Dec. 9, 1969 K. TAUCHERT ET AL 3,482,511

PRINTING ARRANGEMENT WITH TABULATED PRINTING CYLINDER

Filed July 18, 1967 2 Sheets-Sheet 1

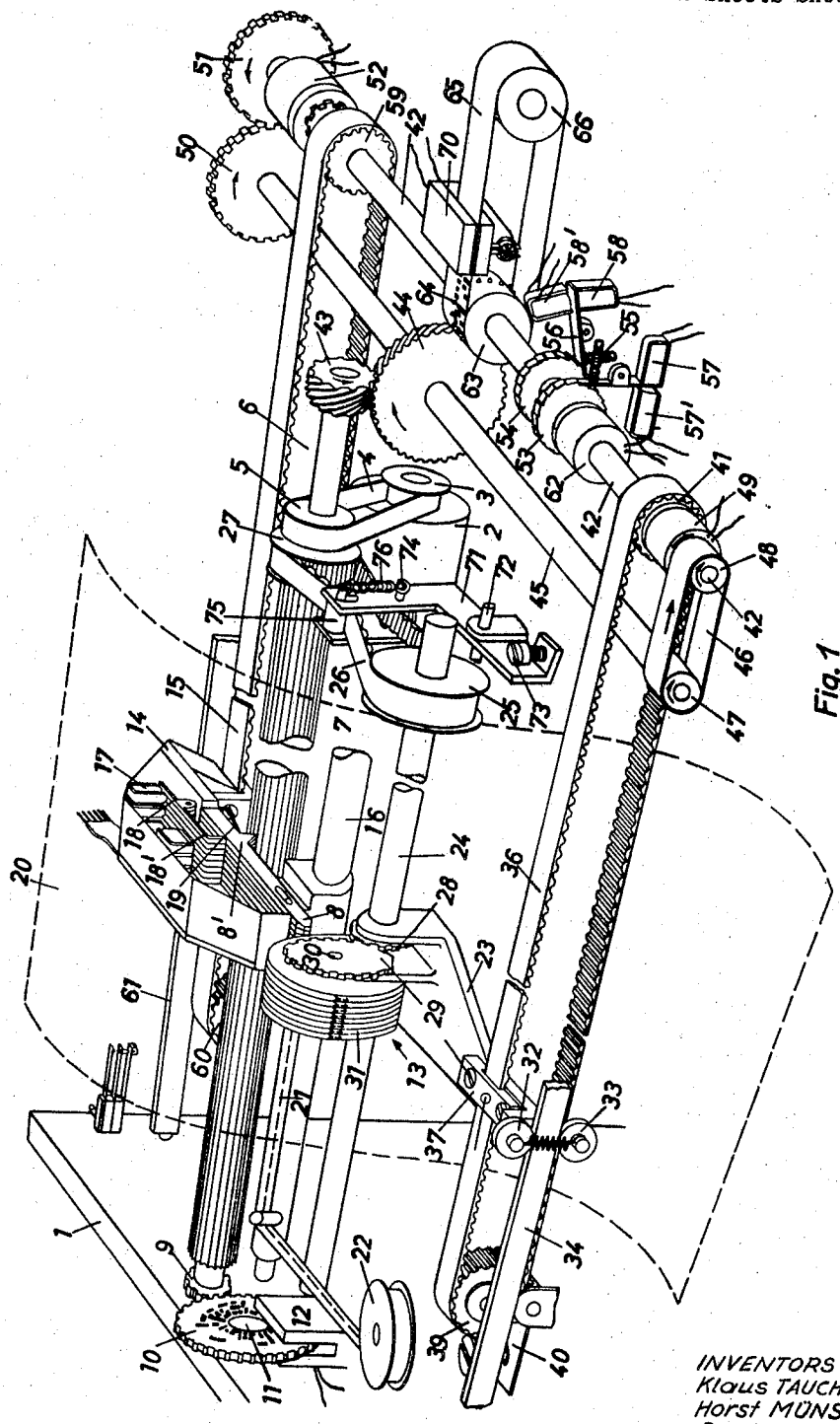

Fig. 1

INVENTORS:
Klaus TAUCHERT
Horst MÜNSTER
Bernhard HETTICH
Gerhard KÖNIG
Karlheinz HOFHEINZ
Peter KADE

by Michael S. Striker
Attorney

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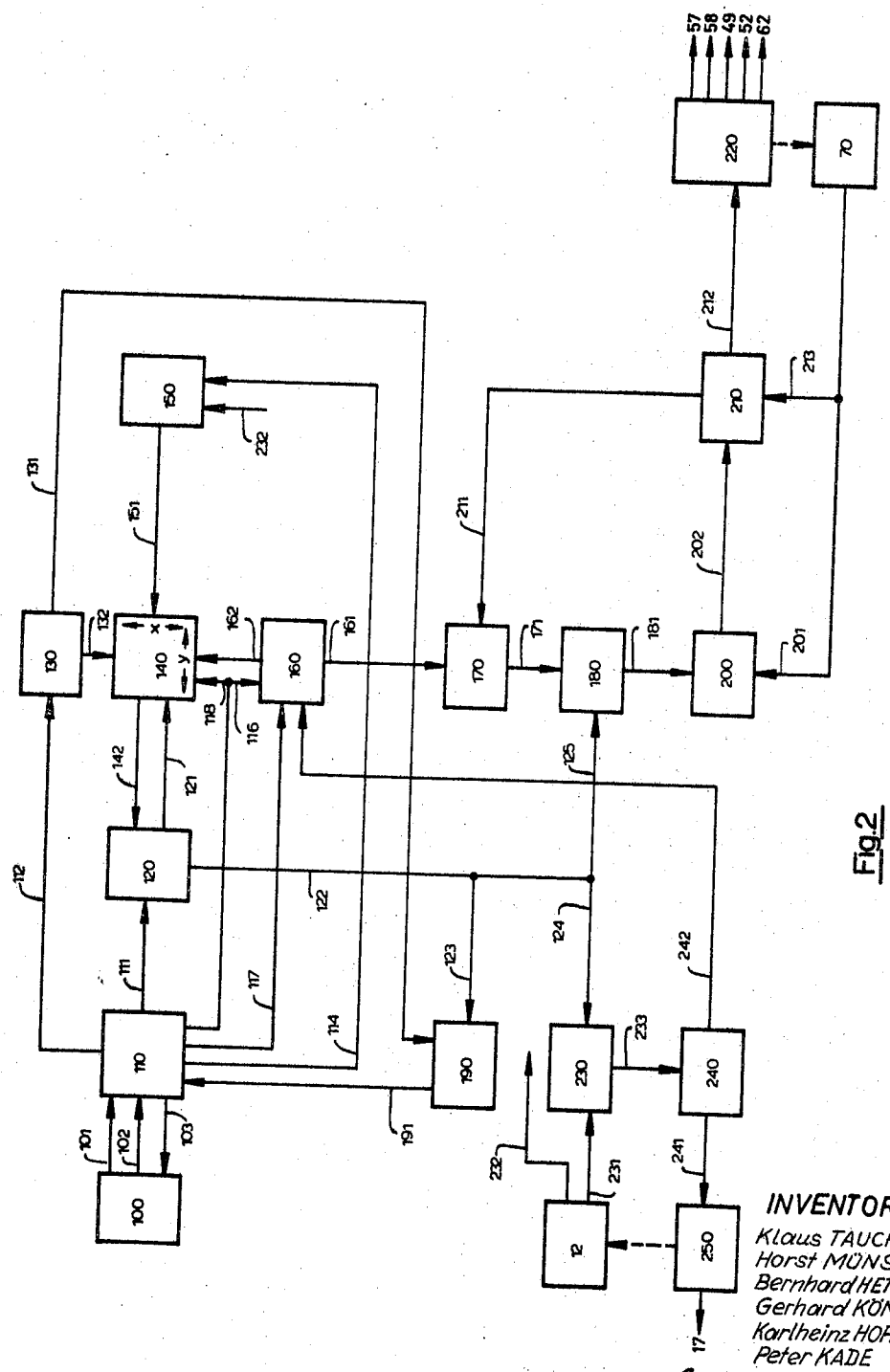

Fig.2

INVENTORS:
Klaus TAUCHERT
Horst MÜNSTER
Bernhard HETTICH
Gerhard KÖNIG
Karlheinz HOFHEINZ
Peter KADE

By Michael S. Striker
Attorney

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PRINTING ARRANGEMENT WITH TABULATED PRINTING CYLINDER

Klaus Tauchert, Horst Munster, Bernhard Hettich, and Gerhard Konig, Villingen, Karlheinz Hofheinz, Braunlingen, and Peter Kade, Villingen, Germany, assignors to Kienzle Apparate G.m.b.H., Villingen, Germany

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Int. Cl. B41f 33/16
U.S. Cl. 101—93 30 Claims

ABSTRACT OF THE DISCLOSURE

A rotary printing cylinder has a limited number of circumferential rows of type faces and is moved by tabulating means in opposite directions to selected locations along a line of impression areas of a sheet disposed between an axial line of type faces and a corresponding number of printing hammers. A control circuit controls the tabulation of the printing cylinder with the printing hammers to desired locations, the selection of type faces, and the operation of the printing hammers when the printing cylinder is in a desired location.

Background of the invention

The present invention relates to a high speed printing apparatus provided with a continuously rotating printing cylinder.

The U.S. Patent 2,776,618 dicloses a printing apparatus in which a printing cylinder has such a length as to provide a type face for each impression area along a line of a sheet, so that a great number of circumferential rows of type faces, and a corresponding great number of printing hammers has to be provided, which is expensive.

The U.S. Patent No. 2,936,704 and the German Patent No. 871,082 disclose printing apparatus with type bars or type chains moving in line direction over an impression area, while the selected type faces are pressed by printing hammers against the impression area to produce imprints when arriving at the desired printing location.

The U.S. Patent No. 2,831,424 discloses a chain printer in which only the digits from 0 to 9, and a few symbols are provided on a short chain which is transported by a carriage in front of the impression area. Printing hammers are also arranged on a slide, and whenever the impression areas covered by the type faces of the chain have been imprinted, the slides carrying the type chain and the printing hammers are tabulated to another location, where another imprint is made of the type faces of the chain. The disadvantage is that the cost of the apparatus is low because only type faces representing digits are used so that the length of the chain can be short and a small number of printing hammers can be used.

The serial printer disclosed in the U.S. Patent No. 2,950,347 discloses a printing cylinder with peripheral type faces arranged in a spiral line. In order to print each character, the printing cylinder has to make four revolutions, which reduces the printing speed to the speed of a standard electric typewriter.

Summary of the invention

It is one object of the invention to improve the known printing arrangements, and to provide a high speed printer of simple construction which can be inexpensively manufactured.

Another object of the invention is to provide a printing arrangement in which a printing cylinder can be tabulated in opposite directions to selected desired locations where

imprints are made by the type faces of the printing cylinder.

Another object of the invention is to provide a printing arrangement with a tabulated printing cylinder which has a selected number of circumferential rows of type faces representing in each row the same system or font of characters, such as letters, digits and symbols, and to tabulate the printing cylinder with a corresponding number of impression hammers along a line of impression areas whose number is substantially greater than the limited number of circumferential rows of type faces on the printing cylinder.

Another object of the invention is to provide a printing cylinder adapted to move stepwise for printing single characters, or in tabulating jumps for printing long words or in spaced columns of a form.

With these objects in view, a printing arrangement according to the invention comprises a rotary printing cylinder means haivng a selected limited number, for example eight circumferential rows of type faces, tabulating means for moving the printing cylinder means in opposite axial directions, drive means for rotating the printing cylinder means, and impression means tabulated with the printing cylinder means for producing impressions of type faces of the rotary printing cylinder means on impression areas.

The type faces of each circumferential row represent the same system of characters, which may be alphanumerical letters, digits and symbols, and are axially spaced from each other a given distance. The printing cylinder means is movable in axial direction to a number of locations which is substantially greater than the selected limited number of circumferential rows of type faces. The locations of the printing cylinder means, and the corresponding impression areas of an imprint receiving sheet are spaced from each other the same given distance as the circumferential rows of type faces are spaced in axial direction.

Drive means rotate the printing cylinder means continuously between a plurality of printing positions in which different axial lines of like type faces are located opposite a line of impression areas in a position of readiness. The impression means include printing hammers, and selected hammers press a sheet against an inked ribbon, and the ribbon against the respective selected type faces of the axial line of type faces which is located opposite a line of impression areas of the sheet opposite the printing hammers.

In the preferred embodiment, the printing cylinder has only eight circumferential rows of type faces so that not more than eight characters can be printed between two tabulating operations. Preferably, axially movable carriage means support the printing cylinder for rotation and the printing hammers for movement toward and away from the printing cylinder, and it is advantageous to provide separate slides for the printing hammers and the printing cylinder and to move the two slides in synchronism in axial direction of the printing cylinder during tabulation.

In the preferred embodiment of the invention, the printing operations take place under the control of an electric circuit including an electronic storage means which determines the selection and operation of the printing hammers, and the tabulation movements of the slides with the printing cylinder and printing hammers to desired loca'ions. The electronic storage means have preferably twenty-four storage locations so that it is possible to write words having up to twenty-four letters although the printing cylinder has only eight rows of type faces. The tabulating means are capable of axially shifting the printing cylinder not only over long distances, but also in single steps having a length equal to the distance between two adjacent circumferential rows of type faces. As compared

with a serial printer in which each step of a carriage corresponds to the space required for printing a single character, eight characters can be printed at extremely high speeds between two tabulations. As compared with conventional printers for accounting machines in which printing wheels or type bars have to be individually set to printing positions, the printing speed is also substantially increased.

Since the tabulating operations of the printing cylinder, and the selection and actuation of the printing hammers is controlled by an electronic storage means, it is not only possible to manually introduce the words and numbers to be printed into the electronic storage means which then control the printing operation, but it is also possible to enter data derived from a computer into the electronic storage means, and to control the printing operations accordingly.

A particular advantage of the construction of the present invention is that it can be operated like a conventional typewriter to print one character after each step of the printing cylinder. In this event, the printing cylinder is tabulated stepwise distances equal to the distance between two adjacent rows of type faces on the printing cylinder. Only the outermost circumferential row of type faces on the left end of the printing cylinder is used for printing, and after each imprint, the printing cylinder is tabulated one step. In this manner, each printed letter becomes immediately visible when the printing cylinder moves one step to the right.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

Brief description of the drawing

FIG. 1 is a fragmentary perspective view illustrating an embodiment of the printing arrangement of the invention, and

FIG. 2 is a schematic circuit diagram illustrating the electric control of the tabulating and printing operations of the apparatus illustrated in FIG. 1.

Description of the preferred embodiment

The printing apparatus illustrated in FIG. 1 is mounted between two vertical frame walls, of which only one wall **1** is illustrated. An electric motor **2** is mounted on a stationary frame part, not shown, and has a pulley **3** driving another pulley **5** through a belt **4**. Pulley **5** is secured to a shaft **6** which carries a power roll, shown to be a snatch roll **7** having axially extending teeth. The ends of shaft **6** are mounted in bearings in the frame walls, the right-hand end portion of shaft **6** being omitted.

A toothed pulley **27** is secured to shaft **6** adjacent pulley **5** and is connected by a toothed belt **26** with another toothed pulley **25** secured to a shaft **24** mounted in bearings of the frame walls, the right end portion of shaft **24** being omitted. The tension of belt **26**, and the precise angular position of pulley **25** in relation to pulley **27** can be adjusted by an adjusting lever **71** mounted on a pivot **72** and adjustable by means of a screw **73** so that a pin **74** presses belt **26** in upward direction. A roller **75** has journals mounted in vertical slots of forked arms of lever **71** and is urged by a spring **76** secured to a stud **74** to urge the upper portion of belt **26** in downward direction so that the belt is tensioned. By adjustment of screw **73**, small adjustments of the angular position of shaft **24** in relation to the angular position of snatch roll **7** can be carried out.

Eight printing hammers **8** are mounted on a slide **14** which has a portion **14***a* guided for axial movement along a supporting rod **16**, and another portion guided for longitudinal movement on a guide rod **61**. A rod **8***a* secured to slide **14** passes through slots **8***b* in printing hammers **8** so that the same are guided for longitudinal and angular movement. Springs **19** urge printing hammers **8** upward to an inoperative position in which projecting teeth **8'** of the printing hammers are located spaced from the teeth of snatch roll **7**, but each printing hammer is operated by a corresponding selector lever **18**, the selector levers being mounted for pivotal movement on a shaft supported by slide **14**. Printing magnets **17**, which can be selectively energized as will be described hereinafter, respectively cooperate with selector levers **18** to turn the same to positions in which projections **18'** urge the respective corresponding printing hammer to turn about pin **8***a* downward against the action of the respective spring **19** to an operative position in which the projecting tooth **8'** is engaged by a tooth of snatch roll **7** which drives any coupled printing hammer in longitudinal direction to an end position in which the snatch roll releases projecting tooth **8'** so that the respective spring **19** returns the actuated printing hammer to its initial position after de-energization of the respective printing magnet **17**.

Another slide **23** has one end mounted for movement along shaft **24**, and another end on which a pair of rollers **32, 33** is mounted for movement toward each other and urged by a connecting spring **33***a* into engagement with opposite sides of a guide rail **34**. A gear **28** is mounted on slide **23** for movement along shaft **24** and is connected to the same for rotation so that gear **28** drives another gear **29** which is mounted on slide **23** in all displaced positions of slide **23**.

A printing cylinder **13** is secured to gear **30** for rotation, and has a selected number of circumferential rows **31** of type faces. The eight axial sections of printing cylinder **13**, each of which carries a circumferential row **31** of type faces, are respectively located opposite the eight printing hammers. Each circumferential row of type faces represents the alphanumerical system of characters, for example, the ten digits, the letters of the alphabet, and the usual symbols, and the same character is represented by the type faces forming axial lines on the periphery of the printing cylinder. The axial line of digits 1 and an adjacent avial line of capital letters A are illustrated in FIG. 1.

The drive means **2** to **5**, **24** to **30** rotate printing cylinder **13** so that the axial lines of type faces representing the same character are successively placed in a position of readiness located directly opposite the line of printing hammers **8**. An inked ribbon **21** is supplied from a reel **22** and wound up on another reel, not shown, so that the inked ribbon is located adjacent the axial line of type faces which is in a position of readiness. An impression-receiving sheet **20**, shown in broken lines, is located between the inked ribbon **21** and the printing hammers **8** and can be transported in the usual manner so that successive lines of sheet **20** are located in the plane in which printing hammers **8**, inked ribbon **21**, and the line of type faces in the position of readiness are located.

Since printing cylinder **13** can move with slide **23** across the entire width of sheet **20**, the rows **31** of type faces can be moved between a number of locations which is substantially greater than the number of circumferential rows **31** of type faces and corresponds to the number of impression areas on a horizontal line of sheet **20**, each impression area having a sufficient width to receive one printed character. The axial distance between adjacent circumferential rows of type faces is the same as the width of an impression area.

When a line of type faces representing a selected character is located in the position of readiness opposite the printing hammers and one or several printing magnets **17** are energized, the respective printing hammer or hammers are moved to the operative position and engaged by the power roll **7** which drives the respective printing

hammer or hammers against the corresponding impression areas of sheet **20** so that the same are pressed against ribbon **21** which is pressed against the respective type faces in the position of readiness, so that the respective character is printed. If the respective character is required only once in the respective eight impression areas, only one printing hammer is actuated, but if the respective character is to appear more than once in the row of eight impression areas, the corresponding number of printing hammers may be simultaneously actuated. During further rotation of printing cylinder **13**, other characters assume the position of readiness and the printing hammers are correspondingly selected and actuated until all eight impression areas are imprinted. However, if only the first printing hammer is actuated at any time, and printing cylinder **13** is moved single steps, only the first circumferential row of type faces is used for printing single characters.

The left end of shaft **6** carries a gear **9** meshing with gear teeth **10** of a code wheel **10** having angularly spaced coded marks **10***a* which pass photoelectric sensing means, schematically indicated at **12**, in succession during rotation of shafts **6** and **24**. The transmission ratio of gears **9**, **10** is selected so that the angular positions of code wheel **10** corresponds to angular positions of printing cylinder **13**. In this maner, an impulse is produced by the sensing means **12** sensing a different coded mark whenever a corresponding character is represented by type faces located in an axial line opposite printing hammers **8** in the position of readiness. Consequently, sensing means **12** will produce an impulse representing the character which at any moment is in a position to be printed.

Shaft **6** carries a worm gear **43** meshing with a gear **44** on a shaft **45** which carries at one end a pulley **47** transmitting motion through a belt **46** to another pulley **48** secured to a shaft **42'** which is connected to one coupling part of an electromagnetically operated coupling means **49** whose other coupling part is connected with a tabulating shaft **42** so that shaft **42** is rotated in clockwise direction as viewed in FIG. 1 when belt **46** moves in the direction of the arrow A corresponding to the direction of rotation of motor **2**.

The other end of shaft **45** carries a gear **50** meshing with a gear **51** which drives a shaft **41''** connected with one coupling part of an electromagnetically operated coupling means **52** whose other coupling part is connected with tabulating shaft **42**. Gear **51** and shaft **41''** turn in the counterclockwise direction indicated by arrow B, so that, depending on which of the coupling means **49** or **52** is energized, tabulating shaft rotates in clockwise or counterclockwise direction.

Shaft **42** carries a toothed pulley **41** connected by toothed belt **36** to another toothed pulley **39** which is mounted on an adjustable support **40** by which the tension of belt **36** can be adjusted. A clamping member **37** is secured by screws to slide **23** and clamps the same to belt **36** so that rotation of tabulating shaft **42** in clockwise direction will move slide **23** with printing cylinder **13** to the right as viewed in FIG. 1, while rotation of tabulating shaft **42** in counterclockwise direction will move slide **23** to the left as viewed in FIG. 1.

Tabulating shaft **42** also carries a toothed pulley **59** connected by a toothed belt **15** with another toothed pulley **60**. Slide **14** is secured to belt **15** and moves with the same. Depending on the direction of rotation of the tabulating shaft **42**, belt **15** and thereby slide **14** with the printing hammers **8** will move toward the left or right as viewed in FIG. 1.

The transmission means **41**, **36**, **39** and **59**, **15**, **60** are designed to move slide **14** and slide **23** at the same speed in rigid synchronism so that the printing hammers **8** are always located opposite the respective associated circumferential rows of type faces **31**. Therefore, slides **14** and **23** constitute carriage means supporting printing cylinder **15** and the impression means **8**, **18**, **17** for synchronous movement. Transmission means **43** to **48**, **42'**, **50**, **51**, **41''** with reversing coupling means **49** and **52** constitute a reversing transmission connecting the drive means **2** to **6** with the tabulating shaft **42**.

Tabulating shaft **42** carries two ratchet wheels **53** and **54** whose teeth face in opposite directions of rotation. Each ratchet wheel **53**, **54** cooperates with a pawl **55**, **56** so that each pawl and ratchet wheel constitutes an arresting means for arresting tabulating shaft **42** rotating in opposite directions. Each pawl **55** and **56** constitutes the armature of a pair of electromagnets **58**, **58'** and **57**, **57'** by which pawls **55**, **56** are controlled to either engage, or release the respective ratchet wheel. When pawl **55** is operated to engage ratchet wheel **53**, rotation of tabulating shaft **42** in clockwise direction is stopped, and upon operation of pawl **56**, ratchet wheel **54** stops rotation of tabulating shaft **42** in counterclockwise direction. Energization of electromagnets **57** and **58** will stop rotation of tabulating shaft **42**, while energization of electromagnets **57'** and **58'** will operate the ratchet pawls **55** and **56** to release the ratchet wheels **53** and **54** so that tabulating shaft **42** is freely rotatable.

As will be explained in greater detail hereinafter, electromagnets **57**, **57'**, **58**, **58'** are operated by the control circuit shown in FIG. 2. Assuming that the rotating tabulating shaft **42** has caused movement of printing cylinder **13** and of printing hammers **8** to a desired location for printing on sheet **20**, the respective electromagnet **57** or **58**, depending on the direction of movement, is energized and stops tabulating shaft **42** in an exactly defined position in which printing cylinder and printing hammers **8** are located at the desired location so that electromagnets **57** and **58** constitute location controlling means.

In order to reduce the impact of ratchet wheels **53**, **54** on the respective actuated pawls **55**, **56**, an electromagnetically operated brake **62** is energized by the control circuit shortly before the printing cylinder arrives in the desired position. When pawls **55** and **56** are retracted from the ratchet wheels **53**, **54**, brake **62** holds tabulating shaft **42** in the desired angular position. Springs are provided for controlling the position of pawls **55**, **56** when the controlling magnet fails.

Tabulating shaft **42** carries a sprocket wheel **63** whose teeth **64** engage a series of holes in an endless tape **65** which is guided about a pulley **66**. Tape **65** has coded marks representing all locations of carriage means **23**, **14** with printing cylinder **13** and impression means **8**, **18**, **17** so that the number of coded marks on endless tape **65** is the same as the number of steps which printing cylinder **13** can move in axial direction. In the embodiment of FIG. 1, 128 locations of the printing cylinder **13** and of the impression means **8**, **19**, **14** are possible, the number of impression areas in each line of sheet **20** being somewhat smaller.

Photoelectric sensing means **70** senses the coded marks on tape **65** and produces impulses representing the sensed coded mark, the angular position of tabulating shaft **42**, and the actual location of printing cylinder **13** and impression means **8**, **18**, **17**. Depending on the coded marks on tape **65**, coupling means **49**, **52**, brake **62** and location controlling magnets **57**, **58** can be synchronously energized.

The printing control and the control of the tabulating movement of the printing cylinder is effected by an electronic control circuit which is shown in schematic form in FIG. 2. A central computing unit **100** is connected with the input register **110** by means of input lines **101**, **102** and feedback lines **103**. Input lines **101**, which consist of four channels, serve to interrogate the printer from the computing arrangement **100**. The actual operating condition of the printer is fed back by the feedback lines **103** which also consist of four channels. If the printer is ready for transfer, commands and character information is transferred in parallel over the infor-

mation lines **102** which consist of eight channels and a clock channel. The transferred command combinations, which precede the bit transfer corresponding to the actual information, are decoded in the input register **110** and stored therein. The commands consist of "red print," "paper transport," and "tabulation." A command "black print" is omitted since this command is automatically set by the signal for starting the transfer at the beginning of a sentence and may be superseded when appropriate by the "red print" command. The command "paper advance" is always accompanied by a paper location information depending on the desired arrangement on the form sheet. No further explanation regarding the commands "red print" and "paper transport" will be given in the following, since these functions take place in conventional fashion and do not form a part of this invention.

All bit-combinations, which originate in the computing arrangement **100** and reach the input register **110** over the lines **102**, are conducted into the central register **120** by lines **111**. The central register **120** serves as a temporary storage. Furthermore, a timing clock **130** is started for each bit combination by the clock channel of the information lines **102** and by line **112**. The combination which is in temporary storage in the central register **120** is connected to the parity check switching arrangement **190** by means of lines **122/123**. This parity check is timed by the clock **130** over line **131**, and the result of the check is fed to the input register **110** over line **191**.

The command "tabulate" contains the desired location of the printing cylinder in which the right-most character of the word is to be printed later. This desired location address which is a binary combination representing one of the **128** selectable print positions of the printing cylinder **113** is, as previously mentioned, temporarily stored in the central register **120** and reaches the buffer storage **140** over line **121**. This buffer storage **140** consists of eight storage locations of eight bits each in the X direction and it consists of four storage levels in the Y direction. The eight storage locations in the X direction correspond to the eight circumferential rows of characters of the printing cylinder **13**, that is each of these storage locations in the X direction accepts the information which is to be printed in one of the eight printing positions corresponding to the eight rows of type faces **31** between each of two successive tabulating operations. If the word contains more than eight characters, a tabulating operation of the printing cylinder must be interposed between the print-outs. Three of the four levels in the Y direction of the storage **140** serve to accept data, so that $8\times3=24$ storage locations are available for data storage. The fourth level of this storage in the Y direction serves to store the desired location address at which the print-out is to take place, that is the printing position at which the right-most character of the word to be printed is to be placed. The X coordinate counter **150** which has eight states corresponding to the number of storage locations of the storage **140** in the X direction, and the Y coordinate counter **160**, which has a zero position and three further positions in which the three data storage levels in the Y direction may be energized serve to energize the individual storage locations. The fourth level of storage **140** in the Y direction, which, as previously mentioned, serves to store the address of the desired location, is energized separately.

In order to store the desired location address, the Y coordinate Y4 is selected by line **118**, while the X counter **150** is set to the position X1 over line **114**. The X counter **150** is connected to the storage **140** by lines **151**. The read write pulses of clock **130** are directed to the storage by lines **132** and control the transfer of the location address combination from the central register **120** and to the buffer storage **140**. The address is then stored in the buffer storage **140** at the coordinates Y4–X1.

The combination "start of information" serves to terminate the transfer of commands to initiate the transfer of information. Each information is checked in the previously described manner, the clock **130** is started, and the combination is made ready for storage over lines **121**. The maximum word length which can be transferred is, as mentioned above, a 24-character word. The timing of the two counters **160**, **150** is such that the X counter **150** is advanced by one unit for each transferred information over line **114**, while the Y counter **160** is advanced over line **117** only after the first, 9th, and 17th character. The transfer of information starts with the right-most character of the word. The first character is stored in the storage position corresponding to the coordinates X1–Y1, the second character in the storage position X2–Y2, etc. and the 24th character then is stored in the storage position X8–Y3.

Corresponding to the organization of the storage **140** and the arrangement of the type cylinder **13** with eight annular rows of type faces, a subdivision of the 24-place word into three blocks results wherein the block **1** (X1Y1–X8Y1) contains the first to the eighth character, block **2** (X1Y2–Y8Y2) contains the 9th to the 16th character and block **3** (X1Y3–Y8Y3) contains the 17th to 24th character. Since the 24-character word must be printed in three steps, each of the three blocks must have a different location address assigned to it. Block **1** (1st through 8th character) corresponds to the storage coordinate Y1, block **2** (9th through 16th character) corresponds to the storage coordinate Y2, block 3 (17th through 24th character) corresponds to the storage coordinate Y3. The setting of the Y coordinate counter after the storage has been effected indicates how the previous desired address must be corrected in order to assure a correctly positioned printing of the word. To achieve this the Y coordinate counter **160** cooperates with the so-called marking generator **170**. A marker **2** is set at the printing of the third block, which corresponds to the storage coordinate Y3. This marker diminishes the desired address by 16. At the printing of the second block, corresponding to the storage coordinate Y2, a marker **1** is set and diminishes the address by −8. For print-out of the first block, corresponding to Y1, the address is left unchanged.

The end of the information transfer, and thereby the end of the complete transfer, is signified by the combination signal "end of sentence," which is recognized in the input register and initiates the execution of the transferred commands and the print-out of the information. If one block is not completely filled when the characters are transferred, for example, if the word only has 11 places, the remaining storage position of this block, that is the 12th to 16th storage positions of the corresponding Y coordinate are filled with the combination signifying "empty position." The reason for this will be explained later.

The execution of the commands can begin after the information transfer. As previously mentioned, the operation "black print" is initiated by the combination "beginning of sentence" and is cancelled by the transmission of the command "red print," after the decoding thereof. The commands "paper advance" and "tabulation" are, as previously mentioned, initiated by the combination "end of sentence." The core storage position X1–Y4 is interrogated over line **118** at the beginning of the tabulating operation. For this, the X counter **150** is set to the position X1 over line **114**. The line **116** serves to block the outputs of the Y counter whereas the marking functions remain set in the mark register **170** over line **161**. The desired location address, which is stored in the core storage position X1–Y4 is read out and the signal reaches the central register **120** over line **142**. It is stored in this register during the time of the shift operation. This desired location address is immediately rewritten into the storage over line **121**. A parity check of the address in the central register **120** is carried out in the parity check arrangement **190** over lines **122** and **123**. The location address furthermore reaches the location address computer **180** over line **125**. There it is

reduced by −8 or −16 by marking generator **170**, depending on the block which is to be printed out. The location address which has been corrected by the marker reaches the address comparison arrangement **200** over line **181**. The actual location address of the printing cylinder which is contained in the coded impulse of photoelectric sensing means **70** FIG. 1, is conducted to the location address comparison arrangement by line **201**. The direction is now computed from the two signals, that is it is computed whether the desired location address is larger or smaller than the actual location address, thus yielding the direction in which the printing cylinder must be moved in order to reach the desired print-out location. This direction is transmitted to the tabulation logic **210** by line **202** and is stored therein.

Since the braking of the movement of carriage means **23, 14** of the printing cylinder and the printing hammers requires a certain amount of time, the brake **62** must be energized one printing location before the desired location. For this purpose, the tabulation logic **210** transmits over line **211** a +1 or −1 signal to the marker register **170** depending on the direction of the carriage movement. The signal +1 signifies a movement to the left while the signal −1 corresponds to a movement to the right of the printing cylinder and the print hammer slides **23, 14**. This directional signal now follows the marker **3**, which changes the desired address additionally by a +1 or −1 value in addition to the correction of −8 or −16.

After a further comparison for correspondence of the two codes at the comparison arrangement **200**, the movement of the printing cylinder and the printing hammer carriage means **23, 14** is initiated over lines **212** if no equality exists. The lines **212** lead to an amplifier arrangement **220** which serves to energize coupling **49** for a movement to the right or coupling **52** for movement to the left, depending on the indicated direction. The coder signals emanating from the photoelectric sensing means **70** is changed by the movement of tabulator shaft **42** since this signal represents the actual location address. Each new actual location address is transmitted over line **213** and initiates a new comparison of the actual location address with the address of the desired location. Shaft **42** and the printing cylinder **13** and print hammers **8** continue to move until a coincidence between the two coded location signals in the comparison arrangement **200** occurs. At that moment, the brake **62** and the magnets **57** and **58** are switched in by lines **212** and the amplifier arrangement **220** while the couplings **49** and **52** are switched out. After the braking phase is finished and a certain swing out time has passed, the tabulating operation is ended and the printing cylinder and printing hammer slides **23** and **14** are in the correct position for printing. After the swing out time the magnets **57'** or **58'** serve to disengage the stopping pawls **55** or **56** from ratchet wheels **53, 54** so that the shaft **42** is only held by the brakes **62**.

Now the actual printing operation takes place and only that information block whose marker previously determined the tabulated location is printed. The Y coordinate counter **160** energizes the corresponding Y coordinates of the storage **140** via line **162**. The coded mark of code wheel **10**, which corresponds to the character at that moment opposite the print hammers **8** in a position of readiness, is sensed by sensing means **12**, and the respective coded impulse reaches the print comparison stage **230** over line **231**.

The X counter **150** is now reset by the timing channel **232** for a full cycle, in which all eight storage positions of the block are read out and immediately again entered into the storage. The characters which have been read out, reach the central register **120** over lines **142** and from there reach the check arrangement **190** over lines **122/123** and the print comparison stage **230** over lines **122/124**. Here, a comparison to determine coincidence is made between the eight characters of the storage **140** with those coded signal combinations of the photoelectric sensing means **12** which represent a character opposite the printing hammers in the position of readiness. When a coincidence is determined, this information is transmitted to the print logic arrangement **240** over line **233** and from there the corresponding printing magnet **17** is energized over an amplifier arrangement **250** and lines **241**. This comparison of the eight stored characters and the continuously changing code combinations of the sensing means **12** which correspond to the rotation of the printing cylinder **13** takes place until all eight printing locations have had coincidence in the print logic arrangement **40**.

It should be noted that the information "empty space" is interrogated separately and that in this case the actuation of the print hammer is prevented. It should again be noted here that a block is filled with "empty space" information. If the block were not filled by the combination corresponding to "empty space," those four storage positions not filled in the new transfer would still contain the old character and would cause an incorrect printing of the word.

After one block has been processed, a pulse is sent to the Y counter **160** by the print logic arrangement **240**, thereby advancing this counter to the next Y coordinate. Simultaneously, the marker is changed from 2 to 1 or from 1 to zero, so that for the new location address comparison, the desired location address is modified by −8 and ±1 or by 0 and ±1. The printing cylinder and print hammer slides are then shifted into a position in which block **2** or block **1**, respectively, are printed out, depending on how many characters were contained in the information to be printed out. After the printing cylinder and printing hammer slides have reached the true desired location and the respective characters have also been printed out, the Y counter is reset to the position YO by a signal on line **242**. Thus, a feedback signal is sent to computing arrangement **100** over line **103** signifying that the print out of the word is finished and that the printer is now ready for receiving new commands and characters.

It should further be noted that preferably all numbers are contained in one quadrant of the circumference of the printing cylinder **13**. Furthermore, the print logic **240** is so arranged that it counts the print signals arriving from the comparison stage **230** in such a manner that the feedback signal is sent to the Y coordinate counter **160** when eight print signals have been generated, independent of whether the type cylinder **13** has or has not completed a full revolution. Thus, for exclusively numerical printing, a great deal of time may be saved which may be used for the next tabulating operation during completion of the revolution.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of printing arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in a tabulated printing cylinder having a small number of circumferential rows of type faces respectively representing the same system of characters, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various application without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are inttended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. Printing arrangement comprising, in combination, printing cylinder means having a selected number of circumferential rows of type faces axially spaced from each other a given distance, the type faces of each row representing a complete font of characters for at least alphanumerical printing and forming a plurality of axial lines, each line having type faces representing the same character; drive means for rotating said printing cylinder means between a plurality of printing positions in which all said lines are during each revolution successively located in a printing line in a position of readiness so that during one revolution of said printing cylinder means all type faces of the fonts traverse said printing line and are located opposite impression areas of the same; impression means including a selected number of printing hammers respectively located opposite said rows of type faces in a line extending along said printing line and being spaced from each other said given distance so as to cooperate with the type faces of the line of type faces of said printing cylinder means located in said printing line; carriage means supporting said printing cylinder means and said impression means; means supporting said carriage means for movement in axial direction between a predetermined number of locations in which said type faces are located, respectively, opposite impression areas of said printing line; reversible tabulating means connected with said carriage means for moving the same with said printing cylinder means and said impression means in opposite directions to selected locations and impression areas along said printing line, said predetermined number of locations being substantially greater than said selected number; actuating means for moving in each location any printing hammer toward said printing cylinder as a selected type face of a correlated row of type faces traverses said printing line; and control means for operating said tabulating means and said actuating means so that impressions are made on selected impression areas.

2. Printing arrangement as claimed in claim 1 wherein said tabulating means include a tabulating shaft, first transmission means connecting said tabulating shaft with said carriage means, and second reversing transmission means connecting said drive means with said tabulating shaft and being operable for reversing the direction of rotation of the same for moving said printing cylinder means and said printing hammers with said carriage means in opposite axial directions.

3. Printing arrangement as claimed in claim 2 wherein said tabulating means comprise step-wise operating arresting means for said tabulating shaft, and location controlling electromagnetic means for actuating said arresting means to stop said tabulating shaft so that said carriage means can be stopped in locations in which said type faces in said position of readiness are located, respectively, opposite different impression areas.

4. Printing arrangement as set forth in claim 3 wherein said arresting means include a pair of ratchet wheels secured to said tabulating shaft and having teeth facing in opposite directions of rotation, a pair of ratchet pawls cooperating with said ratchet wheels, and a pair of location controlling electromagnets for operating said pawls, respectively, during movement of said carriage means and tabulating shaft in opposite directions so that when said tabulating shaft is stopped by said arresting means said type faces in said position of readiness are located in selected locations opposite selected impression areas.

5. Printing arrangement as claimed in claim 3 wherein said tabulating means include an electromagnetically operated brake for braking said tabulating shaft before being stopped by said arresting means, and for holding said tabulating shaft against rotation when said location controlling electromagnets effect release of said tabulating shaft by said arresting means.

6. Printing arrangement as claimed in claim 5 comprising rotary means driven from said tabulating shaft for transporting an endless code tape; sensing means for sensing said code tape and for producing corresponding impulses representing the location of said printing cylinder means; and circuit means for receiving said impulses and including means for comparing said impulses with another impulse representing a desired location.

7. Printing arrangement as claimed in claim 1, said control means comprising rotary means driven from said tabulating means for transporting an endless code tape; sensing means for sensing said code tape and for producing corresponding impulses representing the location of said printing cylinder means; and circuit means for receiving said impulses and including means for comparing said impulses with another impulse representing a desired location of said printing cylinder means.

8. Printing arrangement as claimed in claim 1, said control means including a code disk driven by said drive means in synchronism with said rotary printing cylinder means; sensing means for sensing said code disk and for producing impulses representing the angular position of said printing cylinder means and the character of the axial line of type faces in said position of readiness; and circuit means including means for comparing said impulses with another impulse representing a selected character located in a selected axial line of type faces.

9. Printing arrangement as claimed in claim 5 wherein said impression means include a power roll for operating said printing hammers and driven by said drive means, and printing magnets for coupling said printing hammers with said power roll; and program controlled circuit means connected with said printing magnets, said reversing coupling means, said electromagnetically operated brake, and said location controlling electromagnets.

10. Printing arrangement comprising, in combination, rotary printing cylinder means having a selected number of circumferential rows of type faces axially spaced from each other a given distance, the type faces of each row representing the same system of characters and forming a plurality of axial lines; means supporting said printing cylinder means for axial movement between locations spaced said given distance, the number of said locations being substantially greater than said selected number of circumferential rows of type faces; tabulating means for moving said printing cylinder means in opposite axial directions to selected locations and along a line of impression areas; drive means for rotating said printing cylinder means between a plurality of printing positions in which different axial lines of type faces are located opposite said line of impression areas in a position of readiness; impression means for producing impressions of type faces in said position of readiness on impression areas opposite the same; and a control circuit comprising computing means responsive to external activation and generating desired character signals corresponding to the position of the type face of a character to be printed on said printing cylinder and thus corresponding to the rotational position of said printing cylinder, and for generating desired line location signals signifying the desired location for the printing cylinder in a line when a printout takes place; location indicating means for generating signals signifying the actual location of the printing cylinder in a line; character position indicating means for generating signals indicating the actual rotational position of said printing cylinder; character position comparing means for comparing the desired character signals to said actual rotational position signals and generating a first coincidence signal when said two signals coincide; line location comparing means for comparing said actual line location signals to said desired line location signals and generating a second coincidence signal when said actual and desired line location signals coincide, and generating a non-coincidence signal when said signals do not coincide; activation signal generating means for said impression means responsive to said first coincidence signal and

adapted to actuate said impression means; moving signal generating means controlling said tabulating means for moving said printing cylinder and impression means in synchronism in response to said non-coincidence signal and adapted to move the same until receipt of said second coincidence signal; and timing means adapted to generate timing signals for timing the operations of said control arrangement.

11. An arrangement as set forth in claim **10** wherein said line location indicating means comprise a code tape driven by said tabulating means, and photoelectric sensing means generating said actual line location signals.

12. An arrangement as set forth in claim **10** wherein said desired character signal generating means comprise a code wheel driven synchronously with said printing cylinder; and photoelectric sensing means generating said desired character signals.

13. An arrangement as set forth in claim **10** comprising a buffer storage for controlling said printing and tabulation operations, said buffer storage containing a plurality of buffer storage places equal to a multiple of said number of circumferential rows of type faces, and whereby the print-out of a word containing said multiple number of characters is effected in a number of blocks whose total of numbers of characters is equal to said multiple.

14. An arrangement as set forth in claim **13** wherein said printing cylinder has eight circumferential rows of type faces and said buffer storage has 24 buffer storage positions, and wherein the print-out of a 24-character word is effected in three blocks.

15. An arrangement as set forth in claim **14** also comprising an X coordinate counter having the same number of steps as there are circumferential rows of type faces on the printing cylinder; and a Y coordinate counter having at least one step corresponding to each of said information blocks.

16. An arrangement as set forth in claim **15** wherein said Y coordinate counter also comprises an additional step for generating an end of expression signal.

17. An arrangement as set forth in claim **16** also comprising line location computing means adapted to store the desired line location address corresponding to said desired line location signals prior to the beginning of a tabulation operation.

18. An arrangement as set forth in claim **17** also comprising marker means responsive to said Y coordinate counter and adapted to modify the desired line location address in said line location address generating computing means by a multiple of the number of steps of said X coordinate counter such that said desired line position address is corrected to correspond to the proper block to be printed after the next tabulation operation.

19. An arrangement as set forth in claim **10** wherein said line position comparing means generate a directional non-coincidence signal, such that the direction of the tabulation movement of said printing cylinder and is determined by the sign of the difference between said desired line location signal and said actual line location signal.

20. An arrangement as set forth in claim **19** wherein a positive difference between said desired line location and said actual line location results in a movement to the right of said printing cylinder.

21. An arrangement as set forth in claim **20** wherein said marker generating means are also adapted to generate a near-coincidence marker adapted to correct said desired line location address in a manner that said tabulating means stops when said difference between said actual line location address and said desired line location address has decreased to a predetermined value.

22. An arrangement as set forth in claim **21** wherein said predetermined value comprises one unit equal to said distance.

23. An arrangement as set forth in claim **21** wherein said correction made by said near-coincidence signal in said desired line location address is cancelled after the printing of said block has been completed.

24. An arrangement as set forth in claim **10** also comprising print control counting means adapted to count said first coincidence signals and adapted to generate a tabulation start signal for starting said tabulating means and the tabulation movement of said printing cylinder when said number of coincidence signals is equal to the number of type rims on said printing cylinder.

25. An arrangement as set forth in claim **10** wherein type faces of said rows of type faces representing numbers are contained in one quadrant of said printing cylinder only, in such a manner that a purely numerical print-out is finished after a quarter revolution of said printing cylinder, said tabulating means operating during the remainder of each revolution for tabulating said printing cylinder.

26. Printing arrangement as claimed in claim **1** wherein said impression means include a power roll for operating said printing hammers and driven by said drive means, printing magnets for coupling said printing hammers, respectively, with said power roll; wherein said tabulating means including a tabulating shaft, transmission means connecting said tabulating shaft with said carriage means, reversing transmission means including first and second shafts driven by said drive means in opposite direcions, first and second electromagnetic couplings respectively connecting said first and second shafts with said tabulating shaft, and location controlling electromagnetic means for stopping said tabulating shaft so that said printing cylinder means and said printing hammers can be stopped in selected locations; and comprising program controlled circuit means connected with said printing magnets, said first and second electromagnetic couplings, and said location controlling electromagnetic means.

27. Printing arrangement comprising, in combination, printing cylinder means having a selected number of circumferential rows of type faces axially spaced from each other a given distance, the type faces of each row representing a complete font of characters for at least alphanumerical printing and forming a plurality of axial lines, each line having type faces representing the same character; drive means for rotating said printing cylinder means between a plurality of printing positions in which all said lines are during each revolution successively located in a printing line in a position of readiness so that during one revolution of said printing cylinder means all type faces of the fonts traverse said printing line and are located opposite impression areas of the same; impression means including a selected number of printing hammers respectively located opposite said rows of type faces in a line extending along said printing line and being spaced from each other said given distance so as to cooperate with the type faces of the line of type faces of said printing cylinder means located in said printing line; carriage means supporting said printing cylinder means and said impression means; means supporting said carriage means for movement in axial direction between a predetermined number of locations in which said type faces are located, respectively, opposite impression areas of said printing line; reversible tabulating means connected with said carriage means for moving the same with said printing cylinder means and said impression means in opposite direction to selected locations and impression areas along said printing line, said predetermined number of locations being substantially greater than said selected number; actuating means for moving in each location any printing hammer toward said printing cylinder as a selected type face of a correlated row of type faces traverses said printing line; and control means for operating said tabulating means and said actuating means so that impressions are made on selected impression areas, and including location indicating means operated

by said tabulating means to generate signals representing the actual location of said printing cylinder means and of said impression means, and circuit means for receiving said signals and including comparing means for comparing said signals with other signals representing desired locations of said printing cylinder means and impression means.

28. Printing arrangement as claimed in claim **27** wherein said circuit means include storage means for storing said other signals which represent the desired next location of said printing cylinder means and impression means, and wherein said comparing means generate an output signal controlling said tabulating means to stop said carriage means when the actual location of said printing cylinder means and impression means coincides with said desired next location.

29. Printing arrangement comprising, in combination, printing cylinder means having a selected number of circumferential rows of type faces axially spaced from each other a given distance, the type faces of each row representing a complete font of characters for at least alphanumerical printing and forming a plurality of axial lines, each line having type faces representing the same character; drive means for rotating said printing cylinder means between a plurality of printing positions in which all said lines are during each revolution successively located in a printing line in a position of readiness so that during one revolution of said printing cylinder means all type faces of the fonts traverse said printing line and are located opposite impression areas of the same; impression means including a selected number of printing hammers respectively located opposite said rows of type faces in a line extending along said printing line and being spaced from each other said given distance so as to cooperate with the type faces of the line of type faces of said printing cylinder means located in said printing line; carriage means supporting said printing cylinder means and said impression means; means supporting said carriage means for movement in axial direction between a predetermined number of locations in which said type faces are located, respectively, opposite impression areas of said printing line; reversible tabulating means connected with said carriage means for moving the same with said printing cylinder means and said impression means in opposite directions to selected locations and impression areas along said printing line, said predetermined number of locations being substantially greater than said selected number; actuating means for moving in each location any printing hammer toward said printing cylinder as a selected type face of a correlated row of type faces traverses said printing line; and control means for operating said tabulating means and said actuating means so that impressions are made on selected impression areas, and including character position indicating means operating in synchronism with said printing cylinder means to generate impulses representing the angular position of said printing cylinder means and the type faces and characters located in said printing line, and circuit means for receiving said impulses and including comparing means for comparing said impulses with other impulses representing a desired angular position of said printing cylinder means and desired type faces and characters located in said printing line.

30. Printing arrangement as claimed in claim **29** wherein said circuit means include buffer storage means having a number of storage places which is at least as great as said selected number of rows of type faces, wherein said comparing means compare the contents of said buffer storage means once with the signal generated by said character positon indicating means, and wherein said comparing means generates an output signal controlling said actuating means to operate said printing hammers when the signal stored in said buffer storage means represents the same angular position of said printing cylinder means as indicated by said signal of said character position indicating means.

References Cited

UNITED STATES PATENTS

2,757,775	8/1956	Hickerson	197—49
2,774,816	12/1956	Yost	178—29
2,831,424	4/1958	MacDonald	101—111 X
2,843,243	7/1958	Masterson	197—49 X
2,949,846	8/1960	Hoffman et al.	101—93
3,042,174	7/1962	Howard	197—49 X
3,157,115	11/1964	West et al.	101—93
3,253,539	5/1966	Christoff et al.	101—93
3,256,969	6/1966	Bretti	197—49
3,334,720	8/1967	Hickerson	197—51 X

WILLIAM B. PENN, Primary Examiner

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