United States Patent [19]

Lupkas et al.

[11] **3,832,946**

[45] **Sept. 3, 1974**

[54] **COMPUTER RESPONSIVE SUPPLEMENTAL PRINTER**

[75] Inventors: **Raymond R. Lupkas,** Trumbull; **Gerald C. Freeman,** Norwalk; **Frank T. Check, Jr.,** Orange, all of Conn.

[73] Assignee: **Pitney-Bowes, Inc.,** Stamford, Conn.

[22] Filed: **Nov. 4, 1971**

[21] Appl. No.: **195,729**

[52] **U.S. Cl.** ..... **101/93 C,** 340/174 SR

[51] **Int. Cl.** **B41j 9/10,** B41j 23/00

[58] **Field of Search** ..... 101/93 R, 93 MN, 90, 103, 101/109, 110, 111, 201, 197, 193, 93 C; 197/193

[56] **References Cited**

UNITED STATES PATENTS

1,129,111	2/1915	Moss	101/201
1,785,999	12/1930	Bryce	101/93 C
2,015,787	10/1935	Dietrich	197/193
2,252,004	8/1941	Helmond	197/193
2,255,029	9/1941	Tholstrup	197/193
2,638,542	5/1953	Fleming, Jr.	101/93 C
2,681,615	6/1954	Dayger	101/93 C
2,951,439	9/1960	Stutz	101/93 C
3,123,195	3/1964	Hewitt	101/93 C
3,209,682	10/1965	Cooper	101/93 C
3,278,725	10/1966	Gunst	235/92 R
3,356,997	12/1967	Propster, Jr.	101/93 C
3,367,469	2/1968	Fathauer	101/90 X
3,388,782	6/1968	Schwend	101/93 C
3,513,774	5/1970	Pawletko	101/93 C
3,524,406	8/1970	Traynor	101/93 C
3,556,002	1/1971	Bragg	101/93 C
3,561,355	2/1971	Rapparlie	101/93 C
3,583,315	6/1971	Hebert	101/93 C
3,630,143	12/1971	Price	101/93 C
3,638,197	1/1972	Brennan	197/1
3,700,088	10/1972	Kunst	197/193

Primary Examiner—Robert E. Pulfrey
Assistant Examiner—William Pieprz
Attorney, Agent, or Firm—William D. Soltow, Jr.; Albert W. Scribner; Robert S. Salzman

[57] **ABSTRACT**

A supplemental printer is mounted piggy-back fashion atop a conventional high speed chain printer or other form of computer output printing equipment; and prints, upon the same print-out sheet as the high speed printer, information generated by the same electronic digital computer to which the high speed printer responds. The supplemental printer is capable of printing postage or other special indicia not easily incorporated into the print symbol repertoire of the high speed printer. In order to make the supplemental printer operate rapidly enough to be compatible with electronic data processing equipment, its print impression is divided into parts printed by individual type segments, each actuated by its own individual print solenoid. In order to improve print quality and to minimize the reaction of the piggy-back mounted printer due to the simultaneous firing of the print solenoids, the solenoids are fired sequentially by means of a time spread circuit including a shift register and clock oscillator. Some of the segments are equipped with solenoid-actuated variable numerical print modules for the purpose of printing postage or other variable numerical information. After printing, the segments return to positions at unequal levels in order to deter "wiping off" unauthorized postage or other valuable print impressions.

1 Claim, 13 Drawing Figures

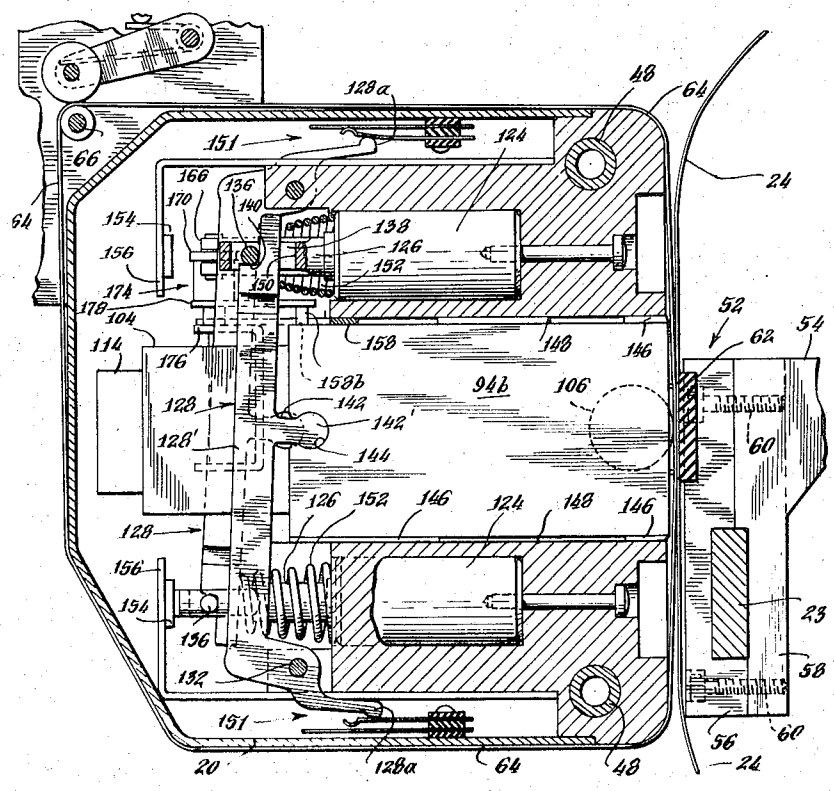
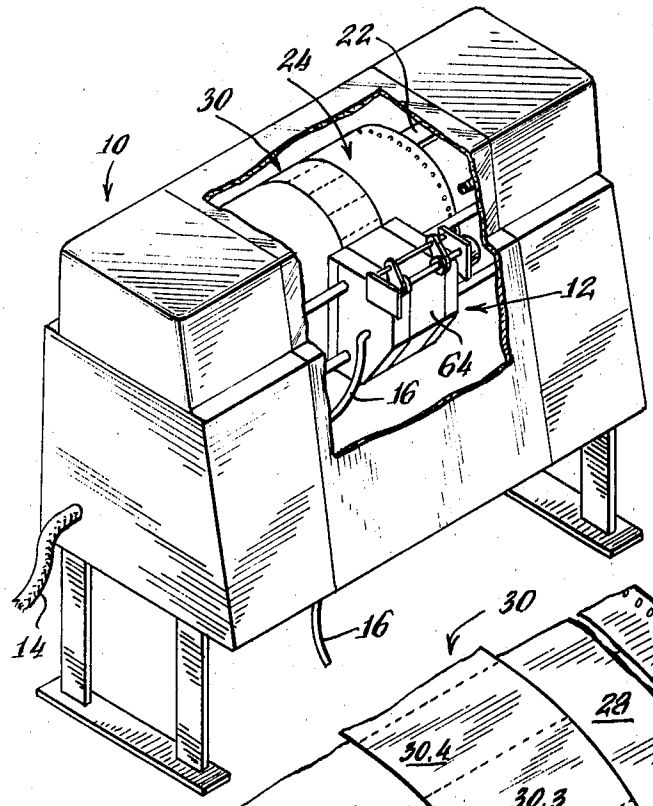


Fig. 1


22
24
30
10
12
64
16
14

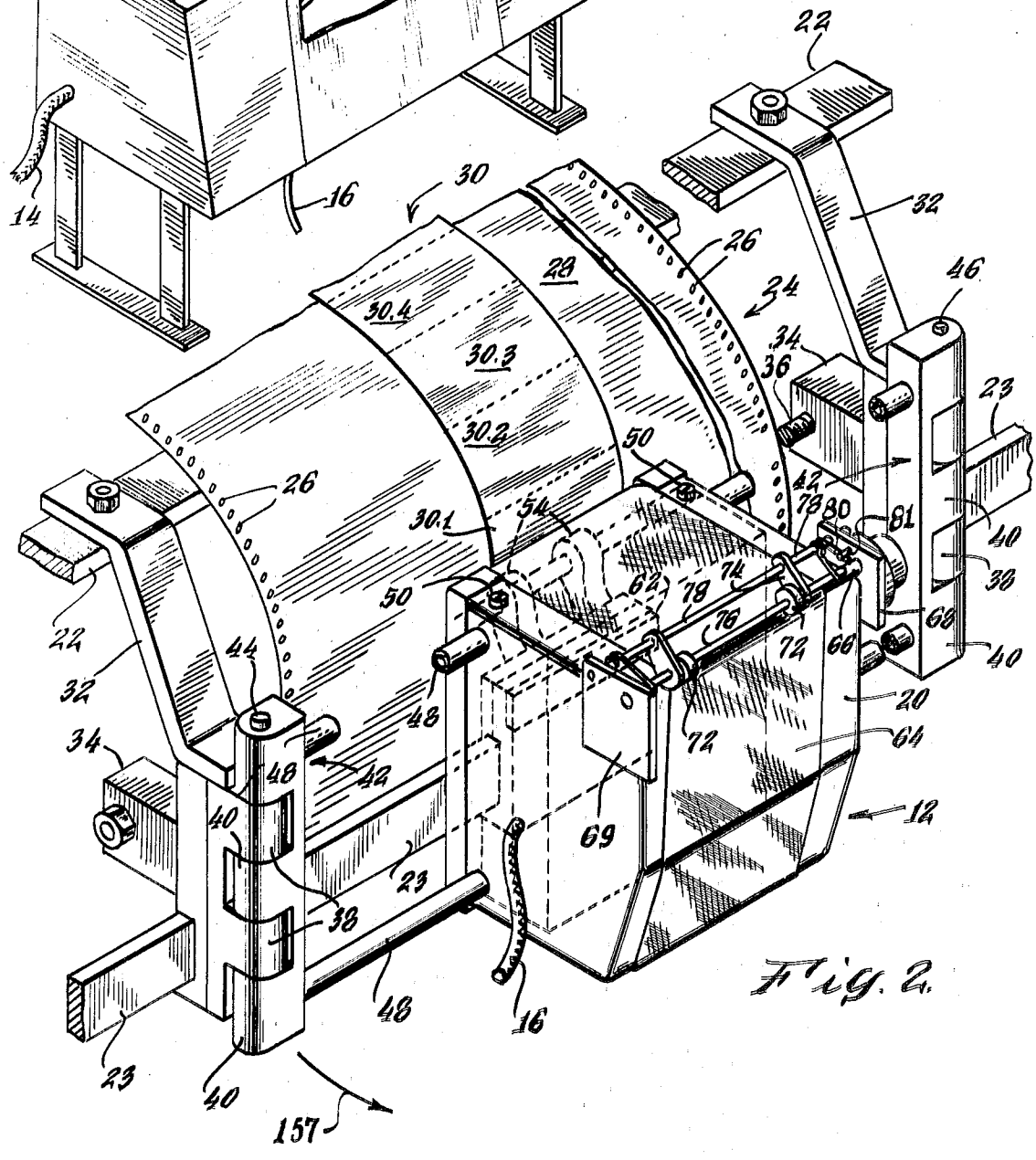

22
30
32
26
28
46
34
30.4
30.3
30.2
36
23
50
42
78
80
81
40
26
30.1
54
62
74
38
50
76
72
66
68
40
22
32
44
20
48
72
64
34
48
42
12
40
69
23
38
48
16
23
40
157

Fig. 2

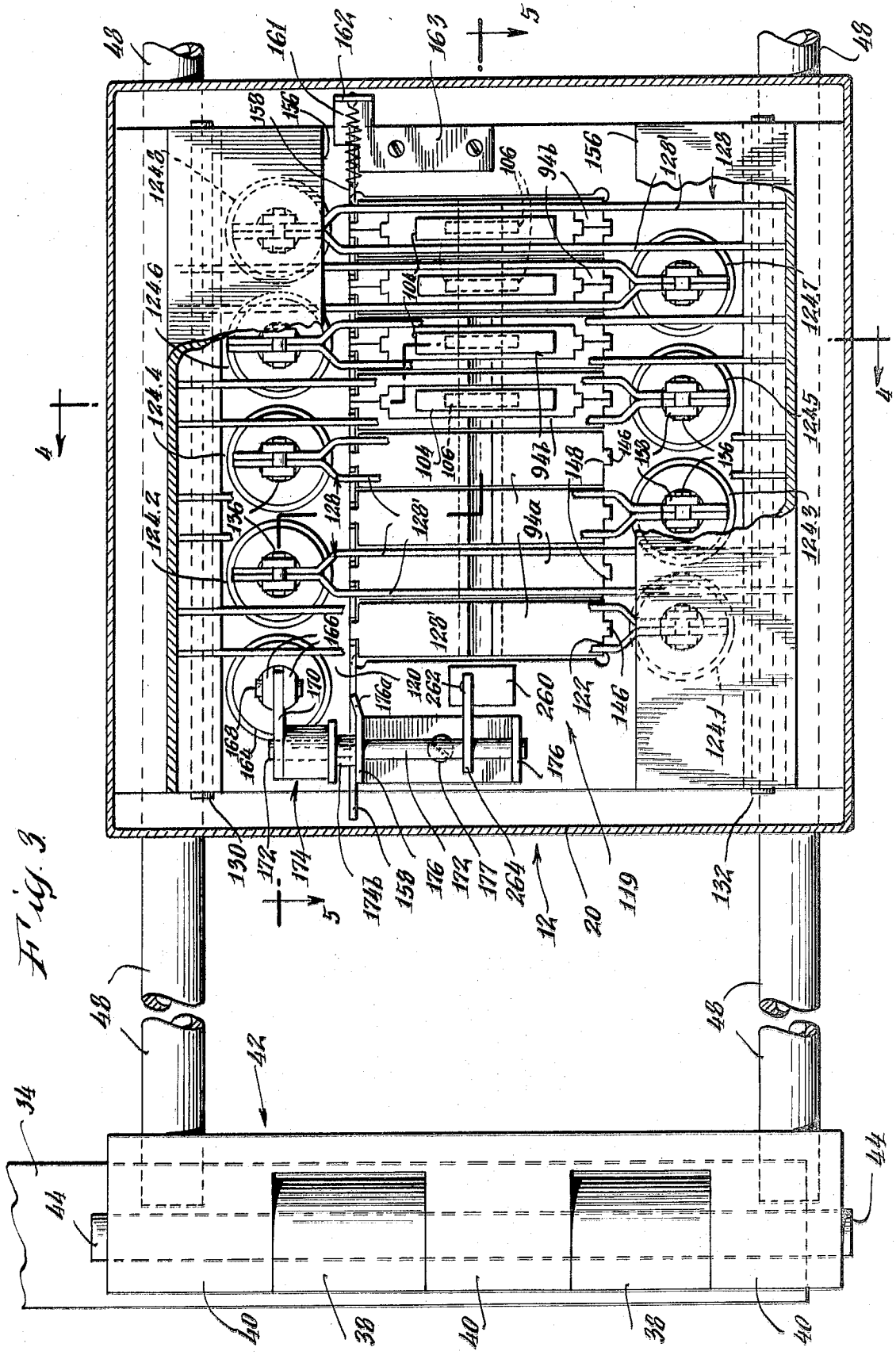

48
161
162
163
5
158
156
106
94b
128'
124.3
124.6
124.4
124.2
124.7
124.5
124.8
124.1
104
148
146
136
94a
166
170
116a
130
172
174
174a
158
176
177
264
12
20
119
132
42
34
44
40
38

Fig. 3

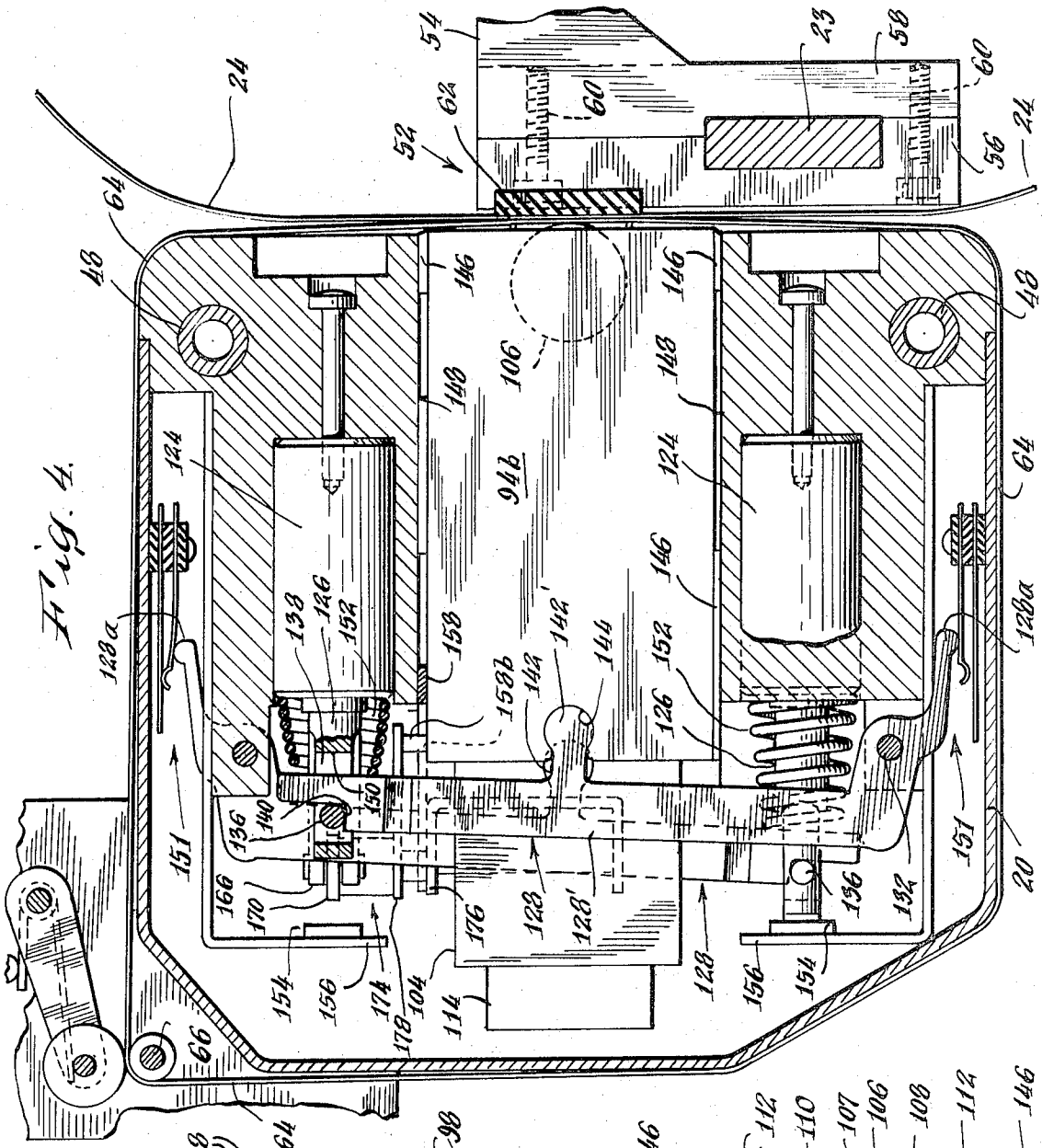


Fig. 4.

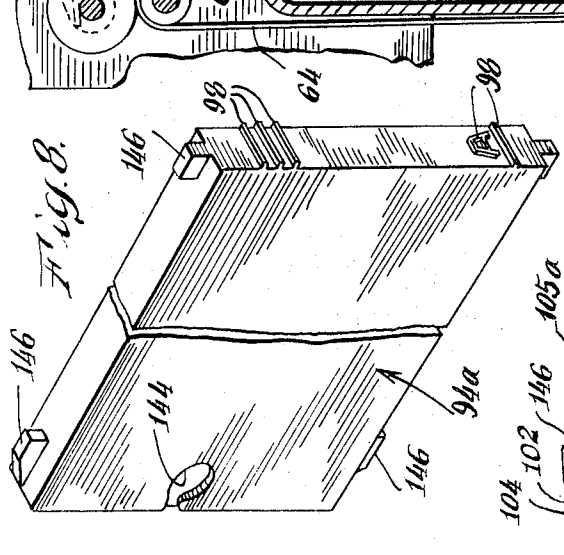


Fig. 8.

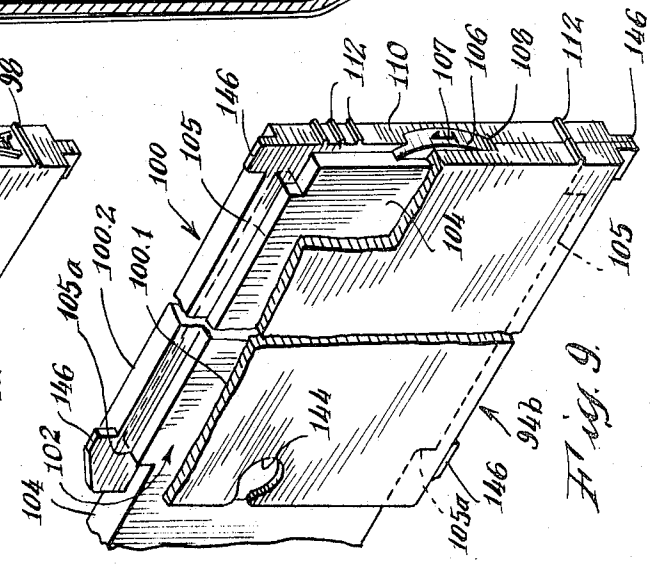


Fig. 9.

Fig. 5.

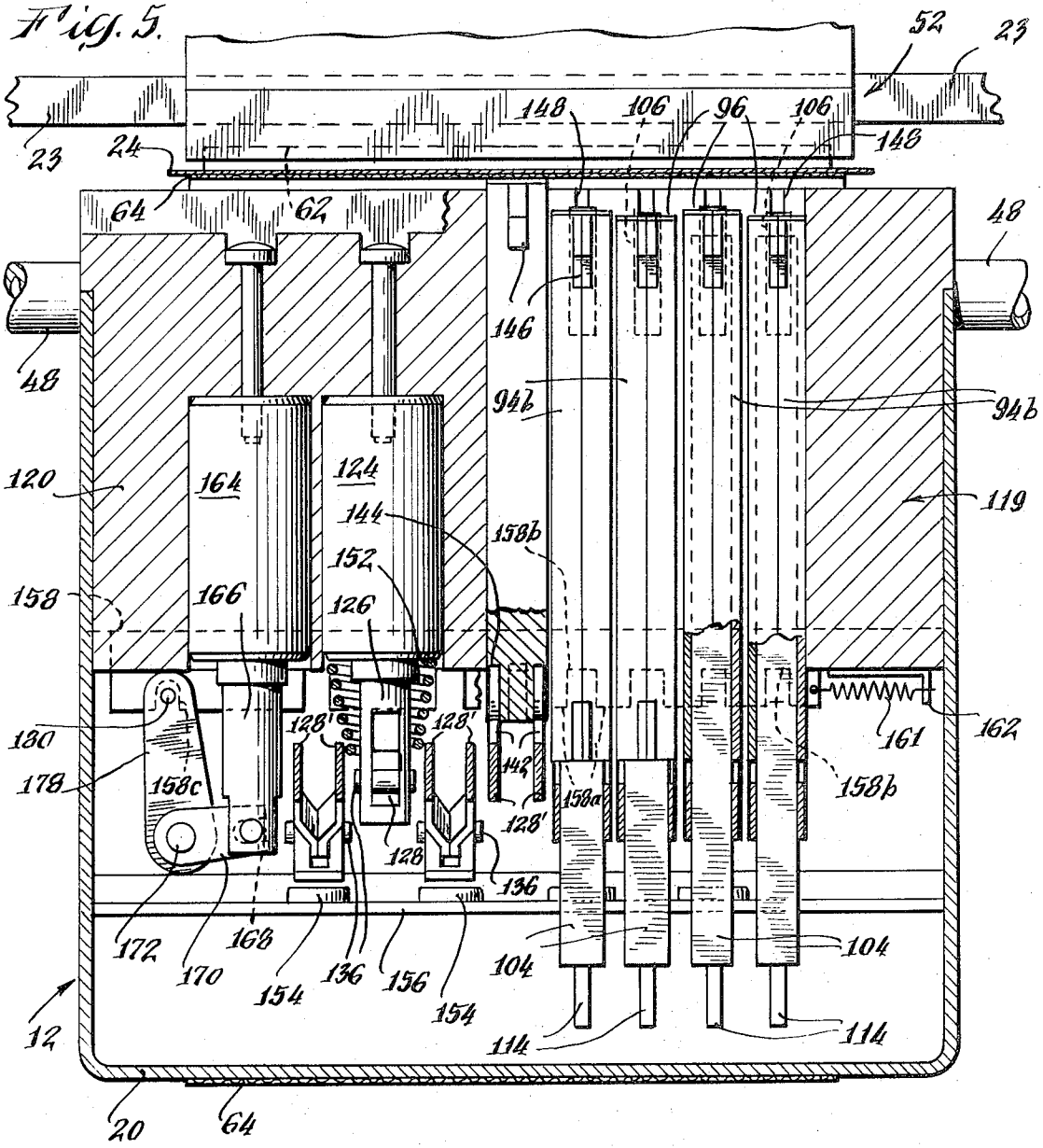
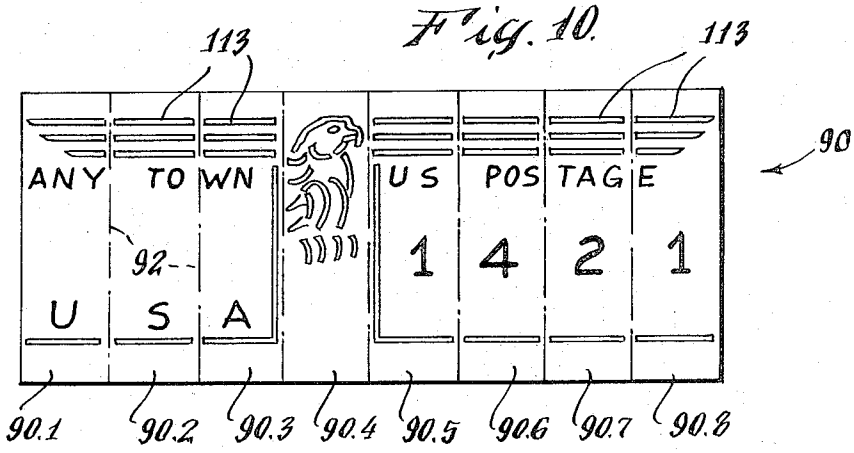

52
23
23
24
148
106
96
106
148
64
62
48
48
146
94b
94b
120
164
124
144
158b
119
158
166
152
126
130
178
158c
128'
128'
142
158a
128'
128
136
161
162
158b
172
170
168
154
136
156
154
104
104
114
114
12
20
64

Fig. 10.


113
113
90
ANY TOWN
U S A
92
U S POSTAGE
1 4 2 1
90.1
90.2
90.3
90.4
90.5
90.6
90.7
90.8

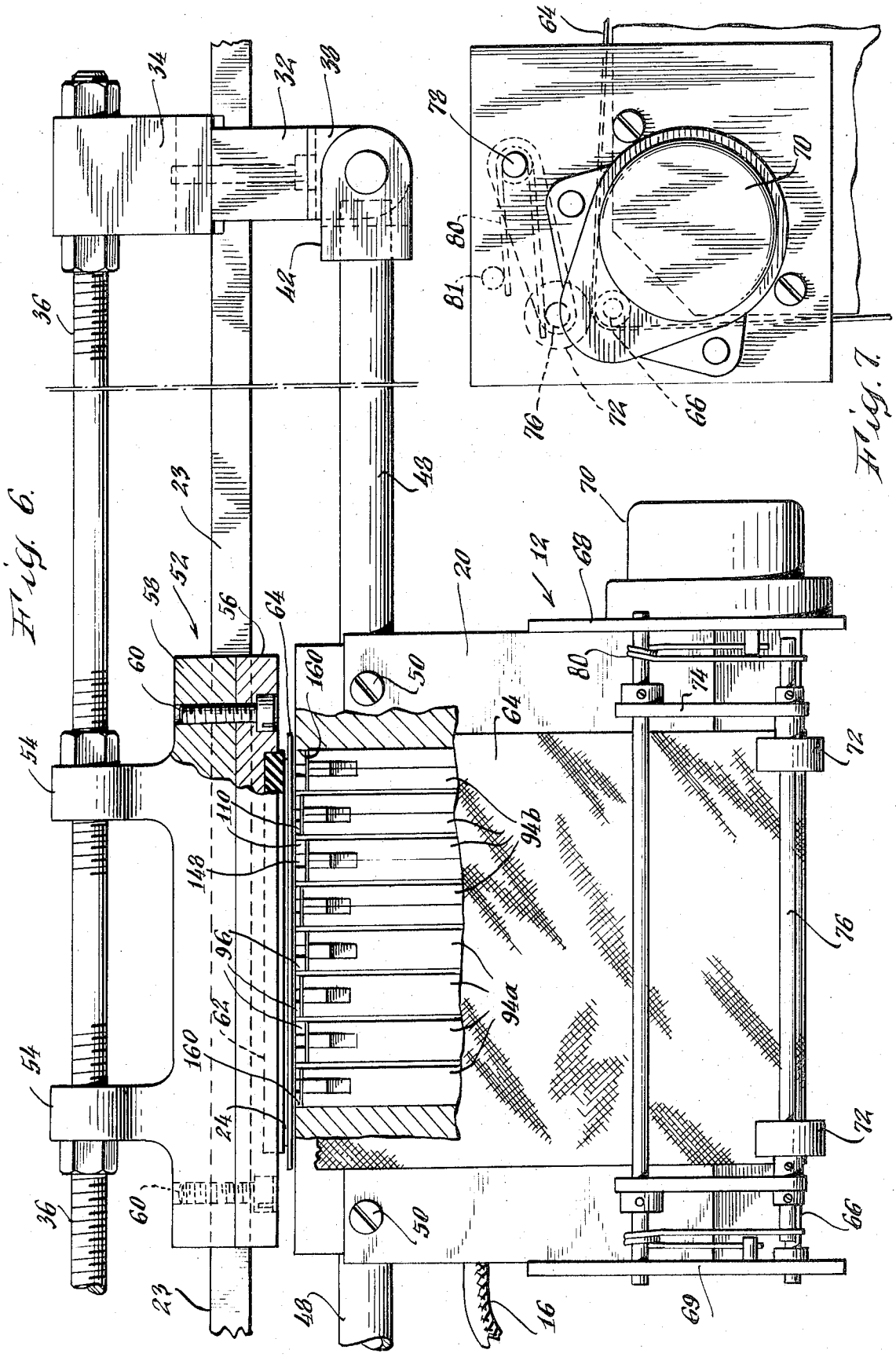

34
32
38
42
36
43
23
52
58
56
64
60
160
54
110
148
96
62
24
50
64
80
74
72
94b
94a
76
66
68
16
48
70
12
20
78
81
82
70
72
66

Fig. 6.

Fig. 7.

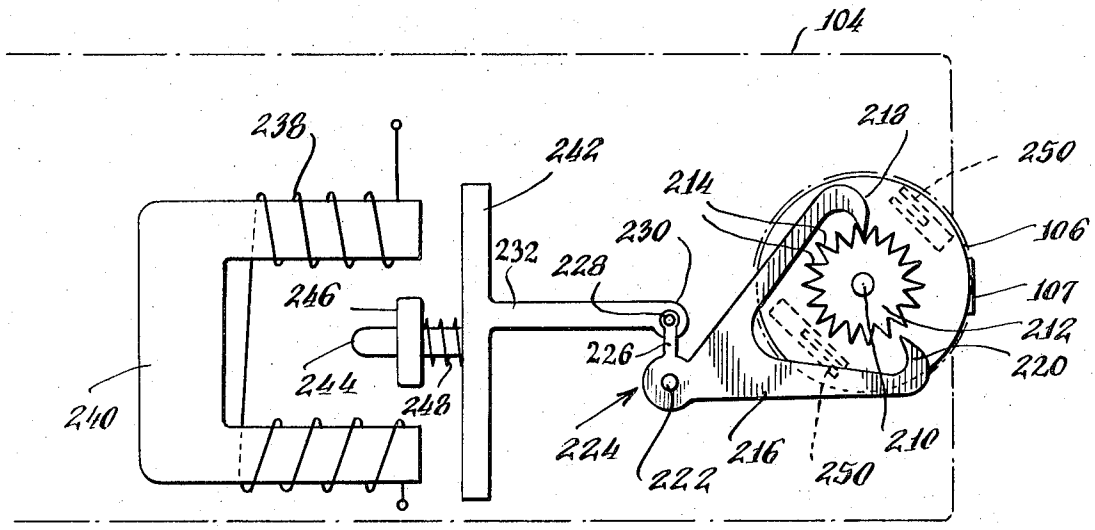

104
238
242
218
250
214
230
106
232
228
107
246
212
226
220
244
248
240
224
222
216
250
210

Fig. 11.

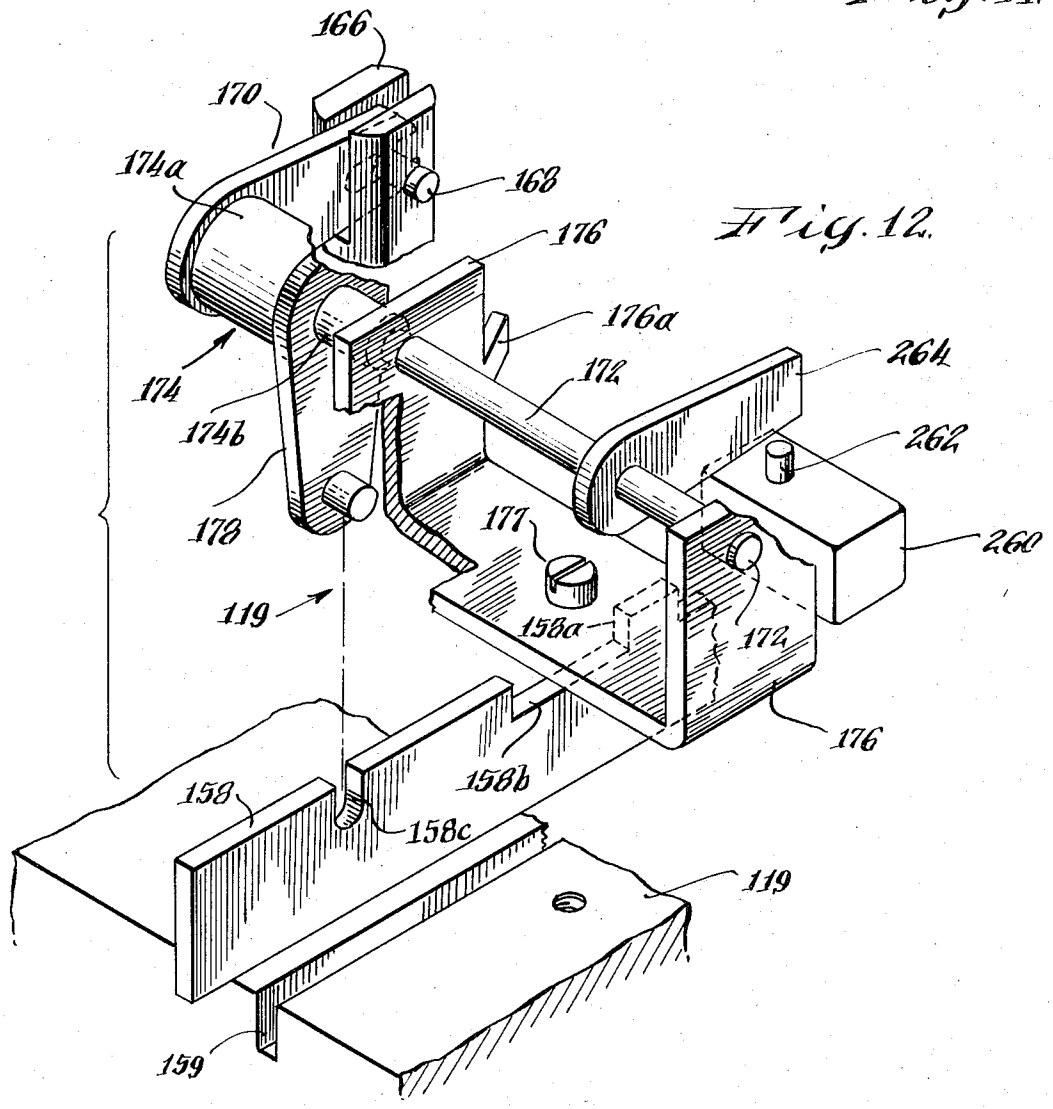

166
170
174a
168
176
176a
264
174
172
174b
262
178
177
260
119
158a
172
176
158
158b
158c
119
159

Fig. 12.

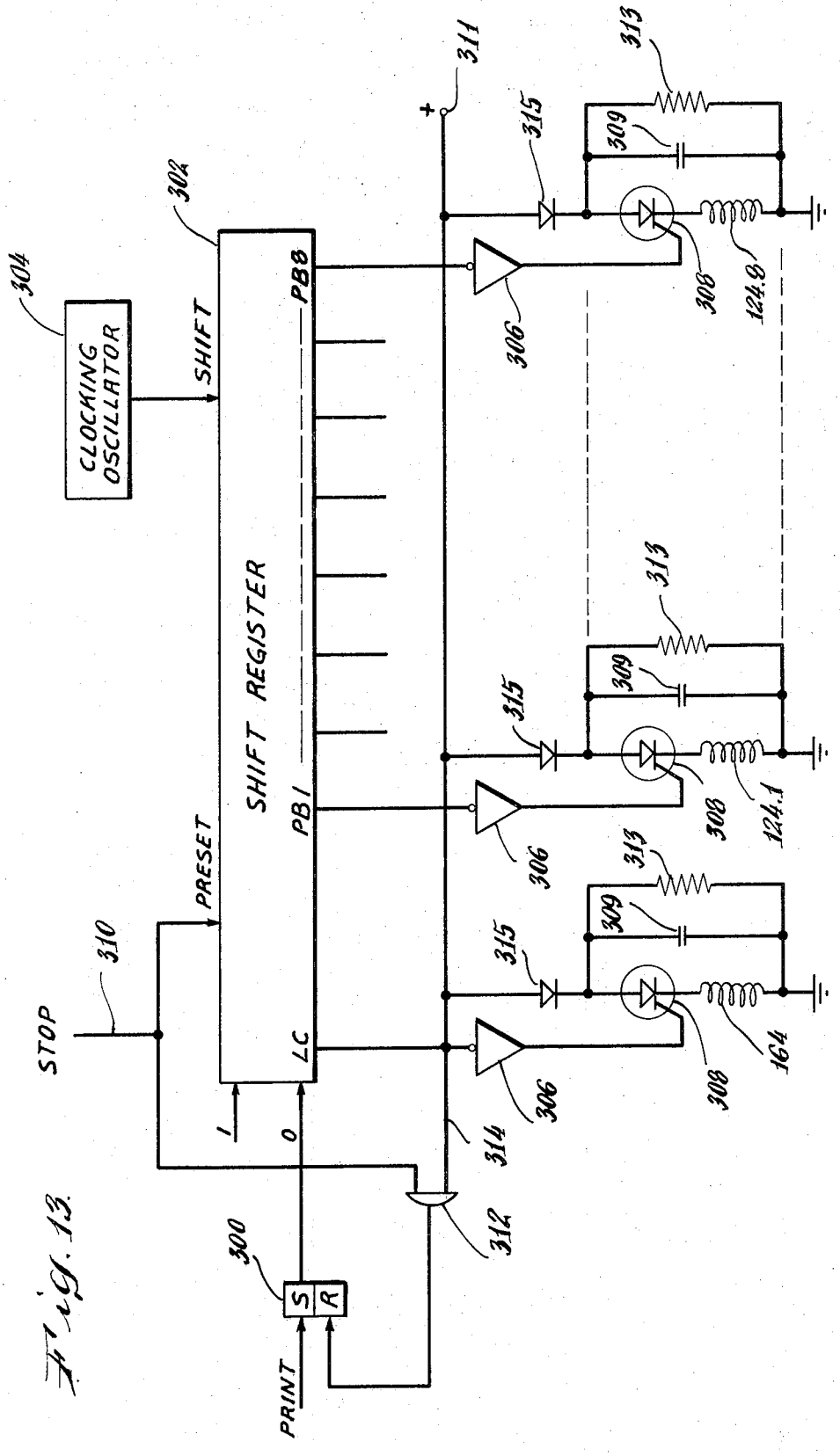

CLOCKING OSCILLATOR
304
SHIFT
302
SHIFT REGISTER
PB0
PB1
LC
PRESET
STOP
310
1
0
300
S
R
PRINT
312
314
306
308
315
309
313
311
+
124.8
124.1
164

Fig. 13.

COMPUTER RESPONSIVE SUPPLEMENTAL PRINTER

FIELD OF THE INVENTION

This invention relates generally to the fields of postage metering and computer peripheral printing equipment. It particularly concerns a supplemental printer physically associated with a computer output printer and designed for rapid, computer-controlled printing of postage or other valuable indicia.

BACKGROUND OF THE INVENTION

In certain instances it is desireable to achieve rapid printing of computer-generated information which can not be satisfactorily handled by conventional high speed computer peripheral printers. Some applications, for example, may require special purpose indicia which are not available on conventional high speed printers, or can not be provided on such printers without unacceptable size reductions. In addition, the special purpose indicia may have certain security problems associated therewith, if the indicia have value validating significance. One application in which one or both of these problems may arise is the preparation of paychecks; and another is the printing of postage.

With regard to the postage printing application in particular, it is conventional for high volume mailers to avail themselves of the high speeds offered by modern electronic digital computers and output printers, in order to increase their output. A typical prior art installation includes a computer which is programmed to receive information as to the weight and destination of a package, and from that information to calculate the required postage. A high speed chain printer is slaved to the computer to print out the destination information on an address label which is subsequently affixed to the package.

The computer also provides the calculated postage amount information to shipping department employees in some form which enables them to affix the proper amount of postage to the package. The most common way of accomplishing this is for the high speed printer to receive the postage amount information from the computer, and print it directly on the address label for the information of the employees. This print-out is not a government-authorized postage impression of the kind provided by a postage meter. The print impression made in a prior art installation as described above includes only the postage amount without any authorized postage validation symbols, and is provided for information only. Thereafter authorized postage of like amount must be affixed by an employee by means of postage stamps or a conventional manually controlled mechanical postage meter.

The intervention of a human being, or of a mechanical postage metering device, slows down a high volume mailing operation of the kind described. Therefore it is desirable to have the authorized postage impression printed automatically in response to the computer-generated postage calculation. Some form of secure, fixed-program postage accounting equipment must also be provided.

It would be possible to use a mechanical postage meter which comprises a secure housing containing authorized postage printing means, a mechanical descending register for storing the postal credit balance,

and mechanical means for guaranteeing that all printed postage amounts are decremented from the register. An electrically actuated controller device may then be provided to translate electrical signal from the computer into mechanical inputs for controlling all meter functions.

The latter approach meets all security requirements, but is considered too slow to meet the speed requirements of some high volume mailing operations. When used in conjunction with an electronic digital computer and high speed printer, it may be necessary for the postage printer to produce approximately two or three postage impressions per second. Mechanical postage meters, however, typically are motor-driven printing devices with mechanical postage-amount-changing mechanisms. Their maximum output rate, about two postage impressions per second, is barely adequate for the application described. Moreover, their output rate drops to about half of that maximum if it is necessary to change the postage amount between print cycles. Thus the utility of mechanical meters in data processing environments is largely limited to fixed-postage-amount applications.

It is possible to use the printing capability of the high speed printer itself for postage purposes, by making appropriate modifications such as replacing standard print characters by special postage symbols. That approach, however, runs into the problem of character size limitations which are inherent in standard high speed printing equipment. It also involves undesirable interference with the electrical interface between the computer and the high speed printer, i.e. breaking into the electrical cable which connects the computer and the high speed printer in order to insert special circuitry for performing postage security accounting functions. It is also necessary to house the printer and the postal accounting circuitry in a large security enclosure to prevent cheating by an unscrupulous computer programmer.

SUMMARY OF THE INVENTION

In accordance with this invention, these problems and disadvantages are circumvented by mounting a supplemental printer atop the conventional computer output printer, in position to print special purpose indicia under the same print-out sheet. In security-sensitive applications such as the printing of authorized postage or paychecks, security of electronic accounting procedures is achieved by providing separate electrical control connections to the conventional computer output printer and to the supplemental value-printing device, respectively. Therefore this approach also avoids the need for breaking into the electrical interface between the computer and its standard peripherals.

According to another aspect of the invention, the speed limitations of conventional postage printing mechanisms are circumvented by providing a segmented, solenoid-actuated postage printing mechanism, in which the entire postage impression field is divided into individual parts each printed by an independently actuated type slug, and each slug is independently actuated by its own solenoid. The individual segments are fired in sequential relationship, in order to improve the print quality. For applications where numerical values are concerned, individual print segments are provided with solenoid-operated variable numerical amount printing modules. In order to deter

wiping off of unauthorized print impressions that have postal or other economic value, the type face surfaces of the print segments are maintained at different levels when in their home positions, so that it is difficult to reach the recessed surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a computer output printer having a supplementary authorized postage printing accessory mounted thereon in accordance with this invention. The cover of the computer output printer has been partially broken away for clarity of illustration.

FIG. 2 is an enlarged perspective view of the supplemental printer of FIG. 1, and the supporting structure which mounts it on the computer output printer.

FIG. 3 is is a vertical section taken through the supplemental printer of FIG. 2.

FIG. 4 is a sectional view taken along the lines 4—4 of FIG. 3, looking in the direction of the arrows.

FIG. 5 is another sectional view, this time taken along the lines 5—5 of FIG. 3, looking in the direction of the arrows.

FIG. 6 is a top plan view of the supplemental printer and portions of the mounting mechanism of FIG. 2, with parts broken away for clarity of illustration.

FIG. 7 is an elevational view of the ink ribbon advance mechanism of the supplemental printer.

FIG. 8 is a perspective view of a fixed information printing slug which forms one part of the authorized postage impression of FIG. 10.

FIG. 9 is a similar perspective view, with parts broken away for clarity of illustration, of a variable numerical information printing slug which forms another part of the postage impression.

FIG. 10 is an enlarged illustration of an authorized postage impression made by the supplemental printer.

FIG. 11 is a schematic illustration of a solenoid and ratchet drive mechanism for one of the number wheel modules in the printing slug of FIG. 9.

FIG. 12 is a perspective view of a locking mechanism for the postage printer of this invention.

FIG. 13 is a schematic diagram of an electrical circuit for firing the print solenoids sequentially.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates a high speed computer output printer 10 having an auxiliary printing mechanism 12 mounted thereon. The computer output printer 10 may be any standard form of high speed printer of the kind which is normally driven by an electronic digital computer in conventional data processing installations. The particular high speed printer 10 illustrated here is basically a standard IBM Model 1403 chain printer, which has been modified only to the extent necessary to mount the supplemental printer 12 thereon.

The supplemental printer 12 may be designed to print any of a variety of special purpose indicia which, for one reason or another, are not printed directly by the chain printer 10 itself. In the case of special validating symbols for postage impressions or paychecks, it may be important from the standpoint of readability that the validating symbol be larger than the type face capacity of the chain printer 10. Or one may wish to avoid the loss of a standard print symbol by replacement with a postage validation symbol. Or in the case of numerical value dispensing applications, such as postage or paycheck printing, a separate printing mechanism may be desirable in order to have separate electrical data input leads for controlling both the high speed printer 10 and the supplemental printer 12, in order that accounting problems associated with the supplemental printer 12 in these applications may be handled by secure, fixed-program, special purpose electronic circuitry without the need for disrupting the data connection between the computer and its high speed printer 10. Thus, in the illustration of FIG. 1 the high speed printer 10 and the supplemental printer 12 receive their data inputs over separate data input cables 14 and 16 respectively.

In this specification the supplemental printer 12 will be discussed in terms of an authorized postage printer used in computer-controlled high volume mailing operations; but it will be readily appreciated that many of the security and accounting problems are the same for other value-dispensing applications such as the preparation of paychecks. The supplemental printer 12 mounted upon the computer output printer 10 is only the postage printing portion of an authorized postage metering system. In order to make such an installation complete, the other end of the data input cable 16 is connected to an electronic postage metering circuit (not shown) which performs the necessary postal accounting functions under secured conditions. The cable 16 is a secured cable, the postage printer 12 is enclosed in a secure housing 20, the metering circuit is also enclosed in a secure housing, and the cable 16 is connected to the metering circuit by a secured connector. For a complete disclosure of the design of such secured cables and connectors, and of an electronic postage metering and printing system which employs the supplemental printer of this invention and deals fully with the postal security and accounting problems involved, see U.S. Patent application Ser. No. 195,694 filed the same day as this application by Eckert, Jones, Hinman, McFiggans, Check and Lupkas, and assigned to the assignee of the present application.

The chain printer 10 impresses printed data upon a paper web 24 in response to computer-generated signals received over the data cable 14. The paper is advanced through the printer line-by-line by means of conventional paper tractors (not shown) acting upon sprocket holes 26 along either edge of the paper web. For mailing label applications, the paper web 24 comprises a backing sheet 28 which has the sprocket holes 26 punched therein and is wide enough to engage the paper tractors on either side of the printer 10, plus a centrally located front strip 30 which is narrower and consists of a series of individual mailing labels 30.1, 30.2, etc.

Printing by the chain printer 10 takes place somewhat below the level of the supplemental postage printer 12, and after each segment of the mailing label strip 30 is completed the paper web 24 is pulled upwardly by the tractors. At a somewhat higher location within the printing station of the high speed printer, the supplemental printer 12 makes its postage printing impression upon the same mailing label strip 30, in response to data which arrives over the secured cable 16 and advises the postage printer of the computer-calculated amounts of postage required for each package. Because of their different print locations along the

path of the paper web, there is a time difference between the related printing operations of printers **10** and **12,** of which the computer must be programmed to take account. After both printing mechanisms **10** and **12** have finished printing their respective impressions thereon, the label strip **30** is separated from the backing sheet **28** and divided into individual mailing labels **30.1, 30.2,** etc. which are then affixed to respective packages for mailing.

The conventional frame structure of an IBM Model **1403** chain printer **10** inclues a pair of upper and lower frame members **22** and **23** respectively which extend horizontally across the printing station, and are used as the basic support for the supplemental postage printer **12** (FIG. **2**). A pair of side bars **32** are each bolted at their upper ends to the upper frame member **22** and at their lower ends to the lower frame member **23** of the main printer **10.** At their lower ends, these side brackets **32** are formed with rearwardly projecting bar-supporting lugs **34** which receive the opposite ends of a threaded bar **36,** and forwardly projecting hinge lugs **38** with interengage with hinge lugs **40** formed on a pair of end brackets **42.** Hinge pins **44** and **46** pass downwardly through vertical holes which are drilled through all the hinge lugs **38** and **40** to secure the end brackets **42** to the side brackets **32** at either side of the printing station (see also FIGS. **3** and **6**). The supplemental postage printer **12** is supported on a pair of slide rails **48** which extend horizontally between the two end brackets **42,** and permit the postage printer **12** to slide horizontally to a position of printing relationship with the label strip **30.** Set screws **50** hold the printer **12** in place after initial adjustment.

As best seen in FIG. **6,** a special platen assembly **52** for cooperating with the postage printer **12** is located directly behind the paper web **24,** and is supported, with provision for lateral position adjustment, by threaded engagement with the bar **36** and clamping engagement with the lower frame member **23.** The threaded engagement with the bar **36** is accomplished by a pair of upwardly and rearwardly extending tapped lugs **54.** The clamping engagement with the lower frame member **23** is accomplished by front and rear plates **56** and **58** respectively which surround the lower frame member **23,** as seen in FIGS. **4** and **6.** Bolts **60** passing through the front plate **56** are threaded to the rear plate **58** to secure them in clamping relationship about the lower frame member **23.** The actual platen surface is a hard rubber insert **62** which is received within an appropriate recess on the front surface of the front clamping plate **56.**

An inked ribbon **64** passes entirely around the outside of the postage printer housing **20** and downwardly between the postage printer mechanism **12** and the paper print-out sheet **24,** in order to provide ink for postage impressions. As seen in FIGS. **2, 6** and **7,** the ribbon **64** is advanced continuously by a roller **66** journaled between plates **68** and **69** and driven by a ribbon advance motor **70** secured to the plate **68.** Both plates **68** and **69** are mounted on the exterior of the housing **20.** Idler rollers **72** are rotatably mounted on a shaft **76** carried by links **74,** and the links in turn are pivotally mounted upon a shaft **78** journaled between the mounting plates **68** and **69.** Torsion springs **80** are wrapped around shaft **78** and react against pins **81** and shaft **76** for biasing the idler rollers **72** against the ink ribbon **64** to maintain driving engagement with the motor-driven roller **66.**

The speed of the computer output printer is such that it can turn out about two or three mailing labels per second. Therefore, if the supplemental postage printer **12** of this invention is to be compatible, it must be able to make two or three postage impressions per second. Conventional mechanical postage printing mechanisms, of the kind that are now widely used for postage metering, are barely capable of such operating speeds, and only under certain limited conditions. Conventional postage printing mechanisms are motor-driven. The inertia of the mechanism and the looseness of the mechanical linkages between the motor and the type elements is such that a print cycle typically takes about half a second when the fastest mechanical postage printers are used. Ideally, then, such printers can turn out two labels per second; but only if the postage amount is not changed between print impressions. Changing the postage amount in a mechanical postage meter typically consumes an additional half second in the fastest mechanical devices, thus increasing the total cycle time to a full second. Consequently, in variable postage applications the production rate would drop to little more than one label per second. The present invention avoids these problems by providing a fast, fully solenoid-operated postage amount changing and printing mechanism which has low inertia and a direct coupling to the type elements.

In addition, most motor-driven postage meters employ a rotary printing action. In addition to the inertia and loose coupling problems mentioned above, rotary mechanisms have dynamic balance problems when operated a high speed. The present invention avoids that problem by providing a flat bed postage printer, i.e. one in which the type elements have a linear print motion. Flat bed printers have been employed for postage dispensation in the past, but they suffered from high inertia and slow response, not only because they were motor-driven, but also because the entire postage impression was formed by one massive, large-area type element. In contrast, the present invention employs a segmented printing mechanism in which the area of the postage impression is divided into a plurality of parts, each of which is printed by an independently moveable type slug actuated by its own individual solenoid. As a result, the printing forces and the inertial mass which each solenoid must handle are drastically reduced. The individual printing slugs also have their own individual return spring mechanisms, to reduce the inertial problems affecting return of the print mechanism, and thus contribute to the overall operating speed of the mechanism.

As seen in FIG. **10,** an entire postage field **90** to be printed by the mechanism of this invention is divided into a plurality of parts **90.1 – 90.8** separated by boundaries **92** (these boundaries are imaginary; they are shown only to indicate the division of the overall postage field **90,** and are not actually visible when postage is printed). Each of the segments **90.1 – 90.8** is printed by an individual type slug **94***a;* **94***b.* Examples of two different types of printing slugs **94***a* and **94***b* which are employed to make the print impressions for the segments **90.1 – 90.8** are seen in FIGS. **8** and **9** respectively. The slug **94***a* illustrated in FIG. **8** is of the kind used to make the printing impressions for the first four segments **90.1 – 90.4,** which contain only fixed subject

matter such as part of the postage validating symbol, geographical information, etc. The segment 94*b* illustrated in FIG. 9 is of the kind used to print the last four segments 90.5 – 90.8, which contain the remainder of the postage validating symbol plus variable numerical data (e.g. 1,421) for forming the postage amount.

Each of the fixed information print slugs 94*a* is a generally rectangular solid member having a narrow end surface 96 formed with type face elements 98 for printing the fixed portion of the postage impression 90. Each of the variable data print slugs 94*b* comprises a jacket 100 of similar external shape but formed in two halves 100.1 and 100.2 shaped to define a rectangular hollow interior 102 into which is inserted a variable numerical print module 104. The module 104 comprises a rotatable wheel 106 having a set of numerical type face elements 107, one of which protrudes through a window 108 formed in the end surface 110 of the slug. Above and below the number window 108 are additional type face elements 112 which cooperate with the type face elements 112 and as of other slugs 94*a*; 94*b* for printing the fixed portion of the postage impression 90. The fixed information type face elements 98 and 112 on the fixed and variable slug 94*a* and 94*b* respectively are aligned with each other so as to form mating lines 113 in the postage impression 90 as seen in FIG. 10. The variable number modules 104 are formed with ribs 105 above and below, which are received by complementary-shaped recesses formed internally of the respective halves 100.1 and 100.2 of the variable print slug jacket 100, so that end surfaces 105*a* of these ribs retain the variable number modules 104 within the print slug interiors 102 against the force of print impact exerted against the number wheels 106.

The variable number modules 104 are commercially available, for example from Practical Automation Company of Shelton, Conn. As seen in FIG. 11, they include respective number selection solenoids 238 for rotating the number printing wheels 106 to a desired numerical position, and respective printed circuits 114 which protrude from the slugs 94b (see FIG. 4) and have electrical leads for conducting number selection input signals to the number selection solenoids and number verification output signals for data feedback to the computer. These leads permit a computer connected to the data cable 16 to send signals to the variable number wheel modules 104 to select the amount of postage, and to receive back signals which verify whether or not the postage amount has been correctly set.

The number wheel 106 is rotatably mounted upon a shaft 210. Coupled to the wheel 106 for rotation therewith is a ratchet wheel 212 having a plurality of peripheral teeth 214. A two-pronged drive pawl 216 includes an upper tooth 218 and a lower tooth 220. Pawl 216 is fixed upon a horizontal shaft 222 for rotation therewith. Also fixed to that shaft is a rocker crank 224 having a crank arm 226 and a drive handle 228 at the end of the arm. The handle is substantially circular in configuration and is rotatably embraced by a drive collar 230 formed at the end of a drive link 232. The link is reciprocated by means of a solenoid 238 which is wound on a U-shaped iron core 240. When the core is energized, the core attracts an armature 242 which is affixed to the drive link 232. The armature 242 has a guiding pin 244 which passes through a suitable opening in a fixed guide member 246. A biasing spring 248 is coiled about the guide pin 244, and compressed between the armature 242 and the guide member 246. In operation the number wheel 106 is advanced one numerical step by the pawl 216 for each electrical drive pulse applied to the coil 238. The coil 238 is energized from the printed circuit 114, and wiper contacts 250 mounted on the wheel 106 cooperate with the printed circuit 114 to reveal the numerical position of the wheel 106.

This type of solenoid-actuated number wheel setting mechanism is very much faster than the mechanical linkages used for postage amount changing in present-day postage meter mechanisms. In actual tests of equipment constructed according to this invention, it has been determined that under worst case conditions (i.e. if number wheel rotation is unidirectional and the resetting displacement in a given instance is only one less than the total number of numerical increments), the maximum resetting time is 140 milliseconds, compared to 500 ms. for prior art mechanisms having mechanical number wheel resetting linkages.

As best seen in FIGS. 3, 4 and 5, the printing mechanism is mounted on a U-shaped machined guide block 119 contained within the secure housing 20 and having upper and lower wings 120 and 122 respectively which are spaced apart to define a print slug guideway between them. As seen in FIG. 3, eight print solenoids 124.1 – 124.8 are mounted within appropriate recesses formed in the guide block. In order to avoid crowding, the odd-numbered solenoids 124.1 – 124.7 for four alternately spaced print slugs 94*a*; 94*b* are mounted on one guide block wing 122, and the even-numbered solenoids 124.2 – 124.8 for the intervening print slugs 94*a*; 94*b* are mounted on the other guide block wing 120.

Each solenoid 124 has a plunger 126 which moves to the right (as seen in the view of FIGS. 4 and 5) at the time of solenoid energization. For each print slug 94*a*; 94*b* and its actuating solenoid 124, there is a bail assembly 128 (FIGS. 3 and 4) which is pivoted at one end by means of pivot shafts 130 or 132 secured at opposite ends to the housing 20. Each bail assembly 128 is engaged at the opposite end by a connecting pin 136 passing between two spaced lugs 138 formed on each solenoid plunger 126.

As best seen in FIG. 3, each bail assembly 128 comprises a pair of individual bail members 128′ which are spaced apart where they are pivoted to the shafts 130 and 132 and where they pass over the print slugs 94*a*; 94*b*, but which meet where they pass between the two lugs 138 of the solenoid plungers 126. The connecting pins 136 pass over the bail members 128′, and nest within notches 140 formed in the bail members as best seen in FIG. 4. Thus, as the solenoid plungers 136 move to the right, the pins 136 rotate the free ends of the bail assemblies 128 pivotally about their respective shafts 130 and 132.

The mid-portions of each bail member 128′ are formed with lugs 142 having circularly shaped tips 142′ received within a pair of circularly shaped openings 144 on each print slug 94. The variable number printing modules 104 are substantially longer than the print slug jackets 100, and therefore extend beyond the associated bail assemblies 128 (as seen in FIG. 4). Spacing the individual bail members 128′ apart allows a central clearance space for the variable print modules 104 (See FIG. 3). In addition, the use of two laterally

spaced bail members 128' causes the tips 142 (FIG. 4) to exert actuating forces evenly on both sides of the associated print slugs 94*a*; 94*b*, so that there are no unbalanced dynamic forces during printing.

As seen in FIGS. 4, 6, 8 and 9, the print slugs 94 are formed with front and rear guide lugs 146 at opposite sides thereof, which mount the slugs 94*a*; 94*b* for sliding motion by slipping into guide recesses 148 formed in the faces of the guide block wings 120 and 122 (FIG. 3). Thus the motion of the print slugs 94*a*; 94*b* is translational in nature, as they reciprocate along the paths defined by the guide recesses 148. The motion of the bail assemblies 128 is pivotal about their shafts 130 and 132, but the circular shape of the drive lug tips 142' (FIG. 4) and of their receiving recesses 144 assures that the force exerted by the bail assemblies 128 upon the print slugs 94*a*; 94*b* will always be parallel to the direction of print slug motion.

The print mechanism is designed so that the solenoid plungers 126 bottom before the print slugs 94*a*; 94*b* make printing impact. As a result, the slugs 94*a*; 94*b* then coast through the remainder of their printing travel momentarily uncoupled from the solenoids 124. This allows the slugs 94*a*; 94*b* to make a brief printing impact against the ink ribbon 64, paper 24 and platen 62, and then to rebound cleanly for the sake of high print quality. In FIG. 4, solely for the purposes of illustration, the bail assembly 128 at the left is seen in its returned position prior to solenoid actuation, and the other bail assembly 128 is seen displaced to the right and at the point of uncoupling. Note that the space between plunger surface 150 and bail assembly 128 allows the bail sufficient clearance to coast free of the connecting pin 136.

For particular applications in which the printer of this invention is controlled by general and/or special purpose computing equipment to keep account of postage or other value dispensed by printing, it would be desirable to have some means of confirming that the print operation ordered by the computing equipment has actually taken place, so that corrective measures can be taken in the event that some malfunction prevents printing. Thus the bail assemblies 128 are provided with heel extensions 128a which are arranged to close normally open print confirmation switches 151 only when the bail assemblies are at or near the position corresponding to print impact of the slugs 94*a*; 94*b*. The switches 151 illustrated in FIG. 4 are of the leaf-sprung type, mounted on the interior wall of housing 20. But if desired, magnetically actuated glass-enclosed reed switches could be used for print confirmation purposes. In either case, contact bounce problems can be eliminated by using the electrical outputs of the print confirmation switches to latch conventional bistable circuits, which then store print confirmation data until reset.

The return motions of the bail assemblies 128 and print slugs 94*a*; 94*b* are driven by coil springs 152 which surround the solenoid plungers 126 and are compressed between the bail assemblies 128 and the solenoids 124 in order to store mechanical energy as the solenoid is actuated. The spring-biased return of the bail assemblies 128 allows the print confirmation switches 151 to re-open, and also causes the solenoid plungers 126 to return because of the driving connection made via pins 136. Return motion of the plungers 126 is limited by cushions 154 mounted on L-shaped stop brackets 156.

With reference to FIGS. 2 and 3, it is occasionally necessary to swing the supplemental postage printer 12 out of the way in order to provide access to paper web 24, the printing chain or other portions of the high speed printer 10. This is accomplished by removing either one of the hinge pins 44 or 46 and swinging the entire assembly of the postage printer 12, the slide rails 48 and the end brackets 42 outwardly about the remaining hinge pin 44 or 46. The arrow 157 in FIG. 2, for example, illustrates the outwardly swinging motion of this assembly about the hinge pin 46 which could be accomplished if hinge pin 44 were removed. In FIGS. 5 and 6 it is seen that the printing slugs 94*a*; 94*b* protrude through a window 160 in the rear of the postage printer housing 20, so as to have printing access to the inked ribbon 64, paper web 24 and platen 62. Clearly, when the piggy-back printer assembly is swung out about one of its hinge pins as just described, this will provide easy access to the inked ribbon 64 and the postage printing type faces 98, 107 and 112 of the print slugs 94*a*; 94*b*. This situation creates a temptation for postage fraud by "wiping off"; i.e. by pressing paper against the inked ribbon and postage printing type faces to accomplish an artificial postage printing impression without actuation of the print solenoids, and therefore without decrementing the electronically stored postal accounting balance.

In order to prevent such cheating, the printing mechanism is so arranged that when all print slugs 94*a*; 94*b* are in their return positions the postage printing type faces are in different planes. This is clearly seen in FIGS. 5 and 6, where the typeface-bearing surfaces 96 and 110 of the slugs 94*a*; 94*b* are seen to be unequally spaced from the printing platen 52. It is not necessary for the printing surface of each slug to be in its own plane. It suffices, and simplifies the mechanical design, if there are at least two different planes, the type faces of some slugs being in one plane which is relatively close to the platen, and the type faces of at least one other slug being in another plane which is further from the printing platen. Thus one or more of the slug surfaces 96 or 110 is recessed relative to the others. The amount of separation of the two planes, i.e. the degree of recessing, is made large enough in relation to the breadth of the slug surfaces 96 and 110 so that it is difficult to reach the more recessed of these surfaces to wipe off an unauthorized postage impression therefrom. In addition, the slug 94*b* containing the least significant digit of numerical information is recessed the most. Although worth the least, that digit is always used, and is therefore the most indispensable of all digits if the postage impression wiped off is to look authentic.

The described uneven placement of the slug surfaces makes it difficult to obtain a fraudulent postage impression, but this advantage would be lost if a postage thief could force the print slugs 94*a*; 94*b* into alignment with each other, thus forming a planar printing surface. Other features of this mechanism, however, present that from happening.

First, it is not possible to force the more exposed print slugs 94*a*; 94*b* backwardly, in the direction opposite to their print stroke. If this was attempted, the print slugs would only force their drive bail assemblies 128 against the connecting pins 136, which in turn would

force the solenoid plungers **126** against their L-shaped stop brackets **156.**

The opposite approach, that of forcing the recessed print slugs to move outwardly in the direction of the printing stroke, is also difficult. In addition to the secured housing **20** which makes access to the internal mechanism very difficult, there is also a locking mechanism which prevents any of the slugs **94***a;* **94***b* from moving through any portion of their print stroke unless an unlocking command comes from the computing equipment over the secured cable **16.**

As seen in FIG. **5,** a locking comb **158** extends horizontally through the postage printing mechanism, and is horizontally slideable (see FIG. **3**) between the upper guide block wing **120** and the print segments **94***a;* **94***b,* and also in a slot **159** milled in the central portion of the guide block **119** (see FIG. **12**). The upper rear guide ribs **146** (FIGS. **8** and **9**) of the print slugs **94***a;* **94***b* are located behind the locking comb **158** and move toward the locking comb during their forward print stroke (see FIGS. **3** and **4**). The locking comb is formed with alternate teeth **158***a* and intervening recesses **158***b*. Sliding motion of the comb causes either the teeth **158***a* or the recesses **158***b* all to line up with the adjacent guide ribs **146,** thus determining whether the print slugs **94***a;* **94***b* are blocked or are released to perform their printing stroke. A tension spring **161** is anchored at one end by an L-shaped bracket **162** secured to guide block **119,** and is secured at its other end to the locking comb **158** for biasing it into the blocking position. The comb can only be moved into the releasing position by a solenoid **164** (FIGS. **3** and **5**) on computer command. The solenoid **164** is received within a recess in the upper guide block wing **120.**

This solenoid has a plunger **166** which is provided with a connecting pin **168** captured between the fingers of a yoke **170** (see FIG. **12**). The yoke in turn is staked on a shaft **172** which is journalled on a U-shaped bracket **176** secured to guide block **119** by a bolt **177.** A drive link **178** has a connecting pin **180** which is received within a comb notch **158***c* as best seen in FIGS. **5** and **12.** A bushing **174** is secured to the shaft **172** for rotation therewith. The bushing has a larger diameter **174***a* for spacing the members **170** and **178** apart, and a smaller diameter **174***b* to which the link **178** is staked. Thus, when the solenoid **166** is energized, the plunger **166** and pin **168** thereof rotate the yoke **170,** the shaft **172** and the link **178** as a unit, causing the pin **180** to drive the locking comb **158** in the releasing direction, extending the comb return spring **161.** (FIG. **5**) The locking comb is seen in FIG. **5** in its releasing position, wherein the guide ribs **146** are free to move into the comb recesses **158***b* when the print slugs are actuated by their solenoids **124.** Subsequently, when the electrical signal terminates, the solenoid **164** no longer holds the locking comb **158** in locking position. But the locking comb **158** can not return to its biased position until after all the print segments **94***a;* **94***b* have returned, because until that time the guide ribs **146** are in the comb recesses **158***b*, interfering with the teeth **158***a*, and thereby preventing sliding motion of the comb **158.** Eventually, however, the comb is biased back to its original position in which the teeth **158**a are in blocking relationship to the guide ribs **146.** Then it is no longer possible to move the print slugs **94***a;* **94***b* toward the platen **62.** The locking comb **158** is retained in its slot **159** (FIG. **12**) by a lug **176***a* bent laterally from bracket **176** (FIGS. **3** and **12**), and by a shim **163** (FIG. **3**) bolted to the guide block **119.**

The position of the actuating mechanism for the locking comb **158** is monitored electrically, to provide information which is useful for print confirmation purposes. As seen in FIGS. **3** and **12,** a conventional double-pole, double-throw switch **260** is mounted on the guide block **119** and actuated by a plunger **262** located in the path of a lever **264** staked to the releasing shaft **172** of the locking comb **158.** When shaft **172** rotates link **178** to release the locking comb, it also rotates lever **264** to strike the plunger **262** and actuate the switch **260.** In an exemplary print confirmation circuit which is disclosed in the Eckert et al. application cited above, release of the locking comb produces a first output from the switch **260** which starts an operating cycle of the print confirmation circuit, and re-locking of the comb **158** produces a second output from the switch **260** (because it is a double-pole, double-throw device) which consummates the operating cycle of the print confirmation circuit. To avoid contact bounce problems, these outputs from switch **260** are preferably used to switch one or more latching circuits.

Test printing operations with the described mechanism, in which all the print solenoids **124** were fired substantially simultaneously, have demonstrated that such simultaneous firing noticeably degrades the print quality. Presumably this is because the supplemental printer **12** of this invention, which is small in relation to the conventional high speed printer **10** of FIG. **1,** does not have sufficient reaction mass of its own, and cannot be mounted sufficiently rigidly on the high speed printer **10,** to press the print slugs **94***a*, **94***b* firmly against the print surface under the shock of simultaneous firing. In accordance with an additional aspect of this invention, however, excellent print quality is obtained if the print solenoids **124** are fired sequentially, even if the spacing is no greater than 1 to 2 milliseconds between consecutive solenoid firings. Apparently this spreads the printing shock over a large enough time span to reduce the peak shock intensity, resulting in print quality which is not noticeably inferior to that obtained in low speed printing operations.

FIG. **13** illustrates an exemplary circuit which may be used for separating the print solenoid firing times in accordance with this invention. An externally generated print signal sets a start flip-flop **300,** causing it to insert a zero into the first stage of a shift register **302** which is continually shifted by a clocking oscillator circuit **304** having a period equal to the desired time spacing between print solenoid firings. The zero inserted into the first shift register stage is therefore propagated through each successive register stage.

The outputs from the successive shift register stages are labeled LC and PB1 through PB8 in that order, to indicate that they are connected to turn on the locking comb solenoid **164** and the print bail solenoids **124.1** through **124.8** respectively. Each shift register stage output LC and PB1–PB8 is connected through a respective inverter stage **306** to the gate of a respective SCR **308** which controls energization of the respective solenoid **164** or **124.1–124.8.** Because of the logical inversion introduced by stages **306,** the SCR's **308** of solenoids **164** and **124.1–124.8** are fired in that order as the initial zero is propagated along the shift register **302.** The time delay between solenoid firings is determined by the clocking rate of the shift register, which

in turn equals the frequency of the clocking oscillator **304.**

The turning on of each SCR **306** in turn discharges a respective capacitor **309** through the associated solenoid **164** or **124.1–124.8.** After discharging the capacitors **309,** the SCR's **308** are turned off and the capacitors **309** are recharged from power terminal **311.** The capacitor recharge time is preferably small enough so that, by the time print segments **94***a;* **94***b* return to home position and the number wheels **106** are reset, the print cycle can be repeated. Therefore, recharging the capacitors **309** is not a limiting factor so far as printing rate is concerned. Diodes **315** are employed to isolate the capacitors **309** from each other during print discharge. Resistors **313** are employed to protect the SCR's **308** from the inductive kick-back of solenoids **164** and **124.1–124.8** when the SCR's are turned off. FIG. **13** does not show any explicit provision for turning off the SCR's **308** after printing, in order to avoid unnecessary detail which forms no part of the present invention. Turning off of the SCR's must be done by momentarily opening their anode-cathode circuits after discharge of capacitors **309,** as is well known in the art. Various circuits for accomplishing this are disclosed, for example, in the General Electric SCR Manual, 4th Edition.

When an external stop signal subsequently arrives over lead **310,** it enables a coincidence gate **312** and presets the shift register **302** (i.e. forces all shift register stages to assume a logical one state). This assures that all the inverters **306** are turned off, and energizes a lead **314** connected to the output of the first shift register stage (LC). The signal on lead **314** then passes through the enabled gate **312** and resets the start flip-flop **300,** concluding the print cycle.

The described solenoid-operated printing mechanism provides significant improvement in speed over prior art postage printers. It was pointed out above that the maximum number wheel resetting time is about 140 milliseconds. Once number wheel setting is accomplished, the time required to drive the print slugs **94***a;* **94***b* to impact and return them to rest position is of the order of 50–60 milliseconds, even allowing for the delaying effect of the time spread circuit in FIG. **13.** Thus the maximum total cycle time is slightly over a quarter second even in the worst case (i.e. maximum number wheel setting displacement). Such a cycle time would permit a production rate of nearly four postage impressions per second, even if the number wheel setting displacement were always maximum. Statistically, the average number wheel setting displacement is much less than maximum for any normal distribution of postage amounts. Therefore under normal conditions the maximum production rate of this printer can exceed four postage impressions per second, which is better than twice as fast as the production rate of mechanically driven postage meters.

It will now be appreciated that the present invention provides a segmented, solenoid-actuated special purpose printer which is capable of speeds compatible with data processing equipment. The segments return to uneven home positions, to deter "wiping off". The printer employs a combination of variable information and fixed information printing means to combine variable amount information and a special validating symbol. This printing concept may be embodied in a supplemental printer mechanism physically mounted in piggy-back relationship upon an otherwise conventional computer output printer, which prints upon the same printout sheet and in response to commands from the same computer. Print quality is preserved by spreading out the individual segment print impacts along the time axis. The piggy-back printer is useful in postage printing and various other applications requiring over-sized or non-standard printing symbols in a computer-controlled installation, or in any application where security problems are an important consideration.

Since the foregoing description and drawings are merely illustrative, the scope of protection of the invention has been more broadly stated in the following claims; and these should be liberally interpreted so as to obtain the benefit of all equivalents to which the invention is fairly entitled.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A flat bed printer comprising, in combination:

A. a plurality of discrete impact segments;

B. a flat platen;

C. means separately mounting each said segment for individual rectilinear movement between respective home positions and print impacting engagement with said platen;

D. separate actuating means operatively coupled to each segment to drive their respective segments from their respective home positions into print impacting engagement with said platen, said actuating means including separate solenoids having armatures operatively coupled to respective ones of said segments, and a circuit for energizing said solenoids in sequence, said circuit comprising a shift register, clocking means for shifting said shift register at a predetermined rate, means responsive to a print signal to enter an enabling signal into said shift register, separate means connected to subsequent stages of said shift register for triggering the energization of respective solenoids as said enabling signal is shifted through said shift register by said clocking means, and means responsive to a stop signal to clear said enabling signal from said shift register; and

E. separate restoring means operatively coupled to each said segment for returning their respective segments to their respective home positions.

* * * * *