

Oct. 26, 1954

J. T. POTTER

2,692,551

HIGH-SPEED ROTARY PRINTER

Filed May 26, 1950

4 Sheets-Sheet 1

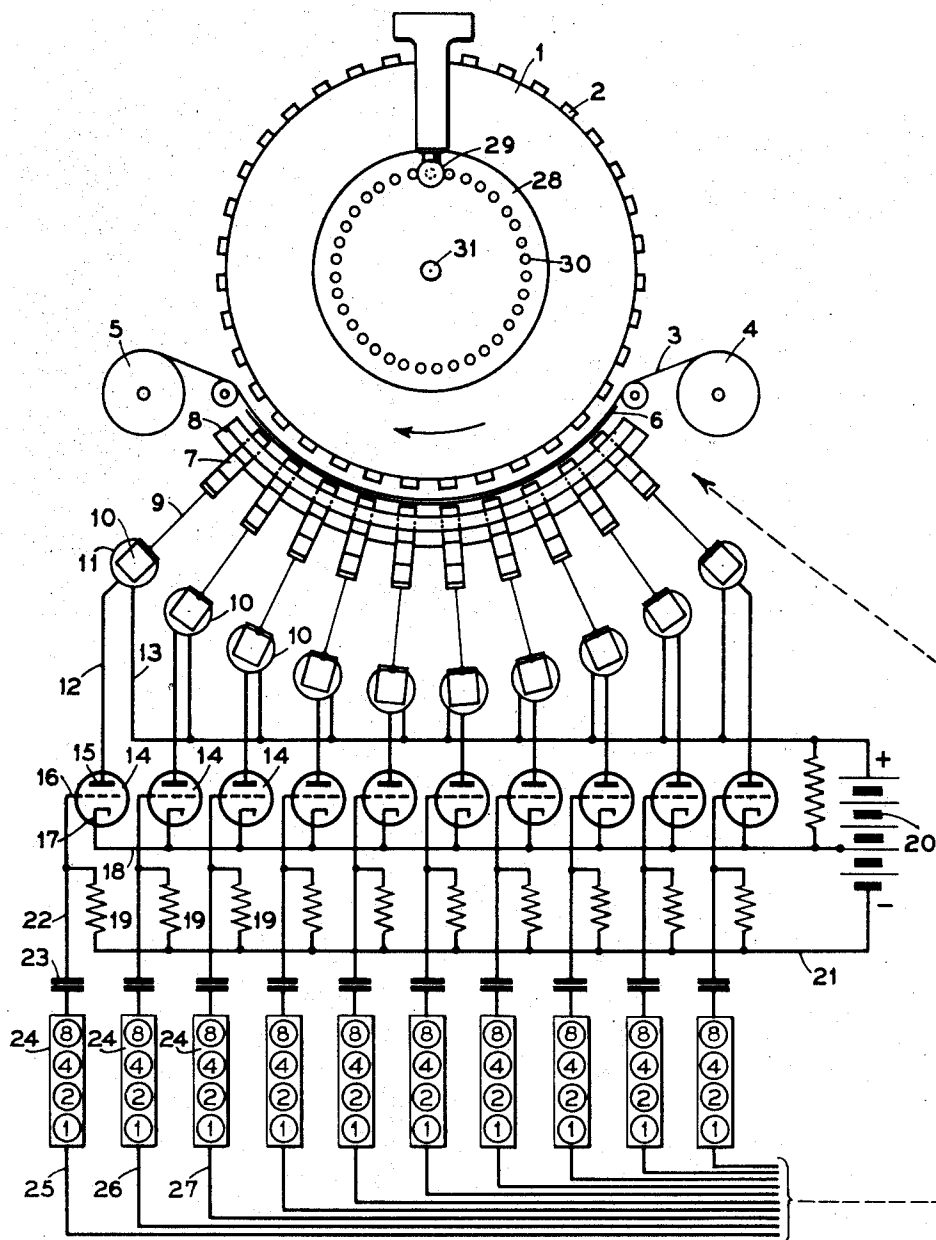


FIG. 1.

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4 Sheets-Sheet 2

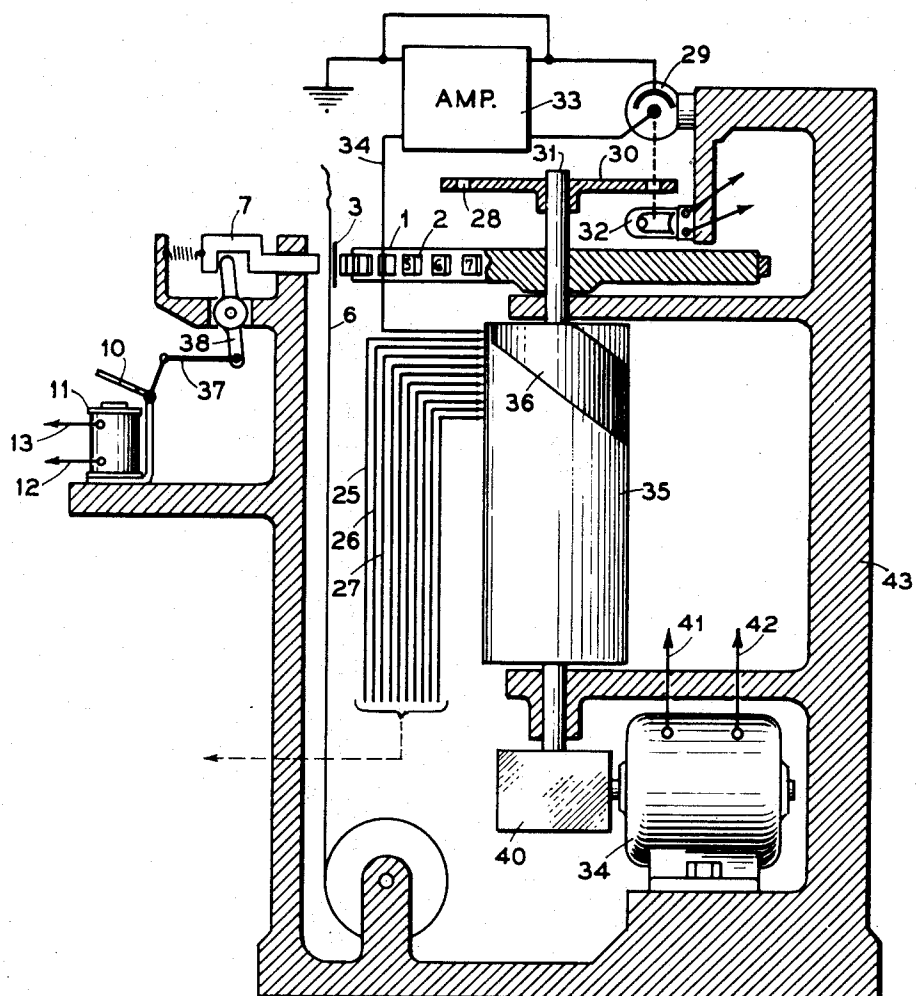


FIG. 2.

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4 Sheets-Sheet 3

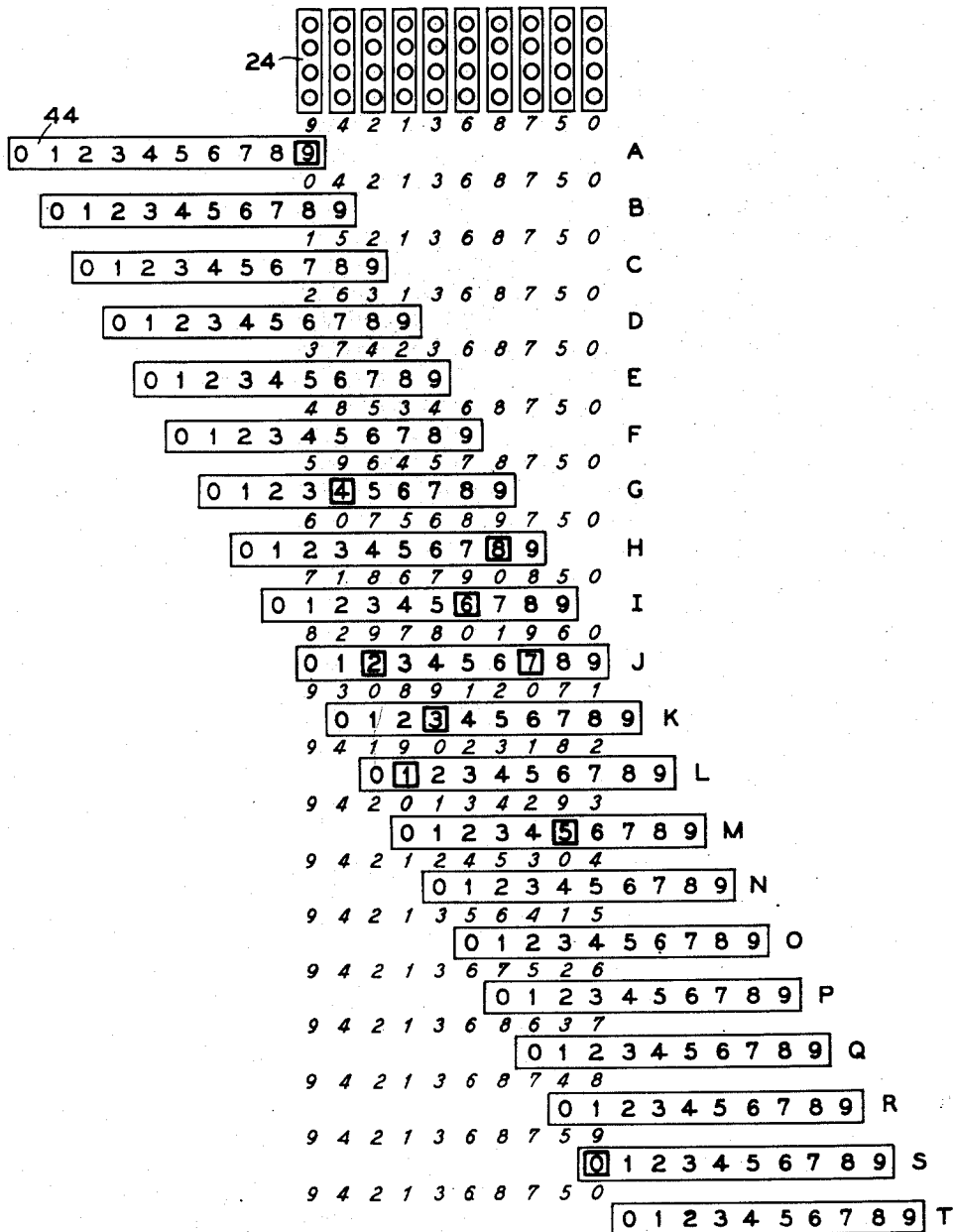


FIG. 3.

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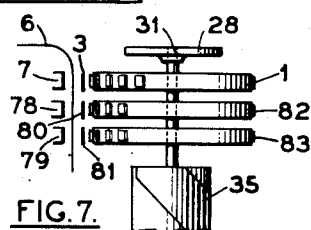
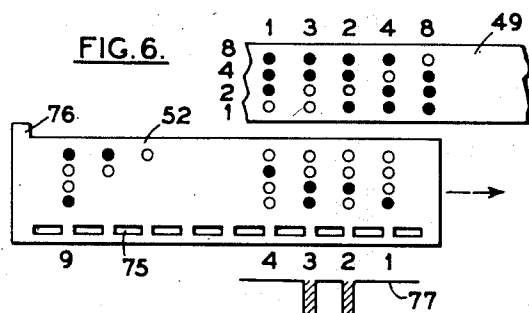
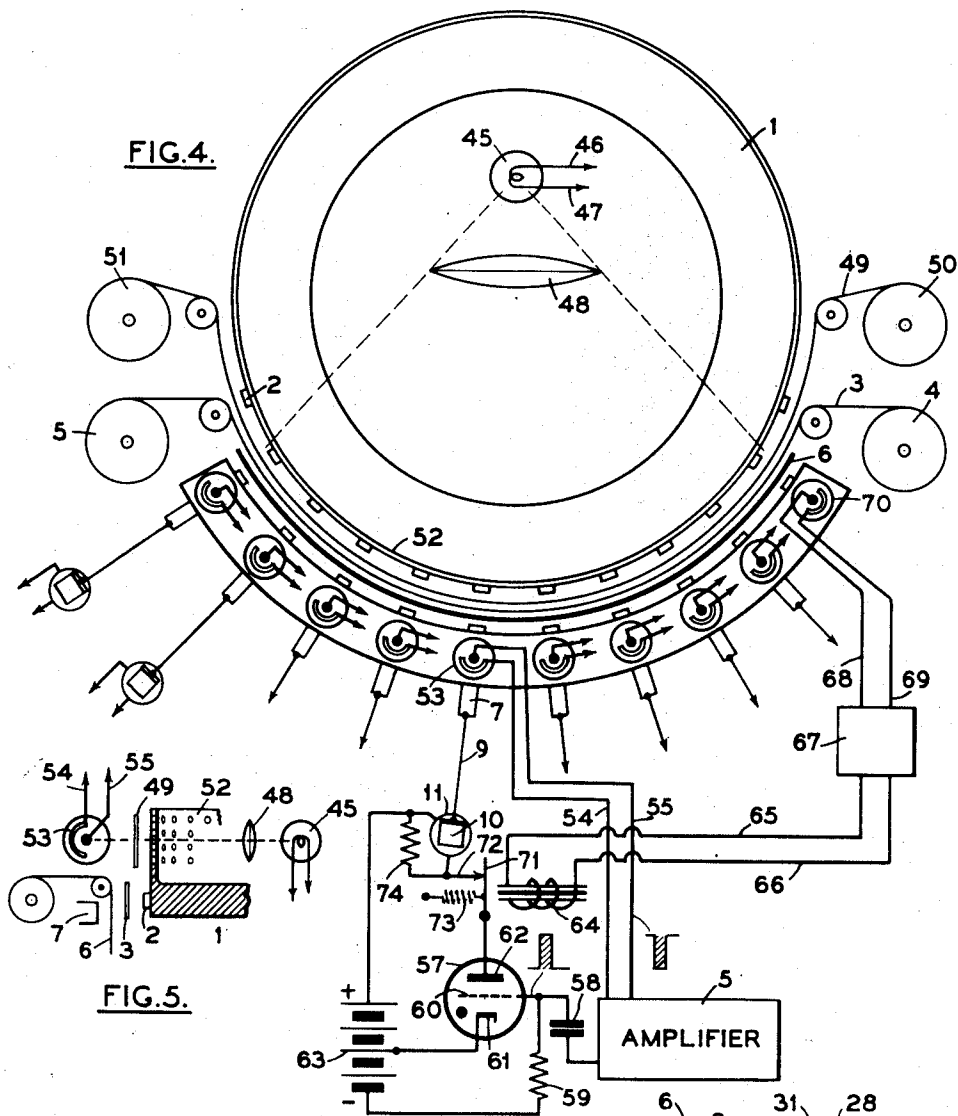
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HIGH-SPEED ROTARY PRINTER

Filed May 26, 1950

4 Sheets-Sheet 4



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2,692,551

HIGH-SPEED ROTARY PRINTER

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Application May 26, 1950, Serial No. 164,314

9 Claims. (Cl. 101-93)

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The present invention concerns electrically controlled printing devices and, in particular, such devices actuated in accordance with stored information which may be coded.

One object of the present invention is to provide a method of and means for printing out stored information which may be in code form at an exceedingly high rate of speed.

Another object is to print out a line at a time from a continuously rotating type wheel operated in such a manner that one pass of the type will complete a line of printing.

Still another object is to provide a printing control and actuating system which is capable of responding to information stored in a number of different ways.

A further object is to provide a rotating type wheel printer in which the printing speed is multiplied to almost any degree by the use of simultaneously operated multiple type wheels.

A still further object is to provide a type wheel printer capable of printing at a rate of the order of 250 lines of print per minute for each type wheel.

Another object is to provide a type wheel printer for printing out the information stored in an electronic computer or digital memory.

A further object is to provide a type wheel printer with means for printing from information contained on a punched tape or the like.

These and other objects of the present invention will be apparent from the detailed description of the invention given in connection with the various figures of the drawing.

A type wheel printer is a printer in which alphabetic and/or numeric characters are mounted around the periphery of a wheel. Such a type wheel may be utilized by moving it back and forth stopping it and printing when a desired character is positioned opposite the printing point. According to the present invention the type wheel is continuously rotated whereby the printing process is greatly speeded. In one method of utilization according to the present invention a line of information is printed at each pass of the characters since the control system automatically distributes the printing of the characters in the proper order during the pass although the order of printing the characters is not necessarily in positional sequence. While the single type wheel printer according to the present invention prints at the exceedingly high rate of speed of the order of 250 lines per minute, the speed may be multiplied to almost any desired rate by using additional type wheels car-

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ried by a common shaft and each printing a line at each shaft rotation. In addition a single type wheel may carry more than one set of characters around its periphery so that several lines may be printed out at each pass of the wheel.

In order to print clearly at a high rate of speed and while the type wheel is in motion a new high speed electrically operated printing hammer is utilized. The electrical impulse is given a predetermined lead time at any particular speed equal to the mechanical lag in the relay, linkage and hammer so that the hammer impact will be centered upon the character to be printed.

In one form of the present invention the total count previously registered in a plurality of decade electronic counters is read out and printed. One way in which this may be accomplished is with the aid of a pulse generator coupled to the type wheel which generates a pulse each time the type wheel moves a distance corresponding to the distance occupied by one character of type. To illustrate, the characters on the type wheel may be numbers starting with 9 and decreasing by one for each position down to and including 0. Also coupled to the type wheel there is provided a commutator which successively connects the output of the pulse generator to the inputs of the counter decades in such a way that the first decade receives the first pulse and succeeding pulses up to ten, the second decade the second pulse and succeeding pulses up to ten, etc. The type positions are such that upon the generation of the first pulse, the numeral 9 is at the first column position and corresponds with the position at which the number set in the first decade counter is to be printed. If the first decade counter contains the number 9, the first pulse fills the counter causing it to reset to zero and generate an output pulse. This output pulse passes to a control circuit for the first printing hammer and actuates the hammer printing the number 9. The next succeeding nine pulses reinsert a count of 9, the original count, in the first decade. In the same manner the other numbers are printed when the number of pulses generated is equal to the complement of the number stored in the counter decade and after printing the succeeding pulses restore the original number. At the end of a pass of the type wheel during which a line has been printed, the paper is advanced to a new line position and the next line is printed.

The type or print wheel may carry any desired combination of numbers, letters or symbols. A series of numbers and/or letters may be repeated around the print wheel. A print wheel accom-

modating 40 characters could carry 10 numbers, 26 letters and 4 characters or 10 numbers repeated four times, for instance. With four sets of numbers the device will print four lines for each revolution of the type wheel. It may readily be understood that this device is capable of printing at an extremely high rate of speed.

Using the same type wheel and high speed hammer combination other printing control means may be used. For instance, information carried by a punched tape may be printed out. To illustrate, numbers punched in a tape according to a four hole binary code may be printed by this device. According to the binary code, the first hole represents the numeral 1, the second hole the numeral 2, the third hole the numeral 4 and the fourth hole the numeral 8. Any number from 0 to 15 may be represented as the sum of the values of the punched holes. Evidently decimal system recording may be accomplished by the binary code merely by omitting numbers above 9. One way in which the information carried by the punched tape may be utilized to operate the type wheel printer is to utilize a scanning mask punched with the complements of the numbers on the type wheel. The mask moves with the type wheel and scans the punched tape. When the mask finds its complement in the punched tape no light will pass through the tape and mask combination. At this point a light positioned to shine through the tape and mask into a photo-electric cell is obscured and a pulse is generated in the photo-electric cell. This pulse is amplified and used to trigger a thyatron in the plate circuit of which is connected the hammer control relay for printing the corresponding number. At the end of the scanning cycle a tab on the side of the mask interrupts the light shining into an additional photo-electric cell which operates a relay to open the thyatron plate circuit priming it for the next cycle. In order to avoid false printing, the scanning sequence starts 0, 1, 2, 3, etc. and continues up to 9. Whenever a hammer has been actuated, the thyatron remains ignited preventing further printing until the end of the particular scanning cycle.

In the drawing:

Fig. 1 shows a diagrammatic representation of one form of the present invention.

Fig. 2 shows a somewhat more detailed view, partly in section, of a portion of the form of the invention shown in Fig. 1.

Fig. 3 shows a number chart useful in explaining the operation of the device of Fig. 1.

Fig. 4 shows a modified form of the present invention.

Fig. 5 shows details of a portion of the form of the invention shown in Fig. 4.

Fig. 6 shows a portion of a typical punched tape and scanning mask used in the form of the invention shown in Fig. 4.

Fig. 7 shows a multiple wheel type printer.

Fig. 1 shows a type wheel 1 carrying around its periphery a plurality of type faces 2 and rotating on shaft 31. Shaft 31 also carries disk 28 provided with a plurality of openings 30 equal in number to the number of type faces 2. A stationary photo-electric cell scanning device 29 generates pulses which are distributed to the counters 24 in a manner which will be described in connection with Fig. 2. The electronic counters 24 when filled, generate an output pulse carried over coupling capacitors 23 to grids 16 respectively of thyratrons 14. Thyratrons 14 have cath-

odes 17, heated by conventional means, not shown, control grids 16 and plates 15. The grids 16 receive an initial negative bias from a suitable source such as battery 20 through grid resistors 19. Plate voltage is supplied from the positive end of battery 20 while cathodes 17 are returned to an intermediate point on battery 20. Relay coils 11 are connected between plates 15 and battery 20 over leads 12 and 13 so that when any one of thyratrons 14 fires or ignites due to a pulse on its grid, the corresponding relay armature 10 is pulled down and hammer 7 carried by frame 8 is actuated by linkage 9 and the type character 2 directly opposite the hammer at the moment it is actuated prints on paper 6 through ribbon 3. Ribbon 3 passes across the type over the arc occupied by the hammers from spool 5 to spool 4.

In operation pulses generated by the scanning of holes 30 by photo-electric cell 29 are fed to counters 24 over wires 25, 26, 27, etc. until the counter is filled. When any given counter fills, it resets to zero and generates an output pulse which, as has been described above, actuates its corresponding printing hammer printing the number which was initially registered in the counter and in a column position corresponding to the particular counter decade. Further details of this operation will be set forth in connection with Figs. 2 and 3.

Fig. 2 shows a side view and certain details, part in section, of the system of Fig. 1 and corresponding parts are denoted by the same numbers. Fig. 2 shows type wheel 1, type faces 2, shaft 31, mounting wheel 1 and also mounting disk 30 provided with openings 28. Openings 28 are scanned by photo-electric cell 29 receiving light through openings 28 from a suitable light source 32 energized from a conventional source, not shown. The photo-electric cell output pulses are amplified by amplifier 33 and are then applied over lead 34 to commutator 36 carried by drum 35. Drum 35 is carried by shaft 31 and hence rotates in synchronism with disks 1 and 30. Suitable rotating means for shaft 31 is provided in the form of motor 39 receiving power over leads 41-42 from a suitable source, not shown, and turning shaft 31 at a suitable speed through gear box 40. As drum 35 rotates, commutator contacts lead 25 and maintains this contact so that all the pulses generated in a predetermined angular rotation of drum 35 are fed to the first counter decade 24 (Fig. 1). As drum 35 continues to rotate, after it has rotated an angular distance equal to the angular displacement of type 2 one from another, lead 26 contacts commutator 36 feeding all but the first pulse to the second counter decade 24 (Fig. 1) so that it starts to receive a count at one less than the first counter decade. Continuing its rotation drum 35 causes commutator 36 to contact and feed pulses over lead 27 and the succeeding leads and to the corresponding counter decades at one less count for each succeeding lead and decade. The manner in which this results in the printing of the counter stored number in the proper column will be further described in connection with Fig. 3. Fig. 2 also shows details of relay coil 11, relay armature 10, connecting link 37, hammer actuator 38, hammer 7, paper 6 and ribbon 3. It will be seen that the cut out portion of hammer 7 is larger than the upper end of arm 38 so that when relay 11 supplies a printing impulse the hammer instantaneously presses paper 6 and ribbon 3 against type face 2 and is free to bounce back. This bouncing gives a clear

print from the moving type. The motion of arm 38 is somewhat less than would be required to press the hammer against the type face so that the final travel of the hammer is due to its momentum. It strikes the paper and bounces once giving an extremely short contact time with the paper. The parts above described are mounted on a frame 43 for maintaining them in their proper relative positions.

It will be seen from the above description that the high speed printer according to the present invention prints rows of characters across a paper sheet from a continuously rotating type wheel which rotates in a plane passing through the printing line and perpendicular to the sheet. The commutator 36 functions, as will be set forth in detail below, as a control in a shift register. It is a part of the print registering system which determines the coincidence between a given character to be printed, that is, its instantaneous position at the desired printing point. At this instant the printing hammer for that position is energized printing the desired character in its proper place in the line of print.

Fig. 3 shows a diagram illustrating the operation of the form of the invention of Figs. 1 and 2 in printing a series of counts stored in the counters 24. These counters are assumed to contain counts 9, 4, 2, 1, 3, 6, 8, 7, 5, and 0 reading from left to right as shown by the upper row of numbers at A and directly under the corresponding counter decades 24 and hence in the relative positions in which they are to be printed. The rectangles 44 represent the type of the type wheel in its various positions. At A the type wheel is in the first position, a single pulse is fed to the first counter decade in this position and since its stored count is 9, this single pulse fills the counter and causes the corresponding hammer to operate printing the type 9 as outlined within the box 44. At B is shown the counter decade counts and the position of the type at the second position. It will be seen by the row of figures representing the counts in the counters that the first decade counter count has been advanced by one to 0. Since no counter is filled by the second pulse to the first counter or the first pulse to the second decade, no printing takes place. Following down the successive positions the first point at which a counter decade fills is at G where the second counter decade is filled causing it to print 4 which is the type number in that position. It will be seen that 4 is the required number to be printed from the number below the second counter decade at the top of the drawing. The process continues printing the heavily outlined numbers which in each case will be seen to be the proper numbers in the proper positions. The bottom line T shows that after the printing cycle has been completed printing out the desired numbers that the counts of the initial series have been replaced in the corresponding counter decades.

Fig. 4 shows a modified form of the invention in which information carried on a punched tape is printed out. The type wheel 1, type faces 2, ribbon 3, paper 6, hammer 7, relay 10-11 and linkage 9 are of the same form as in previous figures. In this case, however, the information to be printed out is carried by a printed or punched medium such as punched tape 49 passing between reels 50-51. This tape is scanned by a mask 52 carried by wheel 1. The mask is printed or punched with the complement of the number on the type face just below it. Fig. 5 shows the

cross-sectional relationship of these parts. Light for the scanning is supplied by lamp 45 energized over leads 46-47 from a suitable source, not shown, and is directed to mask 52 by lens 48. Light passing through tape 49 and mask 52 is picked up by a series of photo-electric cells, one for each type position such as cell 53. While a photo-electric cell, amplifier and control circuit for relays 11 is provided for each type or print column position across the paper, only the circuit of cell 53 will be described in detail as the others are similar. The output of photo-electric cell 53 is applied to amplifier 56 over leads 54-55. Pulses from photo-electric cell 53 and amplified by amplifier 56 are applied to relay control thyatron 57. Thyatron 57 is any suitable thyatron such as the one shown having cathode 61, control grid 60 and plate 62. Plate voltage and grid bias voltage is supplied from any suitable source such as battery 63. Grid 60 is normally at cut-off due to the negative bias supplied through resistor 59. Relay coil 11 is connected in series with battery 63 and plate 62 so that when thyatron 57 fires, armature 10 is pulled down and hammer 7 is actuated causing a type face 2 to print on paper 6. When a pulse from amplifier 56 is applied to grid 60 through coupling capacitor 58, thyatron 57 fires and the type face 2 which is at that instant opposite hammer 7 prints on paper 6. The resistor 74 across relay coil 11 may be used to prevent thyatron 57 from extinguishing due to the reactance of coil 11. At the end of a line of printing photo-electric cell 70 receives an impulse which applied to amplifier 67 over leads 68-69 is amplified and energizes relay coil 64 over leads 65-66. The energizing of coil 64 opens contacts 71-72 and by interrupting the voltage to plate 62 causes thyatron 57 to extinguish ready for another line of printing. Contacts 71-72 are closed by restoring spring 73.

Fig. 5 shows a cross-sectional view of the relationship of wheel 1, type face 2, ribbon 3, paper 6, mask 52, tape 49, photo-electric cell 53, lens 48 and lamp 45. It will be apparent that tape 49 may be replaced by a printed or punched card. The difference in scanning a printed tape or card over one which is punched is merely one of utilizing reflected light rather than transmitted light. This may evidently be accomplished merely by placing the photo-electric cell on the same side of the tape or card as the light source so as to receive reflected light.

Fig. 6 shows a portion of a punched tape 49 punched with holes representing numerals according to a 1-2-4-8 binary system. The light circles represent holes while the dark circles represent unpunched hole positions. It will be assumed that the lower row of holes are in the 1 position, the second row the 2 position, the third row the 4 position and the upper row the 8 position. Thus the first column on the tape represents the number 1, the second column the number 3, the third column number 2, the fourth number 4 and the fifth number 8. Below tape 49 is a scanning mask 52 in which holes are punched complementing numbers 1 to 9 starting with 1 in the right hand column and progressing to the left. Thus column one on the right has the upper three hole positions punched out and the lower hole position unpunched. When this mask column is placed in opposition to a column punched for number 1, no light will shine through the combination. Similarly, when each mask column representing a number is placed over a column

punched to represent the number, no light will pass through the combination. Spaces between the columns on the mask are provided with slots 75. Hence, as the mask passes across the tape from left to right, light shows through the tape and mask or slots 75 until a match is achieved indicating the number on the mask corresponds with the number on the tape. At this point the light is shut off to the corresponding photo-electric cell and a pulse is generated in the photo-electric cell. This pulse, as has been described above, is amplified and actuates the thyatron, relay and printing hammer. Plot 77 represents the pulse conditions produced by the two matches (2 and 3 between the tape and mask in the position shown.

If the mask scans from lower numbers to higher numbers, the first match which is produced is the correct match. Cancellation of light which may take place on higher numbers does not cause false printing since, as has been described above, once a thyatron has fired it cannot fire again until extinguished at the end of a scanned line. The tab 76 on mask 52 is utilized to actuate the resetting photo-electric cell 70 at the end of a line. Thus, if the row of numbers to be printed is all 9's, the hammers will operate one after the other as the 9 position on the mask moves across the printing area. Also, if the numbers are 9 down to 1 in sequence, all the hammers will be energized at the same instant when the mask is centered on the printing line.

It will be seen that the instruction to print is derived from an electrical or optical matrix which when properly matched, generates a print initiating signal. The electrical advance supplied by the commutator may be designated a shift register. In the printing from the decade counters the shift register operates to shift the insertion of pulses from decade to decade as the printing wheel advances character by character. Ten pulses are inserted in each register and printing takes place upon the insertion of the complement into the counter, the remainder of the pulses merely reinserting the original count in the decade. The term matrix is used to denote an electrical, optical or other system capable of detecting a match between two quantities or complements or similarly sensing a predetermined relationship to generate an output or control signal denoting such condition.

Fig. 7 shows how a plurality of type wheels 1, 82 and 83 may be utilized to print a plurality of lines of copy on paper sheet 6 at each revolution of common shaft 31. Ribbons 3, 80 and 81 and hammers 7, 78 and 79 are provided for wheels 1, 82 and 83 respectively. It will be apparent that the speed of printing may be multiplied by any desired factor, equal to the number of wheels provided while maintaining the same wheel rotational speed, hammer action time, etc.

By utilizing the mechanical relationships shown many advantages over known printing devices are obtained. The type wheel rotates continuously eliminating inertia problems encountered when the print wheel is stopped to print. The type faces are rigidly mounted on the type wheel providing for very high speed operation and eliminating inaccuracies due to movable type faces. The hammers slide in a simple straight line action and hence register accurately over the entire type face regardless of speed, paper thickness, etc. Many of the more complicated hammer actions are easily misaligned and rendered inaccurate by varying paper thickness, etc.

The term shift register has been used above to describe the shifting of the pulses from decade to decade as the type wheel advances. This action may also be called successively varying columnar shift.

While only a few forms of the present invention have been shown and described, many modifications will be apparent to those skilled in the art within the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. In a high speed printing device, the combination of, a wheel carrying a plurality of type faces distributed around at least a portion of its periphery, a plurality of printing hammers arranged in an arc coaxial with and at least partially surrounding said wheel, means for rotating said wheel at a substantially constant speed, and means for selectively actuating said hammers during said rotation to print from said type faces upon a sheet of paper, whereby each of said type faces may be printed from as they rotate past each of said hammers, so that as much as a complete line may be printed during one continuous rotating movement of the type wheel.

2. In a high speed printing device, the combination of, a wheel, a plurality of type faces distributed around the periphery of said wheel, a plurality of printing hammers arranged in an arc coaxial with and at least partially surrounding said wheel, means for rotating said wheel at a substantially constant speed, and means for selectively actuating one or more said hammers at predetermined instants to print from said type faces onto predetermined positions on a paper sheet during the rotation of said wheel whereby any and all of said type faces may be printed from at selected positions about said arc as said type faces rotate past said hammers.

3. In a high speed printing device, the combination of, a wheel, a plurality of printing characters distributed around the periphery of said wheel, a plurality of printing hammers arranged in an arc coaxial with and at least partially surrounding said wheel, means for rotating said wheel at a substantially constant speed, means for generating signals in accordance with a plurality of predetermined instantaneous positions of said wheel, and means for utilizing said signals to at least partially control actuation of said hammers to print said characters at predetermined positions on a record sheet during said rotation.

4. In a high speed printing device, the combination of, a wheel, means for rotating said wheel unidirectionally, a plurality of printing characters distributed around the periphery of said wheel, a plurality of printing hammers arranged in an arc coaxial with and at least partially surrounding said wheel, a print instruction means including a signal generator for generating pulses in accordance with the angular position of said wheel, and a shift register and an electronic counter arranged to instruct a plurality of said hammers the proper instant to be energized when the proper character is in printing position.

5. In a high speed printing device, the combination of, a wheel, a plurality of printing characters distributed around the periphery of said wheel, a plurality of printing hammers for cooperating with said printing characters arranged in an arc at least partially surrounding said wheel, and a print instruction means including an optical matrix for determining a match between the coding

of a character to be printed and the proper printing instant.

6. In a high speed printing device, the combination of, a type wheel, means for rotating said wheel in a plane passing through a line representing a line to be printed on a paper sheet, a plurality of hammers arranged in an arc coaxial with and at least partially surrounding said wheel, print instruction means for determining the proper instant for printing by each of said hammers, and means for actuating said hammers in accordance with the determination of said print instruction means whereby as much as a complete line may be printed during one continuous pass of said type wheel.

7. In a high speed printing device, the combination of, a wheel, means for rotating said wheel, a plurality of printing characters distributed around the periphery of said wheel, a plurality of printing hammers arranged in an arc coaxial with and at least partially surrounding said wheel, means for actuating said hammers in straight lines radial to said wheel, and means for selectively energizing said actuating means during the rotation of said wheel to print on a paper sheet whereby as much as a complete line may be printed during one continuous rotative movement of the wheel.

8. In a high speed printing device, the combination of, a type wheel comprising a wheel mounting a plurality of type characters distributed around its periphery, a plurality of printing hammers arranged in an arc concentric with and at least partially surrounding the periphery of said wheel for cooperating with said type characters to print on a paper sheet, means for rotating said wheel unidirectionally, and means for actuating a given hammer in accordance with the angular

position of said wheel, the position of a given type character on said wheel and the desired position of said printed character on said sheet whereby as much as a complete line may be printed during one continuous rotative movement of the wheel.

9. In a high speed printing device, the combination of, a type wheel comprising a wheel mounting a plurality of type characters distributed around its periphery, a plurality of printing hammers arranged in an arc concentric with and at least partially surrounding the periphery of said wheel for cooperating with said type characters to print on a paper sheet, means for rotating said wheel unidirectionally, and means for actuating a given hammer in accordance with the angular position of said wheel, the position of a given type character on said wheel and the desired position of said printed character on said sheet including a pulse generator coupled to said wheel for generating a pulse for each angular advance equal to a type character width.

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