary code gated into a shift register associated with the first stacker pocket and serially shifted into subsequent registers associated with each of the other stacker pockets as the document moves through the system. The binary code is applied to an AND gate system and a deflector is actuated to divert the document into a particular pocket.

### BACKGROUND OF THE INVENTION

Document sorting systems in general use today are relatively expensive primarily because they employ mechanical methods for code comparison. One presently available document sorter uses a magnetic drum to store a code for each of the stacker pockets into which the documents are to be sorted. Although magnetic drums are considered to operate fairly rapidly, they are relatively expensive and require considerable set up time and adjustments.

In accordance with the present invention, a logic circuit is employed to determine into which stacker pocket a particular document belongs. Since the document code can be transmitted through the logic circuit much faster than the document itself can be transmitted through the sorting system, the speed of document sorting is not restricted by the mechanics of selecting a particular stacker pocket. More particularly, the code on the document is read, converted into a binary signal, and gated into a shift register as the document passes a given location. As the document moves through the system, the binary code is serially shifted into subsequent series connected registers associated with each of the various stacker pockets. At each register the code is applied to an AND gate system responsive to a preselected code to select the correct stacker pocket for a particular document.

### SUMMARY OF THE INVENTION

A document sorting system having a plurality of stacker pockets wherein a document code is translated into a sorting code signal and where the sorting code is shifted through a plurality of registers, one register for each stacker pocket, at a rate proportional to the velocity of said document through the sorting system; as the sorting code is shifted into each subsequent register, it is connected to an AND gate system set with a preselected code to determine the correct stacker pocket.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic diagram, partially in plan, of a logic circuit sorting system;

FIGURE 2 is a schematic of a light responsive code reading system; and

FIGURE 3 is a schematic of an AND gate system.

2

### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGURE 1, a document 10 is picked up from the feed tray (not shown) of a document carrier and transferred to a moving transportation belt 11. The belt 11 is usually a moving double-belt system such as shown in the oblique view of FIGURE 1 at 11a. It is, of course, essential that the transportation belt moves at the same speed throughout the system. Since document sorting machines are of a modular design, the belt is divided into a number of subsystems each moving in synchronism with each other. The document 10 is transported by the belt 11 to a read drum 12 and a reading head 13. As the document 10 moves past the reading head 13, the code thereon actuates reading heads, thereby generating a sorting code signal. There are a number of different types of reading drums and reading heads available for use in document sorting systems. The particular construction and operation of the drum and the reading head will depend on the type of code carried by the document. One common document coding method is the punched hole system requiring the use of a light source in the drum and a plurality of photocells in the reading head. Another code configuration is the magnetic ink system which requires a magnetic sensitive pickup device in the reading head. If the document is paper as opposed to a stiff cardboard, the drum is sometimes equipped with a vacuum source to hold the document as it moves past the reading head.

Referring to FIGURE 2, there is shown a detailed schematic of a document reading system including a feed tray 51 for storing the documents 10 and including a spring loaded panel 52 for feeding the documents to a transport system including belts 53 and 54. The document 10 is transported to the area of the first reading drum 56 by means of a transport system including belt 57, belt 58, and belt 59. As the document 10 approaches the area of the first reading drum 56, light is transmitted from the document code through a reading lens 61 and reflected from a mirror 62 to a reading head 63. The image of the character code on the document 10 is magnified by the reading lens 61 in order to project an enlarged view of the code upon the sensing cells which make up the reading head 63. Typically, the reading head 63 is a two-dimensional array of a plurality of cells with each cell consisting of a single bar of silicon having two nickel-silver connection leads. The reading head 63 is a solid-state device having no moving parts with all the individual cells encapsulated in a single piece of glass to form a lens as well as a case.

Each cell of the reading head 63 translates the quantity of light striking it into electrical signals substantially proportional in amplitude to the quantity of light incident thereon. A two-dimensional reading head offers the unique ability to use simultaneously a complete character code, thus eliminating the necessity for controlling a complex time-versus-position relationship in the electrical transformation of the code into a form which can be used by the logic selection system to be described.

The document 10 moves from the area of the first reading drum 56 to the area of a second reading drum 64 on the belt 59. In addition to the belt 59, the transport system in the area of the second reading drum 64 includes a belt 66, similar to the belt 57 associated with the first reading drum. As the document 10 moves past the second reading drum 64, light is transmitted from the coded characters thereon through a reading lens 67

and reflected, after magnification, from a mirror 68 to a reading head 69. The character code recognition system associated with the reading drum 64 is similar to that associated with the reading drum 56 and is intended to read that part of the code on the document 10 that was not visible in the area of the first reading drum. It is, of course, possible that in some systems only one reading drum is required if the entire code is exposed in the area of the first reading drum 56. The document 10 leaves the area of the second reading drum 64 and is transported by means of belts 71 and 72 to the sorting system to be described.

All the belts of the transport systems of the document reading system shown in FIGURE 2 are driven in synchronism with each other by means of either a drive roller D or the reading drums 56 and 64. The belts that are in mating contact with the driven belts move with the driven belt over a series of idle rollers (all rollers shown and not otherwise identified). Each belt system includes a tension roller T to maintain the proper tension on the belt system.

Returning to FIGURE 1, mechanically coupled to the read drum 12 is a pulse generating system including a timing disk 14 having a plurality of circumferentially arranged equally spaced apertures. A light source, such as lamp 16, is positioned on one side of the timing disk 14 and the light therefrom passes through each of the apertures in the timing disk as they rotate past the light source. A light beam passing through the timing disk 14 is detected by a photocell 17 displaced from the timing disk opposite the lamp 16. The photocell 17 generates an electrical signal in response to the light beam impinging thereon which is connected to a pulse shaping circuit 18. The pulse shaping circuit 18 changes the somewhat randomly valued signals from the photocell 17 into a train of equally spaced uniform timing pulses, the spacing between the timing pulses being determined by the speed of the belt 11. In one embodiment of the invention, one pulse is generated from the pulse circuit 18 for each quarter inch of travel of the transportation belt 11.

After the code on the document 10 is read by the reading head 13, the document is transported by the belt 11 past a position detecting photocell 19 displaced a fixed distance from the first stacker pocket. The photocell 19 generates a signal at each interruption of the light beam developed by the light source 21.

The document 10 continues to move on the belt 11 past a deflector 22 that controls entry of documents into a first stacker pocket (not shown). As mentioned previously, document sorting machines are usually modular in construction. That is, any number of stacker pockets can be employed depending on the number of selections possible from one pass of a document past the read head 13. Each module includes from one to three stacker pockets, and each module has its own independent transportation belt system which receives a document from the preceding belt system and cooperates with the belt system of a subsequent module to transport a document thereto. It is also necessary that the stacker pockets be constructed in such a manner that they accept the particular sized documents being sorted. In one embodiment of the invention, the documents were twelve inches long, thus requiring a twelve inch separation between subsequent deflectors.

The document 10 is next transported by the belt 11 past the deflectors 23 until it reaches the open deflector 24. As the document 10 enters the area of the stacker pocket controlled by the deflector 24, it moves in the double-belt system 11a which is driven by a drive roller 26 until deflected by the deflector 24. The document 10 falls into the stacker pocket controlled by the deflector 24 wherein it is stored with other documents having identical codes thereon.

The pocket deflectors are opened by means of a solenoid operated linkage mechanically connected to each of each of said deflectors. In particular, the deflector 24 is

opened upon energization of a solenoid 27 having a plunger coupled to a linkage 28. The linkage 28 rotates a drive arm 29 connected to the deflector. The linkage 28 is spring-loaded by means of a return spring 31 thereby automatically closing the deflector upon de-energization of the solenoid 27.

In case a document code does not open any of the deflectors, the document is transported through the entire storage system until it reaches a hold pocket (not shown) following the last deflector 32.

The particular pocket to receive the document 10 is determined by a logic control system which includes an analog-to-digital converter 33 connected to receive the storing code signal from the reading head 13. The analog-to-digital converter 33 receives the analog signal generated by the reading head 13 and converts it into a pulse train representing a binary code. In the embodiment shown, the binary signal is a six-bit code wherein the first and last bits are enabling pulses and the four center bits represent in binary form the code read from the document 10. The six-bit code generated by the analog-to-digital converter 33 is transferred to a register 34 wherein it is stored until the document 10 passes the photocell 19. The signal generated by the document 10 passing the photocell 19 closes a gate 36 thereby transferring the binary code from the register 34 to a register 37. The binary code transferred through the gate 36 to the register 37 is connected to an AND gate system 38 which is preset in a given pattern that identifies the documents to be stored in the first stacker unit controlled by the deflector 22. If the code in the register 37 contains the pattern preset into the system 38, the deflector 22 is opened. For any other code transferred into the register 37, the deflector 22 remains closed.

Referring to FIGURE 3, there is shown an AND gate system including terminals 76, 77, 78, 79, 80, and 81 connected to receive the six-bit binary code from the register 37. Terminals 76 and 81 receive the enabling pulses and are connected to an AND gate 82. The AND gate 82 generates an output signal whenever an enabling pulse appears on each of the terminals 76 and 81. The first bit of the four-bit binary code generated by the analog-to-digital converter 33 is connected to an inverter 83 through a two-position switch 84 connected to terminal 77. The second, third and fourth bits of the four-bit binary code are connected to inverters 86, 87, and 88, respectively. Terminal 78 connects to the inverter 86 through a two-position switch 89; terminal 79 connects to the inverter 87 through a two-position switch 91; and terminal 80 connects to an inverter 88 through a two-position switch 92. The two-position switch 92 is shown in its second position and as such connects the binary bit on the terminal 80 directly to the input of an AND gate 93 bypassing the inverter 88. The AND gate 93 has as a second input the code bit on terminal 79, either directly or inverted by means of the inverter 87. The binary bits on the terminals 77 and 78 comprise the two inputs to an AND gate 94 and are connected either directly or inverted, depending on the position of the switches 84 and 89, respectively. Connected to the outputs of the AND gates 82, 93 and 94 is an AND gate 96 generating an output signal whenever a signal appears on each of its three input lines. The output of the AND gate 96 is the signal of the system 38 that connects to the deflector 22.

In operation, the switches 84, 89, 91, and 92 are arranged in a preset pattern to generate an output at the AND gate 96 when a preselected code is transferred into the register 37. For purposes of this description, assume that an AND gate generates a logic ONE output signal whenever its two input signals are at the logic ONE level. The AND gate 82 generates a logic ONE output signal when the two enabling pulses connected to the terminals 76 and 81 are at the logic ONE level. With the switches 84 and 89 in the position shown, the AND gate 94 generates a logic ONE output signal if the binary

bits connected to terminals 77 and 78 are at the logic ZERO level. The logic ZERO signals being inverted to logic ONE signals as they pass through the inverters 83 and 86. With the switches 91 and 92 in the position shown, the AND gate 93 generates a logic ONE output signal if the binary bit on terminal 79 is logic ZERO and the binary bit on terminal 80 is logic ONE. The switch 91 connects the logic ZERO signal on terminal 79 to the inverter 87 wherein it is inverted to a logic ONE signal, and the switch 92 connects the logic ONE signal on terminal 80 directly to the input of the AND gate 93. Thus, the AND gate 96 generates an output signal whenever the signals on terminals 76, 80, and 81 are at the logic ONE level and the signals on terminals 77, 78, and 79 are at the logic ZERO level. To change the code required to produce a logic output signal from the AND gate 96, it is only necessary to reposition the switches 84, 89, 91, and 92.

The binary code transferred to the register 37 is serially shifted one bit at a time to a register 39 by the timing pulses generated by the pulse shaping circuit 18. Since the pulse circuit generates a pulse each time the photocell 17 is illuminated by light passing through the apertured timing disk 14, it should be apparent the binary code in the register 37 is transferred to the register 39 at a speed synchronized with the travel of the document 10 on the transportation belt 11. Thus, the binary code generated by the analog-to-digital converter 33 serially moves through a bank of registers, one register for each deflector, as the document 10 moves past the stacker pocket deflectors. The code will always be shifted into a register a sufficient amount of time ahead of the document 10 to insure opening of the proper deflector. As the document 10 moves past the last of the deflectors 23, the binary code is shifted into a register 41 associated with the deflector 24. When the last enabling pulse of the binary code enters the register 41, it is immediately connected to an AND gate system 42. If the binary code shifted into the register 41 matches the pattern preset into the system 42, a signal is generated to a driver amplifier 43 connected to the solenoid 27. As explained previously, energizing the solenoid 27 opens the deflector 24 by means of the linkage 28 and the arm 29. The system 42 continues to generate a signal to the driver amplifier 43 thereby holding open the deflector 24 after the code in the shift register 41 has been transferred to a subsequent register by the timing pulses from the pulse circuit 18. The deflector 24 remains open until a new code is transferred into the register 41 that does not match the pattern preset into the AND gate system 42. Thus, even though the document 10 has been diverted into a particular stacker pocket, the binary code continues to be transferred through the registers 44, 46, and 47 until it reaches the register associated with the deflector 32. At each register, such as register 46, the code is connected to an AND gate system, such as the system 48.

The complete logic system thus includes one register and one digital comparator for each stacker pocket and a driver amplifier connected to the digital comparator for energizing the deflector solenoid. The pulse circuit 18 connects to the clock input of each of the various registers to serially transfer the binary code through the system as previously explained.

It is not believed necessary to detail either the circuitry or operation of the various logic units inasmuch as they are all standard hardware adequately described in numerous texts.

It should be obvious that numerous modifications can be made to the system shown and still retain logic circuit control of the deflectors. For example, a photocell 19 and lamp source 21 are positioned ahead of each deflector to generate a pulse as the document approaches the next stacker pocket. The signal developed as the document passes the photocell generates a train of pulses to serially shift the binary code through the registers 37, 39, etc. One readily apparent way of implementing this type of opera-

tion would be to have the photocell signal actuate a free running multivibrator set to generate a fixed number of output pulses. The photocell system eliminates the need for the timing disk 14, the lamp 16, the photocell 17, and the pulse circuit 18.

Another easily implemented change to the system shown is to replace the serial transfer of the binary code through the registers with a parallel transfer system. A gate, such as gate 36, is connected between two adjacent registers, for example between register 37 and register 39, and the code is transferred from one register to the next by means of pulses from the pulse circuit 18. The gates between adjacent registers could also be actuated by a pulse signal from a photocell, such as photocell 19, positioned before each deflector.

In either of the above modifications, the hardware needed to implement their operation is standard and readily available. Free running multivibrators are well-known devices and there are many circuits that can be used to limit the number of pulses generated by the multivibrator.

While only one embodiment of the invention, together with modifications thereof, has been described in detail herein and shown in the accompanying drawings, it will be evident that various further modifications are possible in the arrangement and construction of its components without departing from the scope of the invention.

I claim:

1. A document sorting system wherein a code on a document is translated into a sorting code signal consisting of a plurality of pulses during travel in a belt and having a plurality of deflectors, the first of which is spaced a predetermined distance from a reading station and the remainder positioned a predetermined distance from each other, energization of one of said deflectors causes deflection of the document from said belt into a pocket, the combination comprising:

a clock source for producing clock pulses at a rate proportional to the velocity of said document in said belt.

a shift register associated with each of said deflectors and serially connected to each other,

means for introducing said signal into the shift register associated with said first deflector,

means for applying said clock pulses to said registers to shift said pulse code signal serially through said registers, and

code comparator means associated with each of said shift registers and including enabling means to generate an energizing signal to the respective deflector when the plurality of pulses shift into said register corresponds to a preset code pulse enabling pulses preceding and following said code.

2. The combination as set forth in claim 1 including circuit means for each of said deflectors for maintaining said gate energized until another code signal is applied to said comparator means.

3. The combination as set forth in claim 1 wherein said signal introducing means includes a gate circuit connected to said first register.

4. The combination as set forth in claim 3 including means for sensing the position of said document to generate a signal to said gate.

5. A document sorting system for a coded document comprising:

reading means for generating a binary code representative of the code on said document,

a plurality of deflectors spaced a predetermined distance from each other and a predetermined distance from said reading means,

a belt for carrying said document past said reading means and each of said plurality of deflectors,

a shift register associated with each of said deflectors, a digital comparator including enabling means for generating an energizing signal when a register connected thereto receives a code, preceded and fol-

7

lowed by enabling pulses, that matches a unique preset code contained in said comparator,  
a clock source for producing clock pulses at a rate proportional to the velocity of said document in said belt,

means for introducing the binary code generated by said reading means, including the enabling pulses preceding and following said code, into the shift register associated with the first deflector spaced from said reading means,

means for applying said clock pulses to said shift registers to shift said binary code and enabling pulses through said registers stepwise, and

energizing means for each of said deflectors including an actuating circuit means responsive to the comparator output for energizing the proper deflector to deflect said document into a pocket.

6. The combination as set forth in claim 5 wherein said signal introducing means includes a gate circuit for transferring the binary code from said reading means to said first shift register.

8

7. The combination as set forth in claim 6 including a document responsive means for actuating said gate when said document approaches the first deflector.

8. The combination as set forth in claim 7 including circuit means for maintaining a deflector energized until a new code is transferred into the correct shift register.

9. The combination as set forth in claim 8 including means for synchronizing the travel of said document with the generation of said clock pulses.

#### References Cited

#### UNITED STATES PATENTS

|           |         |               |           |
|-----------|---------|---------------|-----------|
| 3,038,607 | 6/1962  | Eckert        | 209—111.7 |
| 3,368,672 | 2/1968  | Heaney et al. | 209—74    |
| 3,352,417 | 11/1967 | Cutaia        | 209—74    |

ALLEN N. KNOWLES, Primary Examiner

U.S. Cl. X.R.

209—74, 111