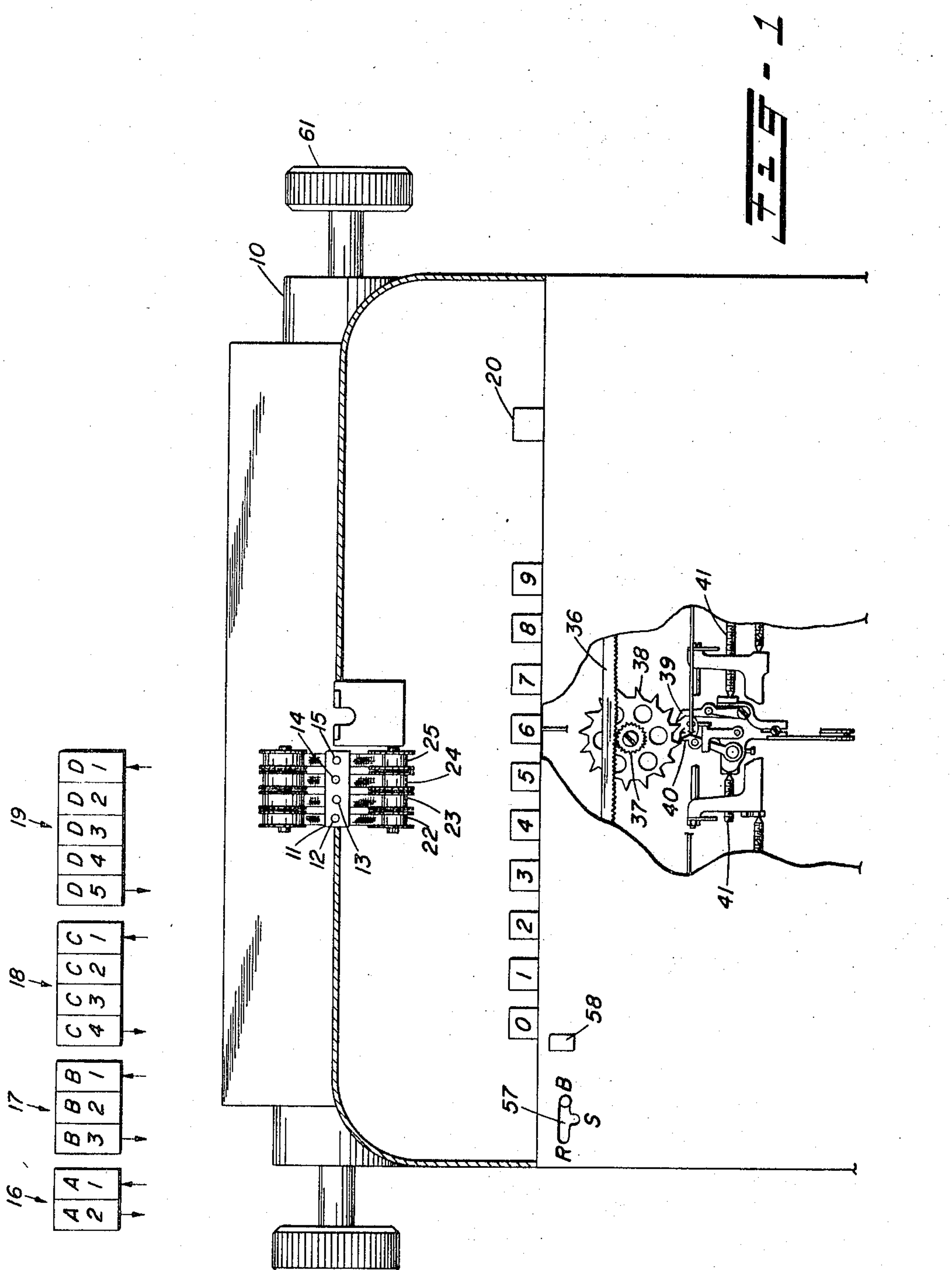
Sept. 12, 1967 F. HALVERSON 3,340,983

PRINTING DEVICE USING CODED INKS

Filed Feb. 9, 1966 5 Sheets-Sheet 1



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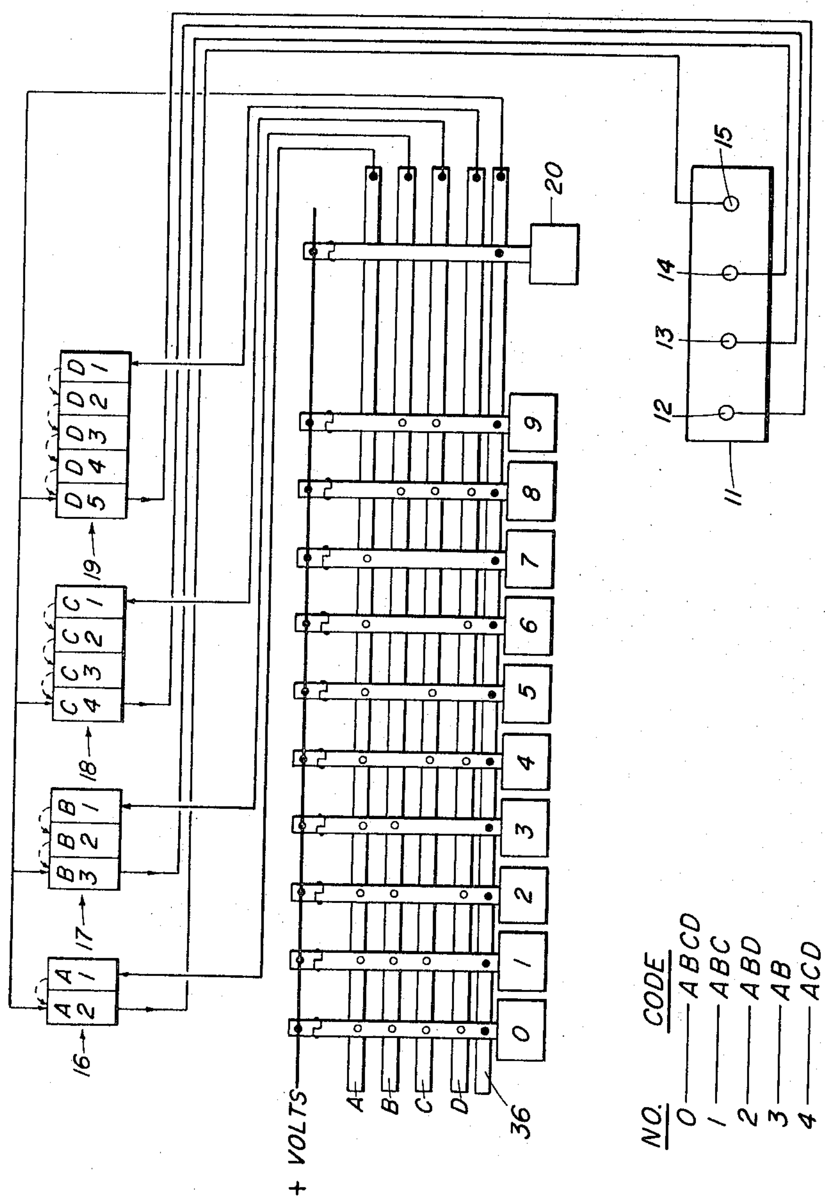

NO.	CODE
0	ABCD
1	ABC
2	ABD
3	AB
4	ACD
5	AC
6	AD
7	A
8	BCD
9	BC

FIG. 2

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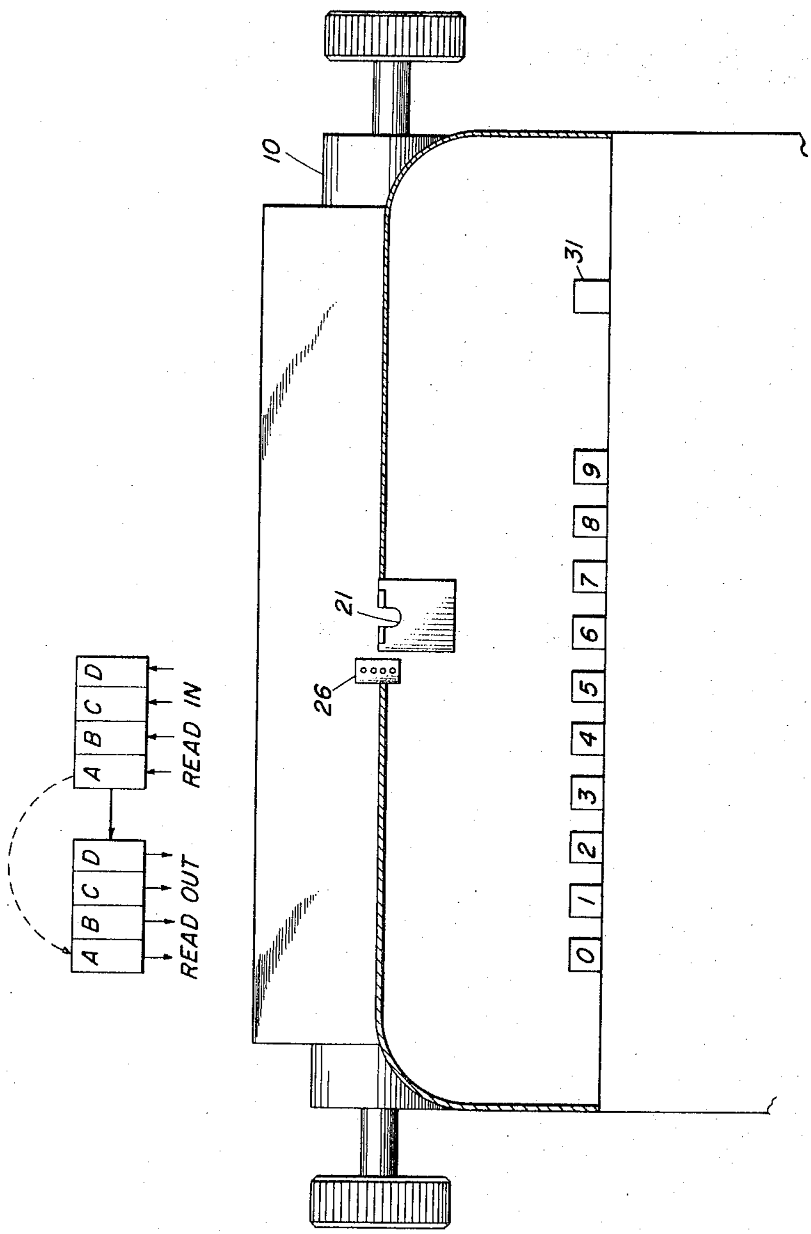

FIG. 3

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PRINTING DEVICE USING CODED INKS

Filed Feb. 9, 1966 5 Sheets-Sheet 4

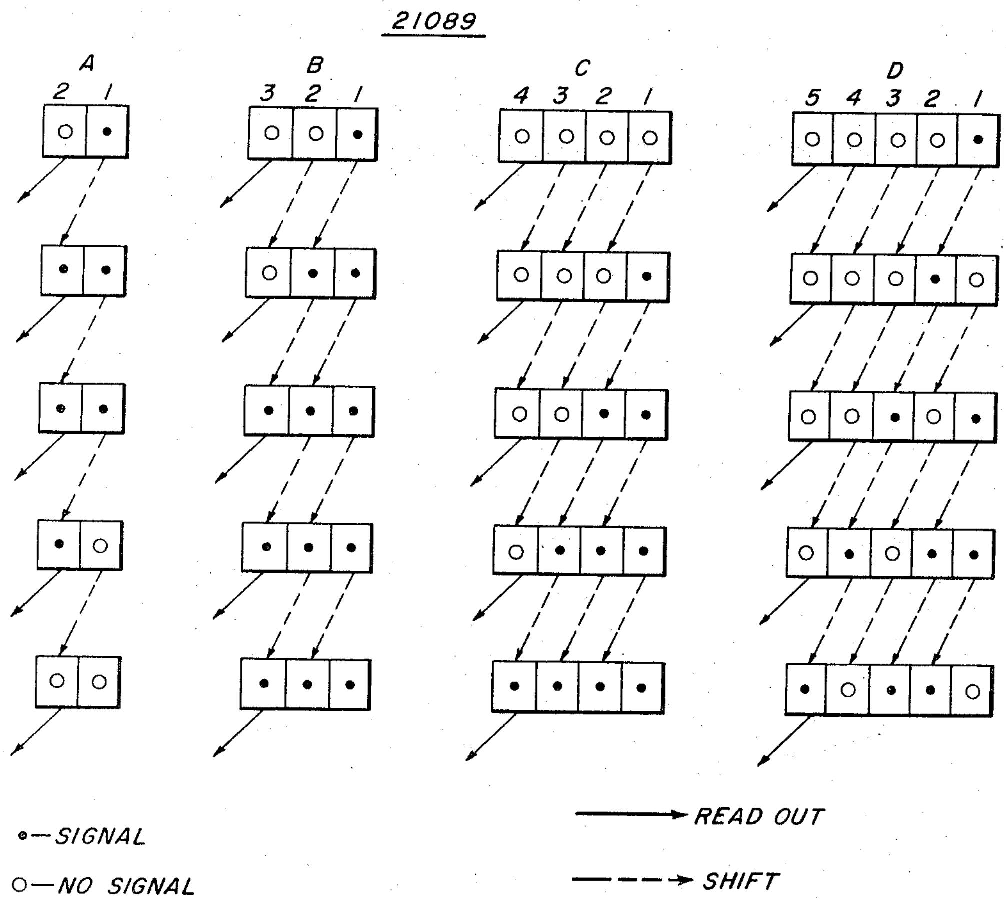

FIG-4

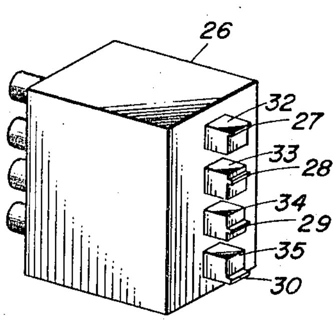

FIG-5

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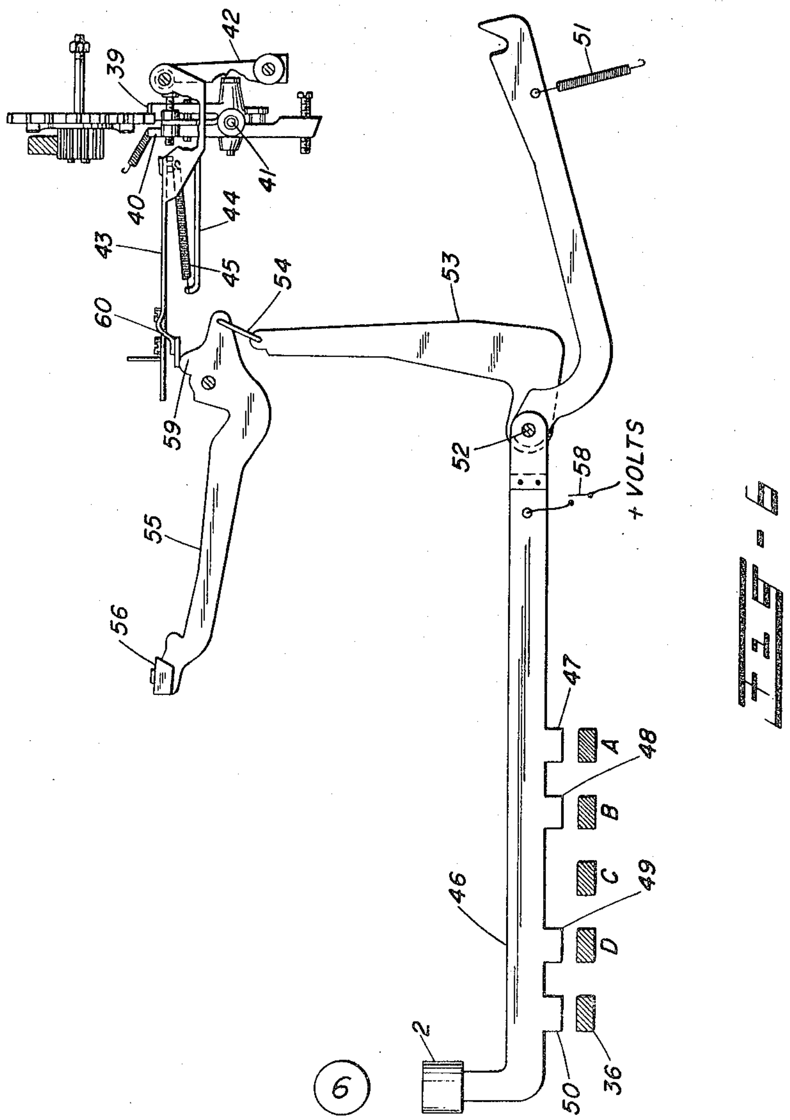
PRINTING DEVICE USING CODED INKS

Filed Feb. 9, 1966 5 Sheets-Sheet 5



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3,340,983

PRINTING DEVICE USING CODED INKS

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9 Claims. (Cl. 197—1)

This invention relates to a method of printing symbols involving coded inks and more particularly coded inks utilizing various photoluminescent materials. The invention also includes apparatus for printing.

In the application of Freeman and Halverson, Ser. No. 437,866, filed Mar. 8, 1965, and assigned to the assignee of this application, there is described a method and apparatus for recording and retrieving information by means of photoluminescent materials. In the application so-called coded inks are utilized in which various symbols, such as numbers, are represented by the presence or absence of particular photoluminescent material rather than representing the symbols by particular shapes which are distinguishable either visually, magnetically or by other characteristics. When dealing with numbers, for example, four different photoluminescent materials may be used, and this gives the possibility of fifteen different codes, the general formula being 2^n-1, where n is the number of photoluminescent materials. Larger numbers of coded materials permit representing still larger numbers of different symbols. For example, with six different photoluminescent materials sixty-three symbols are distinguishable. The different coded inks contained the necessary mixtures of materials which fluoresced under ultraviolet illumination in definite colors.

The code was read by illuminating with ultraviolet light and detecting presence or absence of a particular luminescent material by individual radiation detectors provided with filters or other spectral separation means so that each detector responded only to the range of wavelengths corresponding to the particular substance present. Among the photoluminescent materials preferred in the application referred to above were complexes of rare earth metals having an atomic number greater than 57, which are usually referred to as lanthanide ions. The complexes, such as chelates, were formed with various organic ligands, which under ultraviolet illumination excite the lanthanide ion into a metastable electronic state from which the chelated lanthanide ion can emit a photon having an energy corresponding to transition to a lower electronic level of the chelated ion. This emission is over a very narrow range of wavelengths. It is also possible to use one, but ordinarily not more than one, simple organic fluorescing material, such as for example diphenylanthracene or 4,5-diphenylimidazolone-2.

It is desirable to be able to print or type coded symbols rapidly and advantageously on equipment which is reasonably simple. The present invention is directed to a method and particularly apparatus for typing or printing which uses ordinary typewriter mechanisms with some additional modifications. Essentially the additional structural elements which have to be added to ordinary typewriters, particularly electrical typewriters, are a set of additional coded ink hammers or type bars, memory elements and electrical means to store information temporarily into the memory elements by actuation of the ordinary keys on a typewriter keyboard. Also, a different placement of ribbons may be necessary in some modifications, and in one of the two principal types of apparatus according to the present invention, the typewriter carriage may require somewhat longer travel, for example six spaces.

For simplicity the invention will be described with a

2

typewriter, preferably an electric typewriter, referring only to ten keys for the ten digits used in writing numbers. For this number of symbols coded inks with four components are sufficient. For practical use the typewriter will ordinarily be required to type alphabetical symbols as well as numerical symbols, and for this purpose coded inks with six components are needed. However, since the operation with a larger number of symbols proceeds in exactly the same manner as with ten numerical digits, the simpler representation is shown in the drawings and will be described, in order to avoid an excessive number of elements and wires which would only confuse the drawings without making the operation any clearer. During the description, from time to time, brief references will be made to what additional elements are needed for six components. Also, since the typing function of the typewriter is not changed by the present invention, which merely adds some additional elements, only so much of the typewriter structure will be shown as is needed to make the operation of the additional coding elements clear. Thus, for example, the conventional mechanism for spacing lines vertically will not be shown as this does not come into play in the operation of the machine in any given line. Furthermore, since standard types of memory units are used, they will be illustrated in block diagram form.

The description will be in conjunction with the drawings, in which:

FIG. 1 is an elevation, partly broken away, of a typical typewrite, Underwood Models 5 and 6, with a simplified keyboard of only ten keys;

FIG. 2 is a block diagram of the electrical connections and the code for the ten digits represented by the keys;

FIG. 3 is an elevation similar to FIG. 1 of a modified form of the invention;

FIG. 4 is a diagrammatic showing of the operation of the memory units for a 5-digit number;

FIG. 5 is an enlarged view of the code printing head for the modification shown in FIG. 3, and

FIG. 6 is a side elevation showing one key.

In FIG. 1 an electric typewriter platen is shown at **10** with a type printing guide **21**. As this is of standard type for electric typewriters, neither the conventional ribbon nor type bar is illustrated. They are, of course, present but are not changed by the present invention. On the keyboard are shown ten keys for the digits 0 to 9. Of course in a normal machine there will be the regular keyboard with the full number of keys for letter symbols as well as the ten digits.

FIG. 1 is an elevation of a typical typewriter, an Underwood, a portion of the front being broken away to show the carriage moving mechanism for spacing, including the escapement action. This is shown in the publication "Typewriter Mechanical Training Manual," by Clarence LeRoy Jones, published by the Office Appliance Mechanical Institute, 429 W. Walnut St., Springfield, Mo., and copyrighted in 1945. The carriage mechanism is described on page 1, and the particular escapement mechanism, including actuation of a type bar for an Underwood typewriter, on pages 78 and 79, the key type and escapement mechanism being shown in a side view in FIG. 6 for one of the type keys on the simplified keyboard. The elements operate in exactly the same way as described on page 79 of the publication above referred to, the only change in FIGURE 6 being the fixing of the contacts to actuate the electric circuits of the present invention.

The rack **36**, which is attached to the carrier, appears in the broken away portion of FIG. 1 and meshes with a pinion wheel **37**, which is on a shaft that also carries a star wheel **38**. The rack is, of course, provided with the conventional spring for moving the carriage, but as this is not changed by the present invention it is not shown anymore than the conventional carriage return and vertical spacing lever, which also is not in any way changed by the present invention. For simplicity, therefore, vertical spacing is shown only by means of the conventional platen knobs **61**.

Turning now more particularly to FIG. 6, although some of the same mechanism is shown in FIG. 1, a key is illustrated, key #2 on FIGS. 1 to 3. The key has a bar **46** which is provided with four switch contacts **47**, **48**, **49** and **50**, which will be described in more detail in connection with the description of FIG. 2 below. The bus bars A, B, C, D and **36** are also shown, and the type bar, which of course is of metal as in a standard typewriter, is shown as connected to a source of plus volts through a switch **58**, the latter also showing on FIG. 1. The electrical operation of these elements will be described in more detail below in connection with the description of FIG. 2. A key lever tension spring **51** is shown, and depression of the key lever pulls down a connecting lever **53** which is journaled to it at **52**. The latter is connected to a type bar **55** by the conventional flexible link **54** and the type bar carries a type face **56**, in this case with the FIGURE 2 in raised form on it. Depressing of the key swings the type bar into contact with the ribbon (not shown), in the usual manner.

After the key has struck and is returned to its normal position, a cam contour **59** on the type bar **55** raises a universal bar **43**, which causes the escapement mechanism to pivot clockwise, as shown in FIG. 6, on its pivots **41**. This causes the loose dog **39** to swing out of contact with the teeth of the star wheel **38** and swings the rigid dog **40** in so that the star wheel can turn one tooth. This in turn permits the rack **36** to move a single space. As the type bar swings further back the universal bar **43** is returned to its normal position, which is shown in FIG. 6, by means of the return spring **45**, which is attached to the universal bar support **44**. The carriage is thus moved by the rack **36** one space and now the loose dog **39** again contacts the next tooth on the star wheel. Obviously, of course, the portion of the universal bar **60** extends across the type bar so that the bar **43** is moved regardless of which key is struck. This is, of course, conventional in typewriters, but is mentioned here merely for the sake of completeness.

To the left of the regular typing space **21** there is mounted a horizontal printing head **11** with four printing hammers **12** to **15** mounted so that the hammers are spaced a single typing space on the typing line. The hammers have small printing or impression faces, for example of small dot size, and each hammer is aligned with its own very narrow ribbon, which are numbered **22** to **25** to correspond to the hammers **12** to **15**. For clarity, the width of the ribbons and the hammers is greatly exaggerated. In an actual machine they are only one space wide. It will be noted that there is no contact between ribbons and no possibility exists for the ink in one ribbon to flow to the ink in the other ribbon so that a hammer always makes an impression in its own single component ink.

The four components, such as four photoluminescent components, are labelled A, B, C and D, and the code for the ten digits is reproduced just below, and a part of FIG. 2. Each of the ribbons **22** to **25** is impregnated with a single component: ribbon **25** component A, ribbon **24** component B, ribbon **23** component C and ribbon **22** component D. The hammers are actuated by conventional electric drives, such as solenoids, magnetostrictive transducers and the like. As the design of the hammer actuation is a well known one, it is not shown in mechanical detail on the drawings, appearing only diagrammatically in FIG. 2.

Each component is allotted its own memory circuit,

16 to **19** for components A to D. It will be noted that memory unit **16** has two storage locations, **17** three, **18** four, and **19** five. Each of these has been labelled from right to left with the component letter and the numbers **1**, **2**, **3**, **4** and **5** respectively, as will appear in FIGS. 1, 2 and 4. Storage locations labelled **A1** to **D1** have key actuated read-in facilities of standard design. The extreme left hand locations **A2**, **B3**, **C4**, and **D5** are for external readout and are connected to the hammers **15** and **12** respectively.

The memory units are of standard binary computer type, with signals read in at one location, signals read out externally at another location, and provision for a shift of store signals from right to left by one storage location within a given memory unit on any single command. In order to clarify operation, the following convention has been applied to FIGS. 2 and 4. External read-in and read-out connections are in solid lines, and shift operations are in dotted lines. This convention is illustrated in FIG. 4 for read-out connections and shift connections. Also, the common convention of illustrating the absence of a signal with a zero and presence with a dot is followed in FIG. 4.

The invention will be described in connection with the encoding of a typical five digit number, 21089, reference being had to FIGS. 2 and 4 of the drawings. FIG. 2 is a purely diagrammatic showing in which the keys are represented as receiving a positive voltage on their bars, which have contacts connecting to bus bars for the different components labelled with the component letters. These contacts are represented by small circles on the bars of keys **0** to **9** in FIG. 2, and it will be seen that they are located so that the proper bus bars are energized in accordance with the code appearing in the figure.

If the typewriter carriage is at its extreme right, the beginning of a line, first key **2** is struck. From the code it will be apparent that this requires energizing of bars A, B and D, but no voltage is transferred to C. This is effected as illustrated in FIG. 6 by the contacts **47**, **48** and **49** contacting bus bars A, B and D. Looking at the top line of FIG. 4, it will be seen that a signal is read in to **A1**, **B1** and **D1** but no signal to **C1**. The other storage locations of the memory units have no signals in them, as this is the start of a line and all of the memory units were cleared at the end of a line, as will be described below. Therefore, the readout arrows from the readout locations **A2**, **B3**, **C4** and **D5** will give no signal and no hammer will be actuated. Commands for external readout are taken from bus bar **36**. Every one of the keys has a contact for this bus bar, which is shown as a dot to distinguish it from the contacts for the other four bus bars which give read-in signals. As can be seen in FIG. 6, the contact **50** transfers the voltage to bus **36**.

The key **2** then reverts to its former position, and a key reversion actuates the shift operation for all of the memory units, transferring a signal, or no signal as the case may be, one storage location to the left. Now the key **1** is depressed, energizing bus bars A, B and C, and the situation is represented by the second row in FIG. 4. To avoid confusion the letters and numbering of the storage locations are not repeated after the first row. This has the result that a signal is read in to **A1**, **B1** and **C1** and no signal is read in to **D1**. At the same time, a signal is read out from **A2** which causes hammer **15** to strike through its ribbon **25** and to imprint a dot of the coded ink containing A onto the figure 2, which had been typed by the preceding operation. As there is no signal in the readout location of the memory units for components B, C, and D, the other three hammers are not actuated.

Now key **0** is depressed, and the third row in FIG. 4 shows the results. All four read-in bars are energized and a signal is read in to the read-in location of all four memory units. At the same time, a signal is read out from **A2** and **B3** and hammers **15** and **14** strike through their ribbons. Next, key **8** is depressed, the result being shown in the fourth line in FIG. 4, a signal being read in to B1, C1 and D1 and a signal is read out from A2 and B3, in other words causing hammers **15** and **14** to be actuated once again. Finally, key **9** is depressed, which is shown in the fifth row of FIG. 4; a signal is read in to B1 and C1, and signals are read out from B3, C4 and D5. In other words, hammers **14**, **13** and **12** are actuated.

If we now consider what has happened to the symbols that have been typed, it will be apparent that the figure two has received dots of components A, B, and D, this symbol having been located first opposite hammer **15**, then **14**, then **13** and finally **12**. It will be seen, however, that when it was opposite hammer **13**, the hammer was not actuated, as is shown in the fourth line of FIG. 4, and therefore this symbol received dots of components A, B and D, which is what it should receive according to the code. The symbol for the figure one which was typed received a dot from hammer **15**, then a dot from hammer **14**, and finally a dot from hammer **13**. However, it will not have received a dot from hammer **12** because when the next symbol is typed and hammer **12** would be opposite the symbol one, there is no signal read out from D5.

The procedure is repeated symbol after symbol until the end of the line is reached, which however is not the end of the carriage movement, the latter being capable of moving four more spaces to the left. At this point key **20** is depressed. This contacts bar **36** and orders read-outs from A2, B3, C4 and D5. Raising the key **20** moves the carriage one space further to the left as is illustrated in FIGS. 1 and 6 and actuates the shift operation in each memory unit. It will be apparent that raising the key **20** initiates exactly the same operations as the raising of any other key which has been struck. When key **20** is depressed again it actuates readout from the memory units and when it is raised moves the carriage one space to the left and actuates shift operations as has been described above. Key **20** is depressed and released a total of four times. It will be noted that each time the key **20** is depressed, there is no signal read in to any of the memory units, and therefore after releasing from the fourth operation, there will be no signal on any of the storage locations of the memory units. In other words, the memory units will have been cleared to start the next line, which occurs as in ordinary electric typewriters by the platen being turned up the requisite distance and moved all the way over to the right. This clearing of the memory units was mentioned when the actuation of key **2** was described, and is the reason why the memory units for the four components in the top line of FIG. 4 showed no signals except where the first key depressed had sent a signal to their read-in storage locations.

A single key **20** when actuated four times is a relatively simple mechanism. However, for machines which are to be used for fast typing, it is possible to forget to depress key **20** the requisite number of times. Of course it can be depressed more than the requisite number of times, because nothing happens after the fourth actuation. Therefore, for maximum speed and reliability, it may be desirable to connect key **20** to a small programmer which will contact in succession bar **36** four times. The operation is the same as the repeated manual operations described above.

FIGS. 3 and 5 illustrate a somewhat simplified mechanism in another modification, but one which requires more space. The same elements are given the same reference numerals; however, the memory units are now greatly simplified: each one has only two storage locations, one for read-in and one for external read-out. In other words, they are similar structurally to the memory unit A of FIGS. 1, 2 and 4. Shifting occurs when a key is lifted, but is always from A read-in to A read-out, B read-in to B read-out, etc. In order to avoid confusion, only the dashed arrow for the shift from A read-in to A read-out is shown in FIG. 3.

The printing head **26** is different from printing head **11** in FIGS. 1 and 2 in that it is vertical instead of horizontal and is provided with four hammers **32** to **35**. The hammers, instead of having a small dot on their printing faces, are provided with vertically separated ridges **27** to **30**, and a different type of end-of-the-line key **31** is provided. Let us now consider what happens if the same number, 21089, is typed, as was described in connection with FIGURES 1, 2 and 4. When the key **2** is struck, it reads in a signal into the read-in storage location of A, B and D, just as it did in FIG. 4. When the key is lifted, shifting takes place, as described above, and a signal is transferred into the external read-out locations of A, B and D, but no signal is transferred in C because, of course, no signal was read in to the read-in location of this memory unit. The carriage moves one space to the left when the key is released, and now when the key **1** is depressed it orders a read-out from the memory read-out locations, but there are signals stored only in A, B and D. This will cause hammers **32**, **34** and **35** to strike simultaneously, printing spaced narrow lines over the symbol two. At the same time it reads in, as described above, a signal to the read-in locations of A, B and C. On raising this key the signals are shifted to the read-out locations, and when key **0** is struck, hammers **33**, **34** and **35** are actuated, but not hammer **32**. This prints lines from these hammers onto the symbol one which is in accordance with its code, and at the same time signals are read in to the read-in locations of all four memory units. Striking the key **8** then causes a read-out in accordance with the code for zero. In other words, all four hammers strike, and a signal is read in to B, C and D but not into A. Then when the key **9** is struck it orders a read-out of signals in B, C and D, which causes hammers **32**, **33** and **34** to strike, and prints the three lines representing the code of digit eight over it. At the same time, the signals for digit nine are read in to the read-in locations of memory units B and C. When the next key is struck, it will order a read-out for the digit nine, that is to say, hammers **33** and **34** will strike. At the end of the line key **31** is depressed, and this orders read-outs from A, B, C and D. Key **31** is then locked out by a conventional mechanism (not shown), the platen turns up for another line, and the operations are repeated.

When we compare the modification of FIGURES 1, 2 and 4 with that shown in FIGS. 3 and 5, it will be apparent that the former prints small dots on a symbol, located one over another. If the ribbons **22** to **25** have moved slightly, as they should, there will be no contamination of one ribbon with ink from the previous coded impression. However, unless the ribbons do move sufficiently so that a dot never goes through the same portion of the ribbon, contamination is possible, at least theoretically. A smaller area covered by the coding dots which is made possible in the modification of FIGURES 1, 2 and 4 is, therefore, bought at a price of moving the ribbons more rapidly, which means shorter life, and the somewhat greater complexity of the memory units, each one having a number of storage locations, one more than the position of the hammer which it controls. The electronics are not thereby rendered seriously complicated. There is, however, either the necessity of striking key **20** four times at the end of a line or providing for suitable programming, as has been described above.

The modification of FIGS. 3 and 5, which of course uses ribbons that are very narrow and horizontally zoned instead of vertically, has the advantage that all of the coded lines are printed at the same time, and unless the ribbons sag there is no possibility of contamination of one ribbon with ink from a previous impression. There is also some simplification of the memory units and of the end-of-the-line operation of key **31**. The disadvantages are a head which is normally larger, thus needing somewhat greater spacing, which may preclude in practical machines a single-spaced operation. This operation, however, can be effected readily with the modification of FIGS. 1, 2 and 4. In other words, both modifications have their advantages and disadvantages, but it is a definite advantage of the invention as a whole that the various modifications provide flexibility so that the best modification can be chosen in any particular case in accordance with its requirements. Needless to say, FIG. 5 is even more grossly exaggerated in size than FIGS. 1 and 2 in order to show the more complex shape of the hammer faces. However, even when greatly reduced in size, as it is in a practical machine, it still requires somewhat more vertical height than in the other modification.

The invention has been described in conjunction with symbols which are printed in visible ink. This is desirable where it is wished to be able to read the message visually as well as under ultraviolet illumination. However, sometimes it may be desirable to print secret messages in colorless code. In such a case a machine may be used which does not have ordinary printing keys, or better yet, the ribbon lever **57** is thrown to the stencil position so that the symbol is not typed visually. Where only secret messages are to be encoded, the elimination of ordinary type bars permits a simpler typewriter, as the typing mechanism can be eliminated. For some purposes this simplification is desirable, and it is an advantage of the present invention that it operates effectively. Of course if the typewriter types ordinary symbols and for some reason it is decided not to have any coded ink encoding, this is effected by throwing the switch **58** which cuts out the electrical connections to the memory units and to the actuators for the code printing hammers. This adds to the flexibility and versatility of the invention.

I claim:

1. In a typewriter having keyboard, carriage, carriage advancing means, and a typing point, the improvement which comprises in combination,

(a) a plurality of printing hammers adjacent to the printing point and spaced horizontally therefrom in the direction of carriage travel, said hammers being provided with means for inking each hammer with a separate ink, the ink for each hammer being different in composition from the ink for any other hammer, means for preventing mixing of any one of the different inks with any of the others, and

(b) means controlled by key action for causing preselected coded hammers to strike paper on the carriage over a typed symbol, said actuation occurring subsequent to typing of a symbol for a particular key.

2. A typewriter according to claim **1** provided with manually actuatable means for preventing typing of symbols when the keys are struck, without preventing control of actuation of the hammers.

3. A typewriter according to claim **1** in which the hammers have typing impression faces less than the area of a typed symbol, the hammers being positioned so that each coded impression is spatially separated from any other, and the hammer actuating means cause simultaneous actuation of all hammers called for by the code of a particular symbol.

4. A typewriter according to claim **1** in which the hammers are positioned in a horizontal line spaced by the spacing of a single typed symbol and the hammers are controlled by memory units which are capable of giving read-out signals on subsequent key actuation whereby the coded ink impressions over a symbol are successively typed in layers.

5. A typewriter according to claim **4** provided with a manually actuatable means for inhibiting typing of symbols on actuation of any key.

6. A typewriter according to claim **4** provided with a key, actuatable at the end of a line, to control the typing of the coded inks by the hammers on the last symbols in the line.

7. A typewriter according to claim **4** in which the memory units are the same in number as the coded ink components, the first memory unit having two storage locations and successive memory units having one additional storage location, so that the last memory unit has one more storage location than the total number of ink components, one location being an external read-out position and one a read-in position, and a key controlled shift operation for shifting signals in each memory unit one position from the read-in location toward the read-out location.

8. A typewriter according to claim **7** including means for actuation at the end of a line to cause successive shifts and readouts equal to the number of components.

9. A typewriter according to claim **7** in which the hammers are provided with vertically spaced, narrow, horizontal line impressions.

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