Oct. 15, 1963 L. ROSSETTO ETAL 3,106,880

TYPOGRAPHICAL PHOTOCOMPOSING MACHINE

Filed March 26, 1954 19 Sheets-Sheet 1

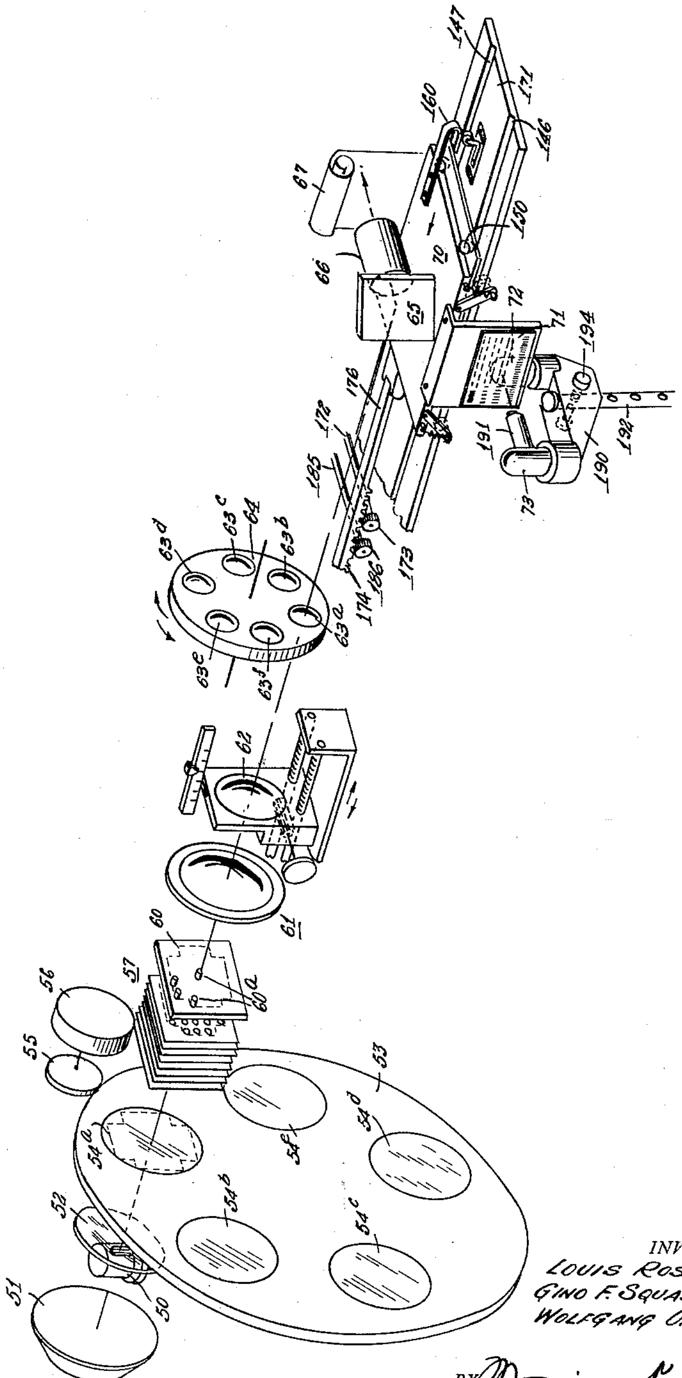

Fig. 1

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TYPOGRAPHICAL PHOTOCOMPOSING MACHINE

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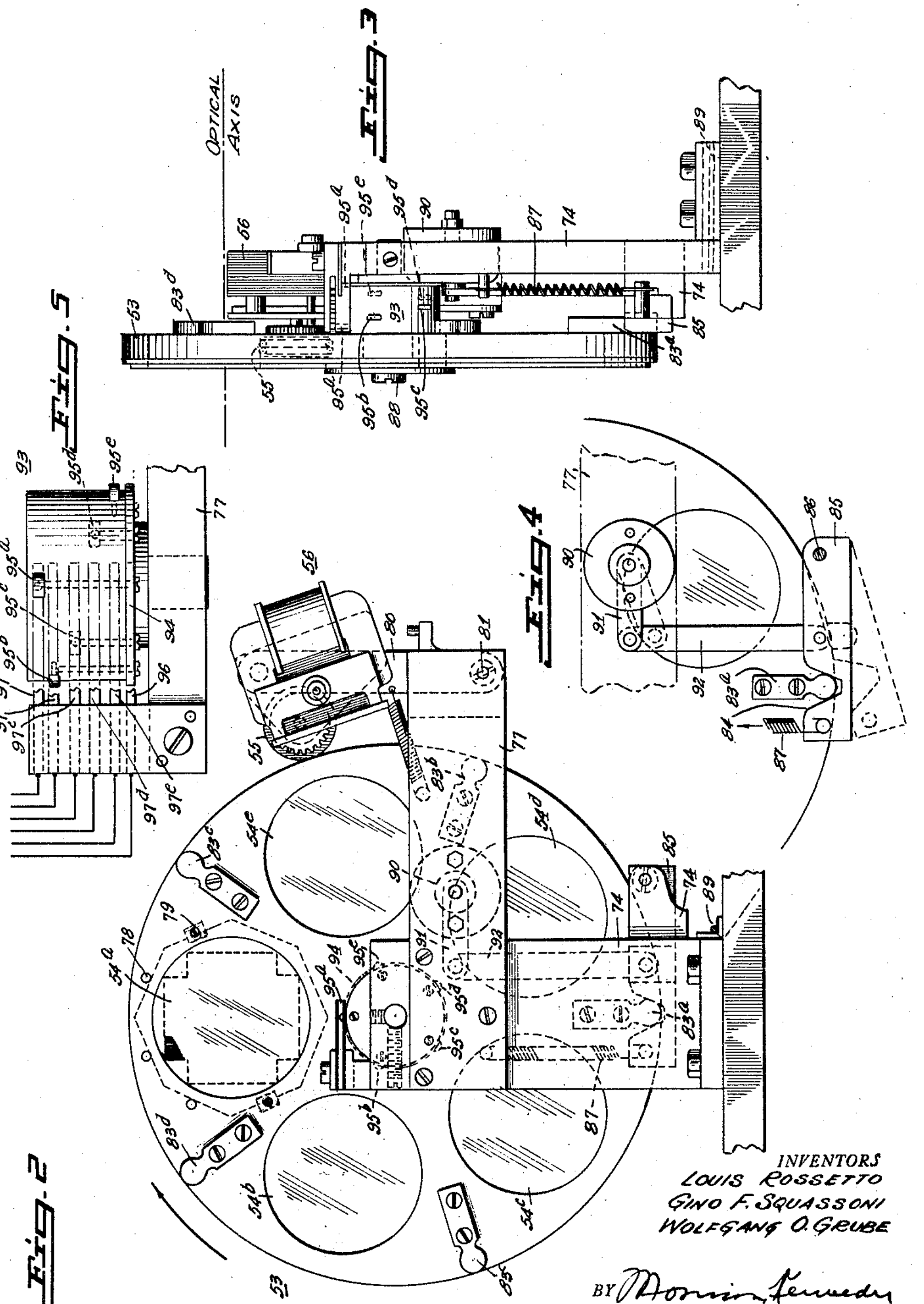

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TYPOGRAPHICAL PHOTOCOMPOSING MACHINE

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Fig. 6

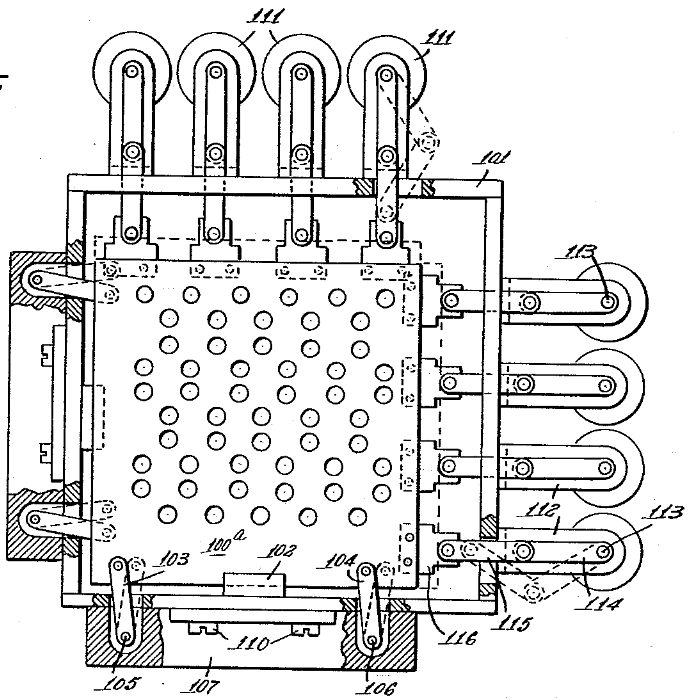
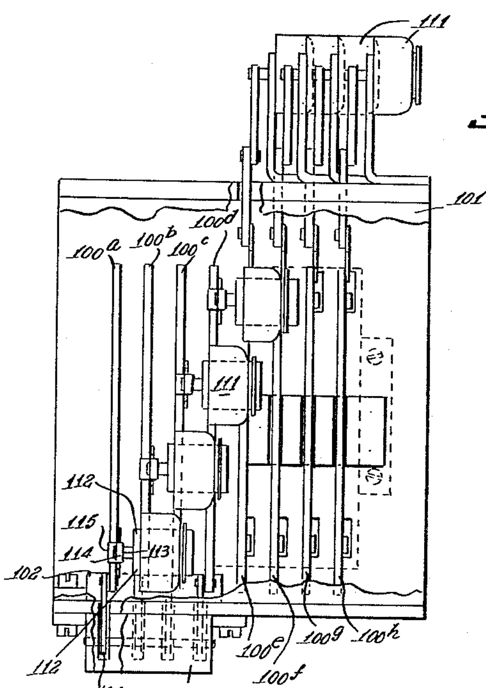


Fig. 7



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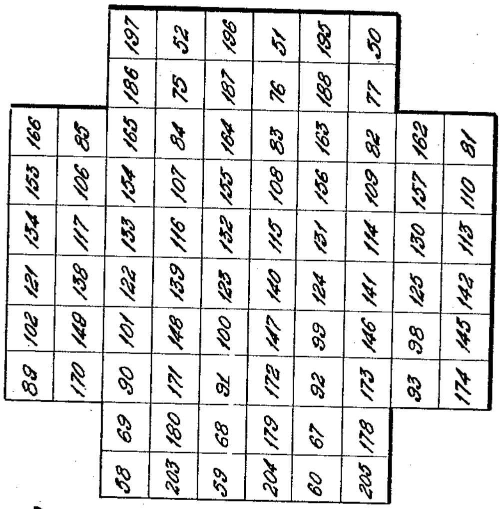

FIG. 9

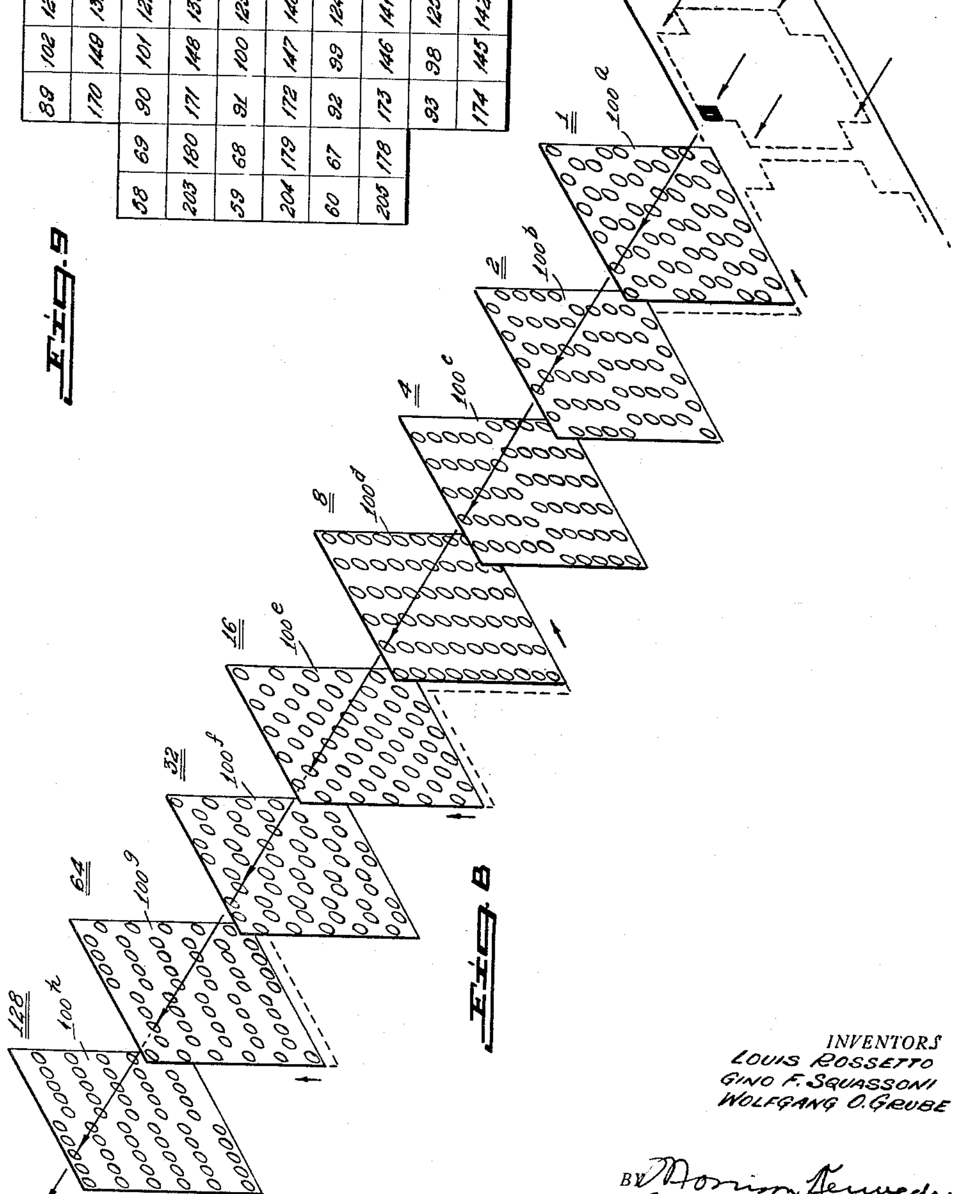

FIG. 8

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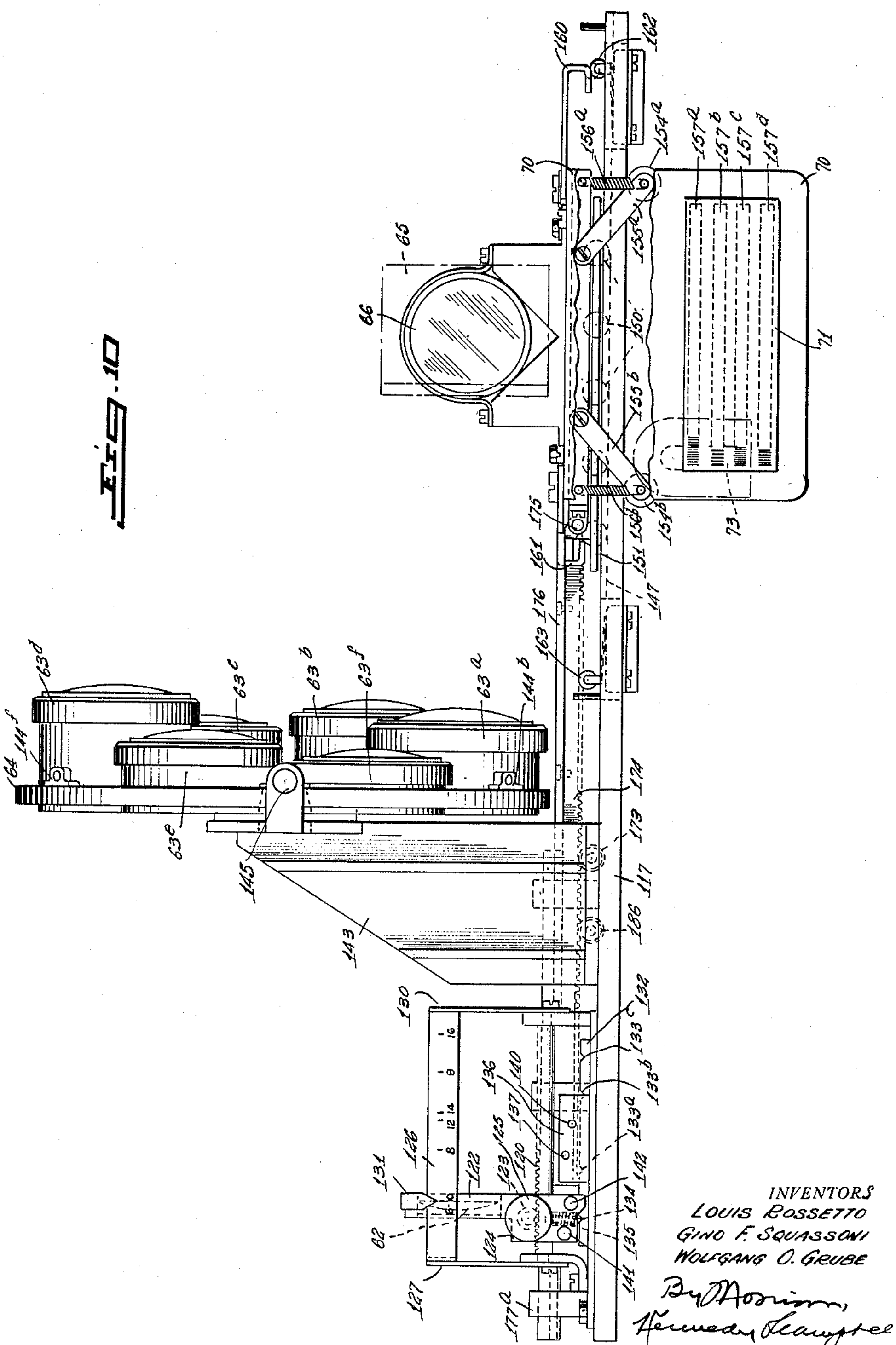

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TYPOGRAPHICAL PHOTOCOMPOSING MACHINE

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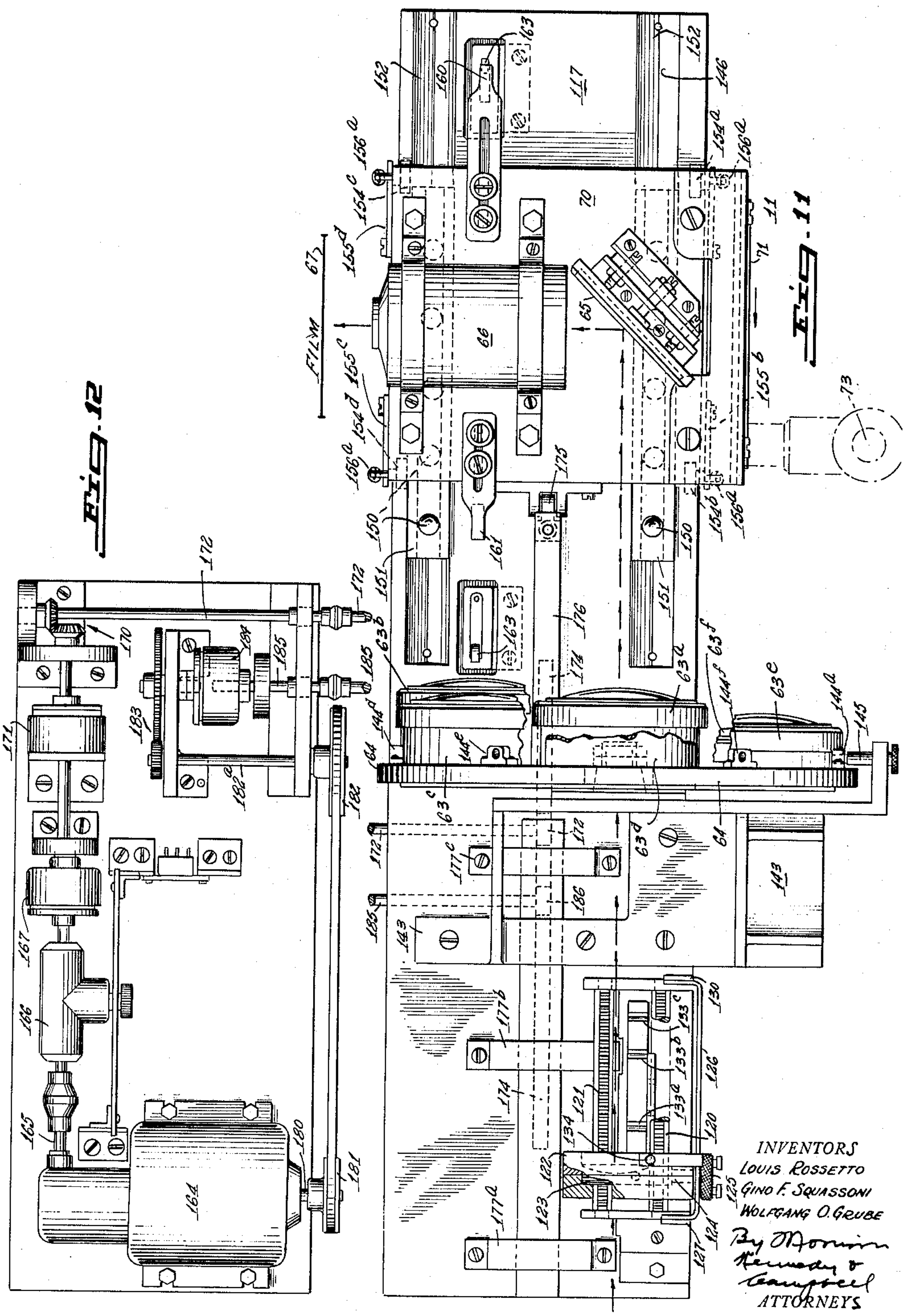

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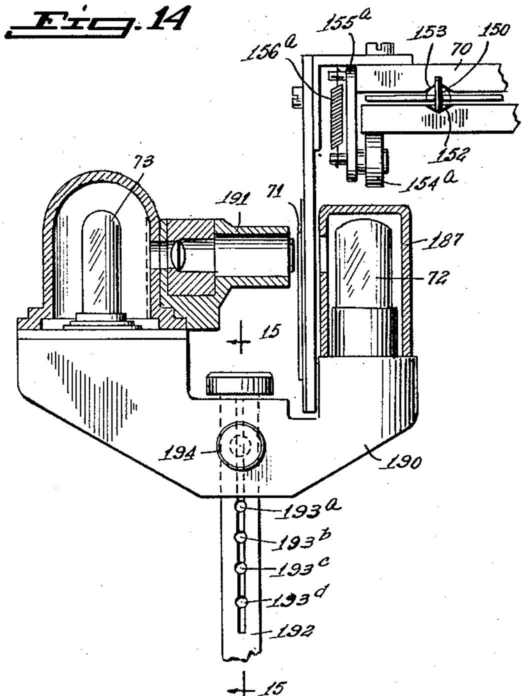
Fig. 14



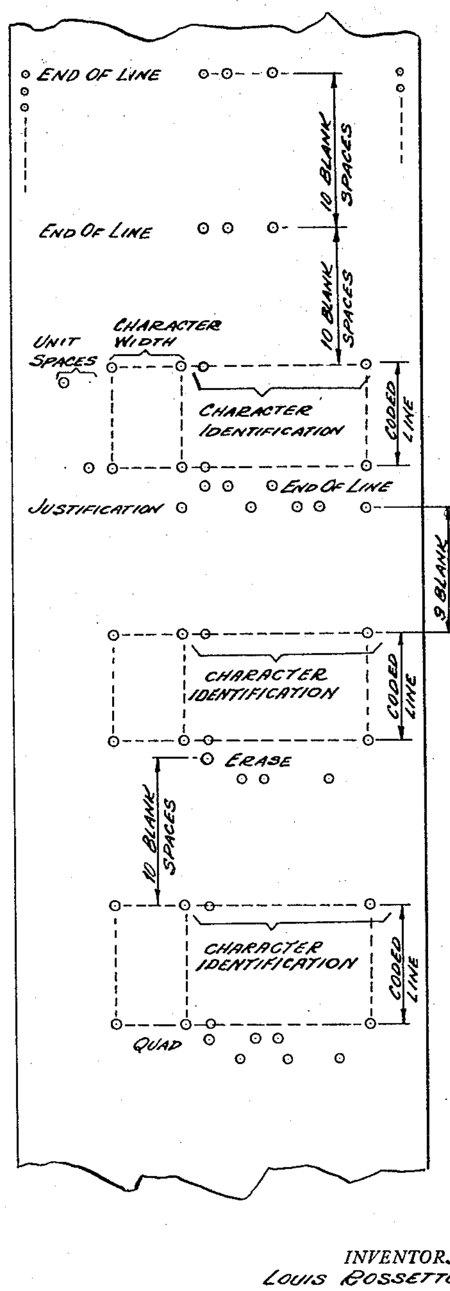


Fig. 21

Fig. 15

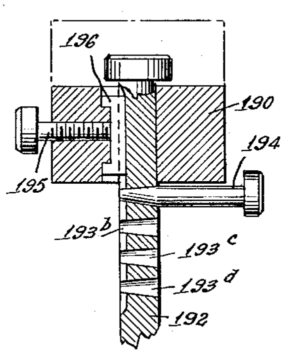
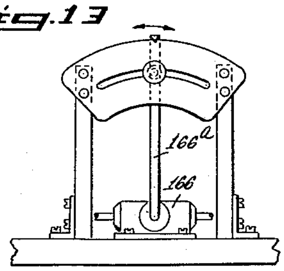


Fig. 13



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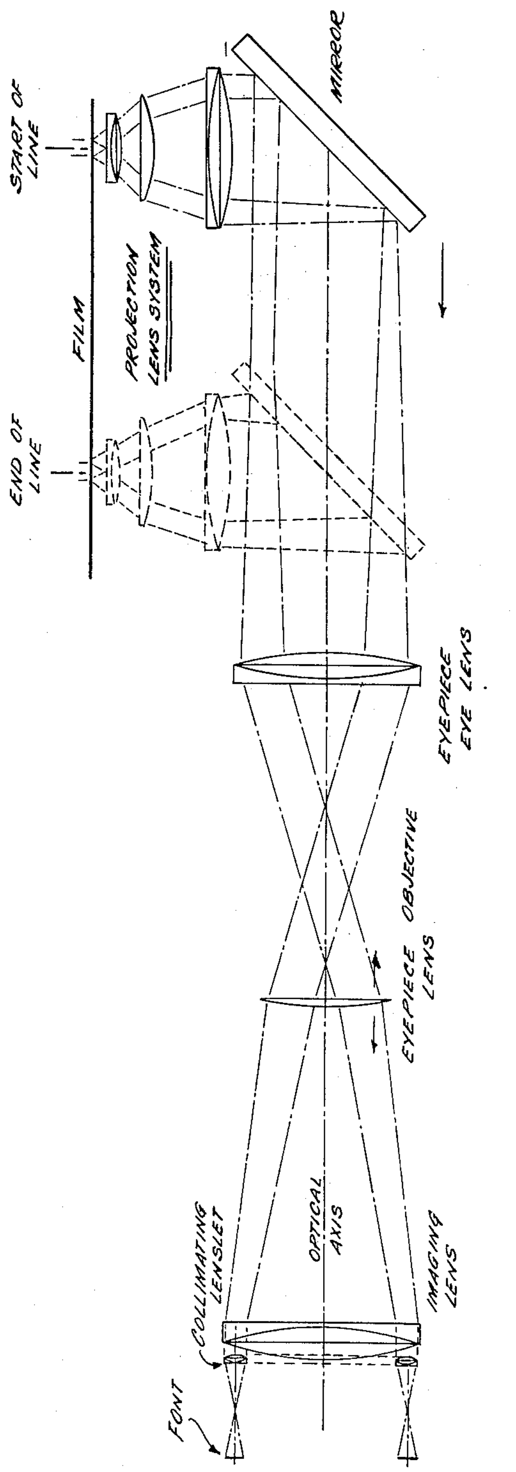

FIG. 16

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TYPOGRAPHICAL PHOTOCOMPOSING MACHINE

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Fig. 17

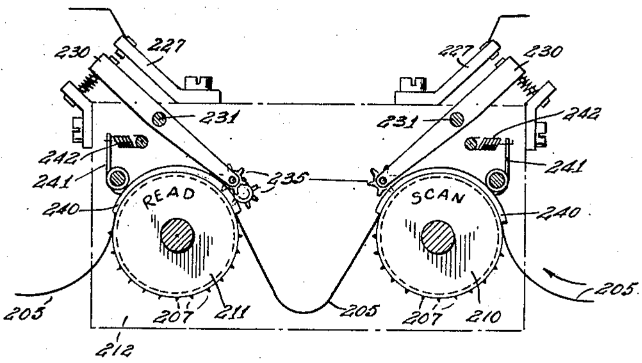

Fig. 18

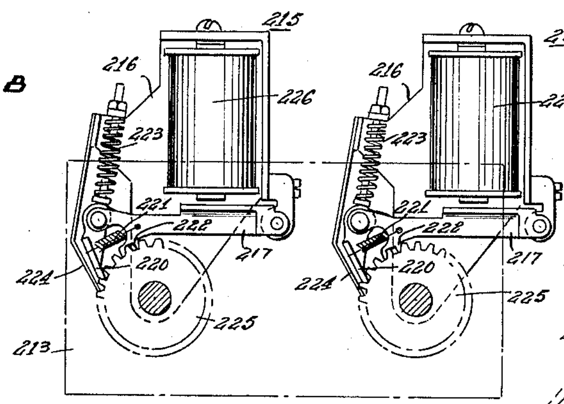

Fig. 19

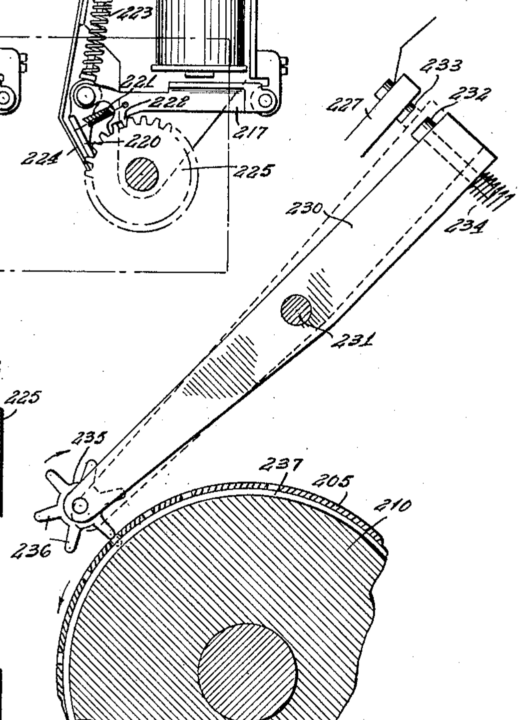

Fig. 20

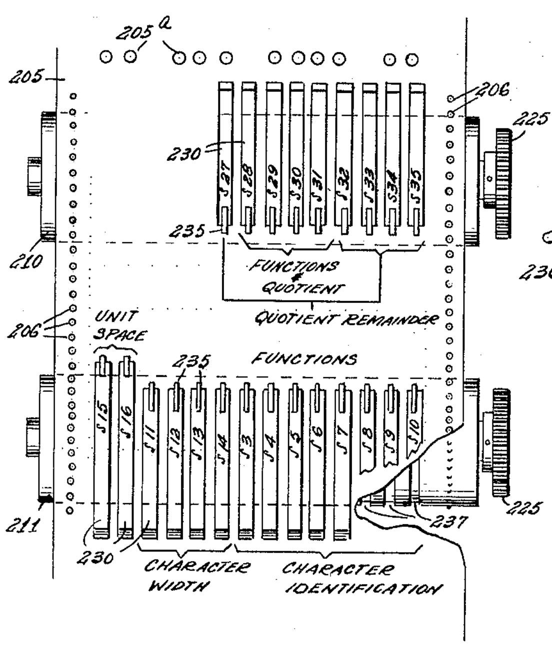

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Fig. 22

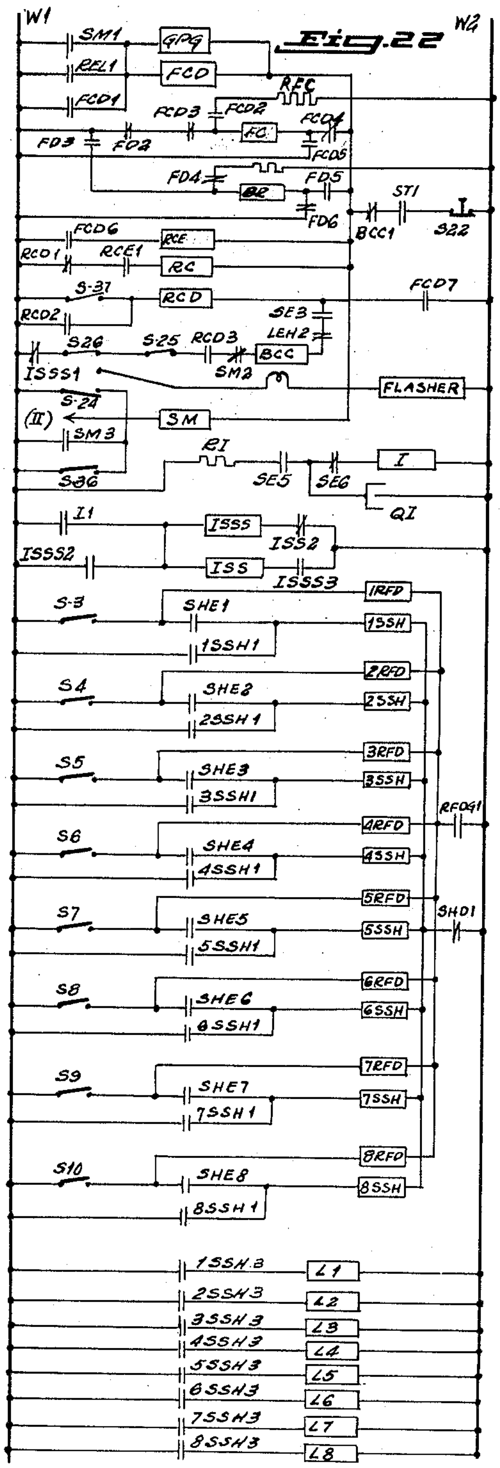

Fig. 23

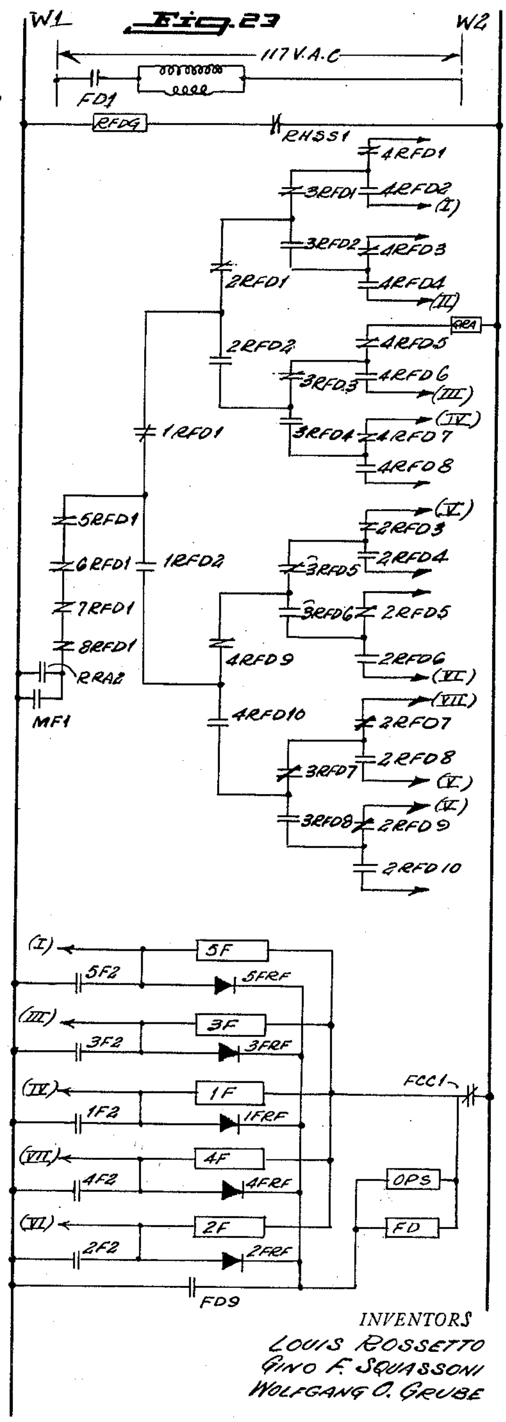

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Fig. 24

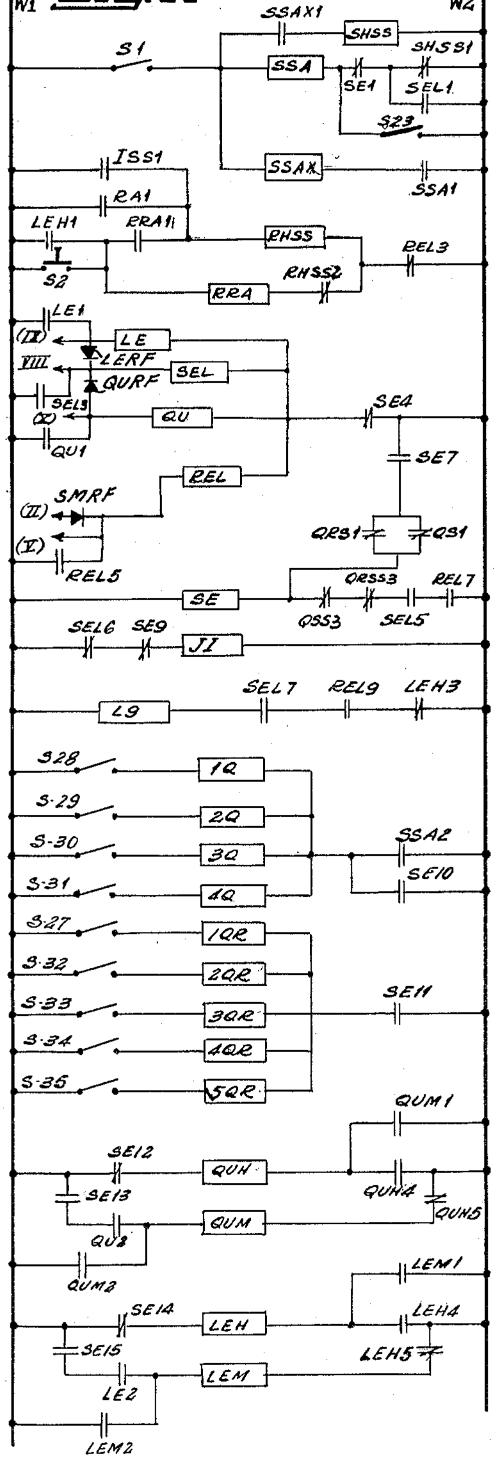

Fig. 25

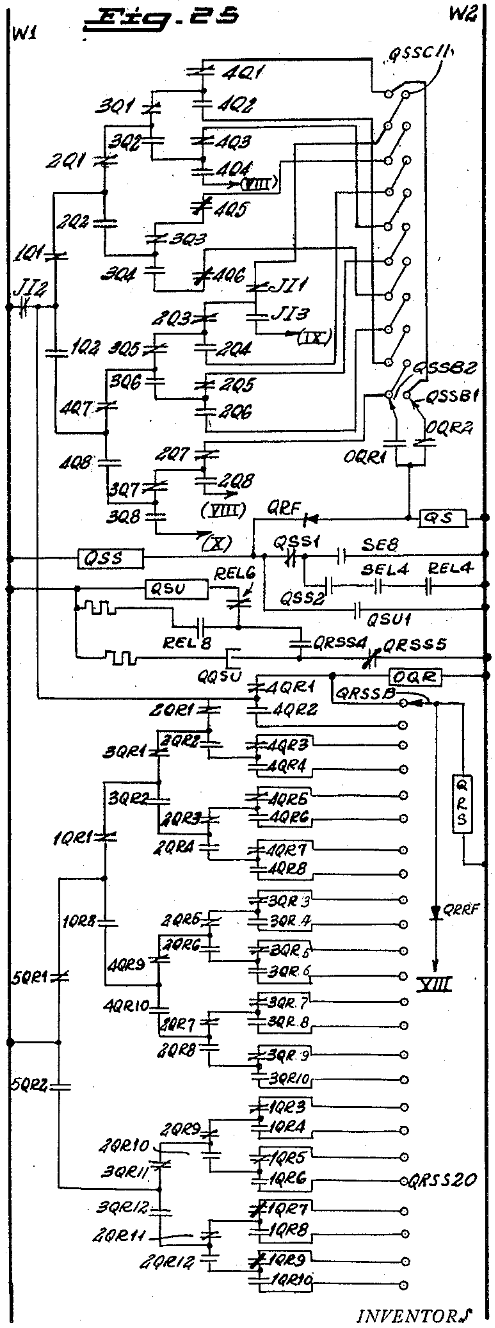

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Fig. 26

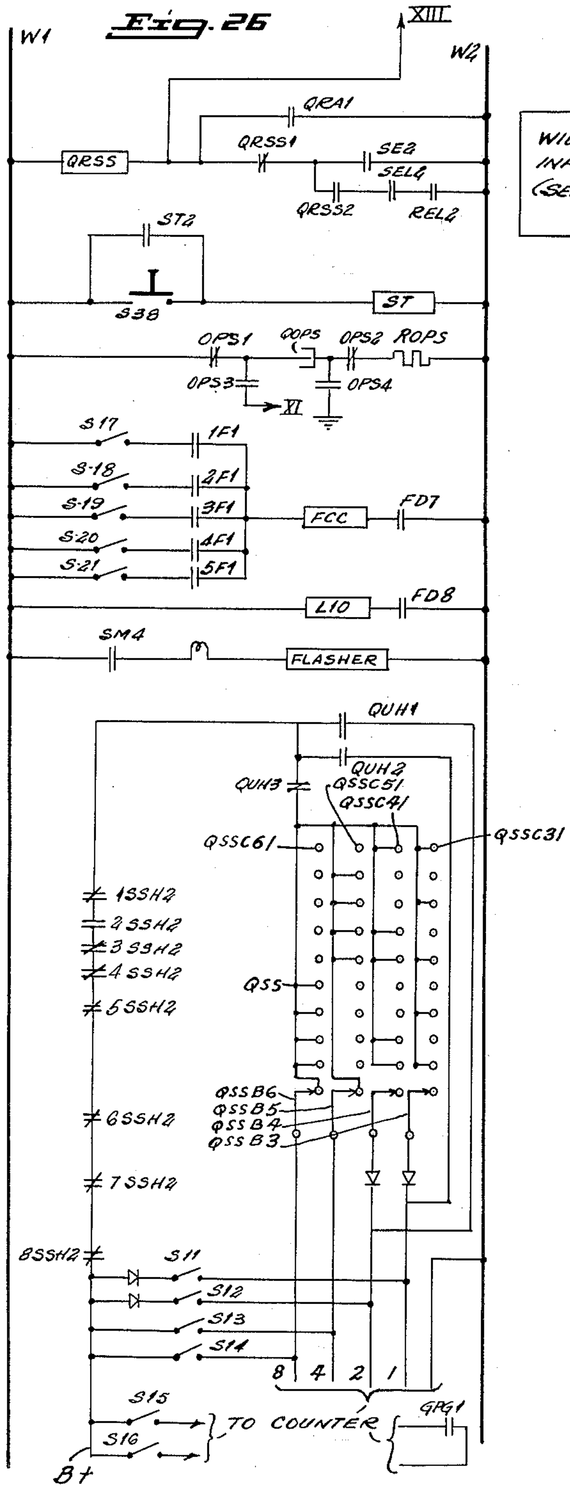
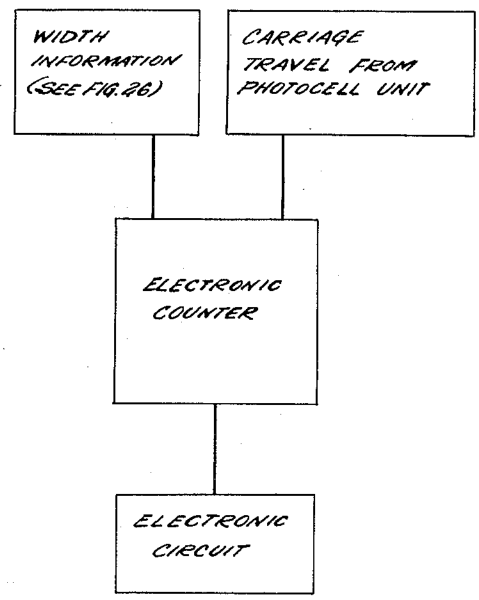


Fig. 27



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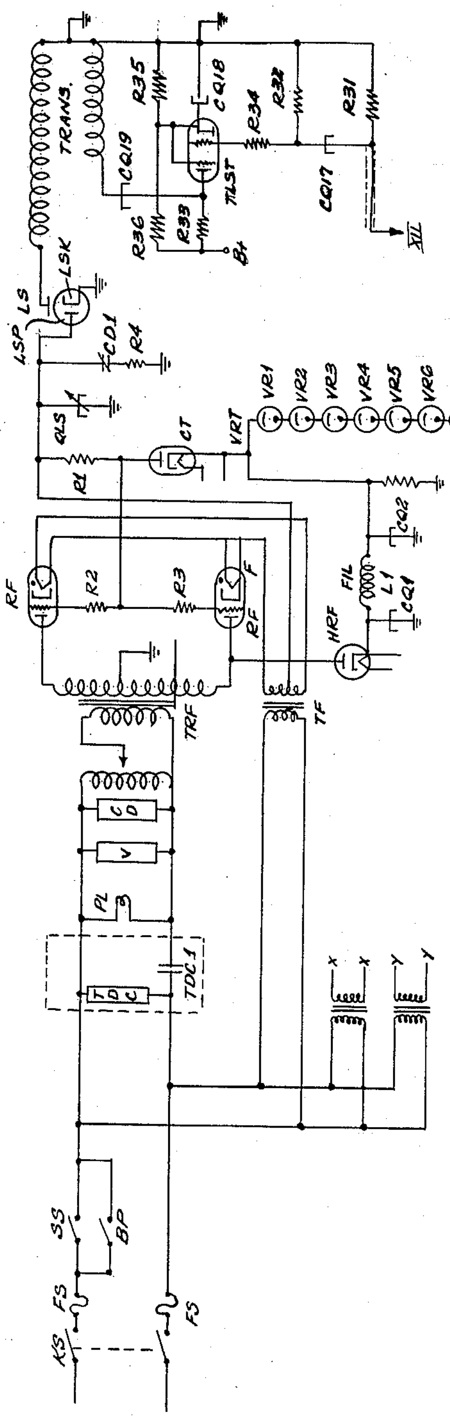

Fig. 28

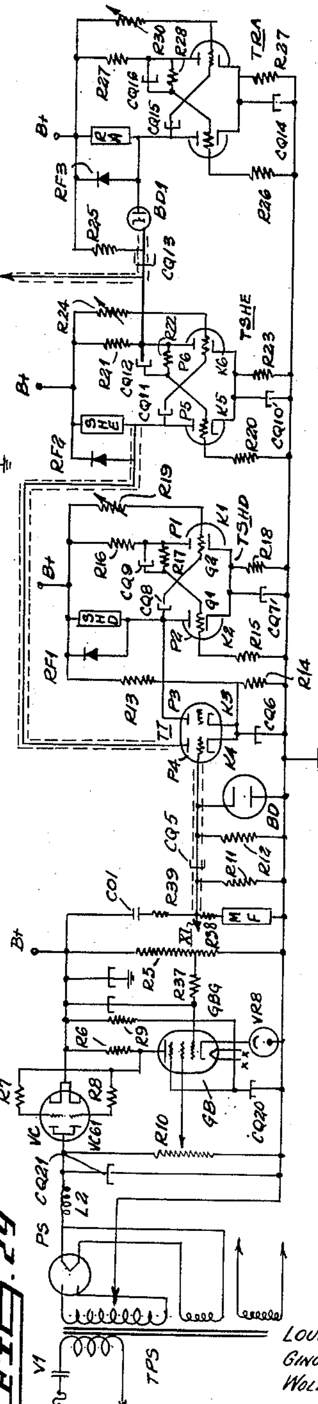

Fig. 29

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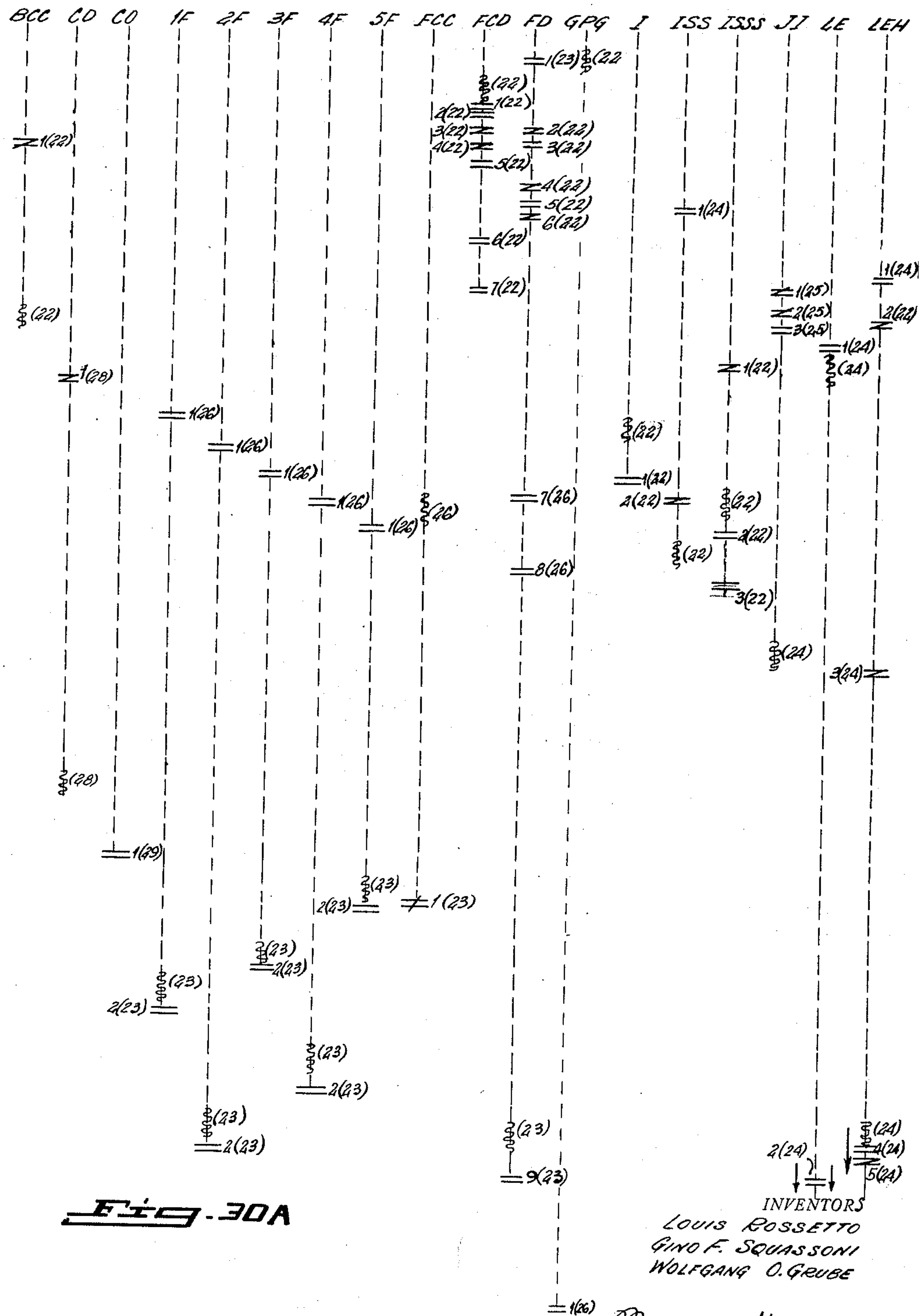

Fig. 30A

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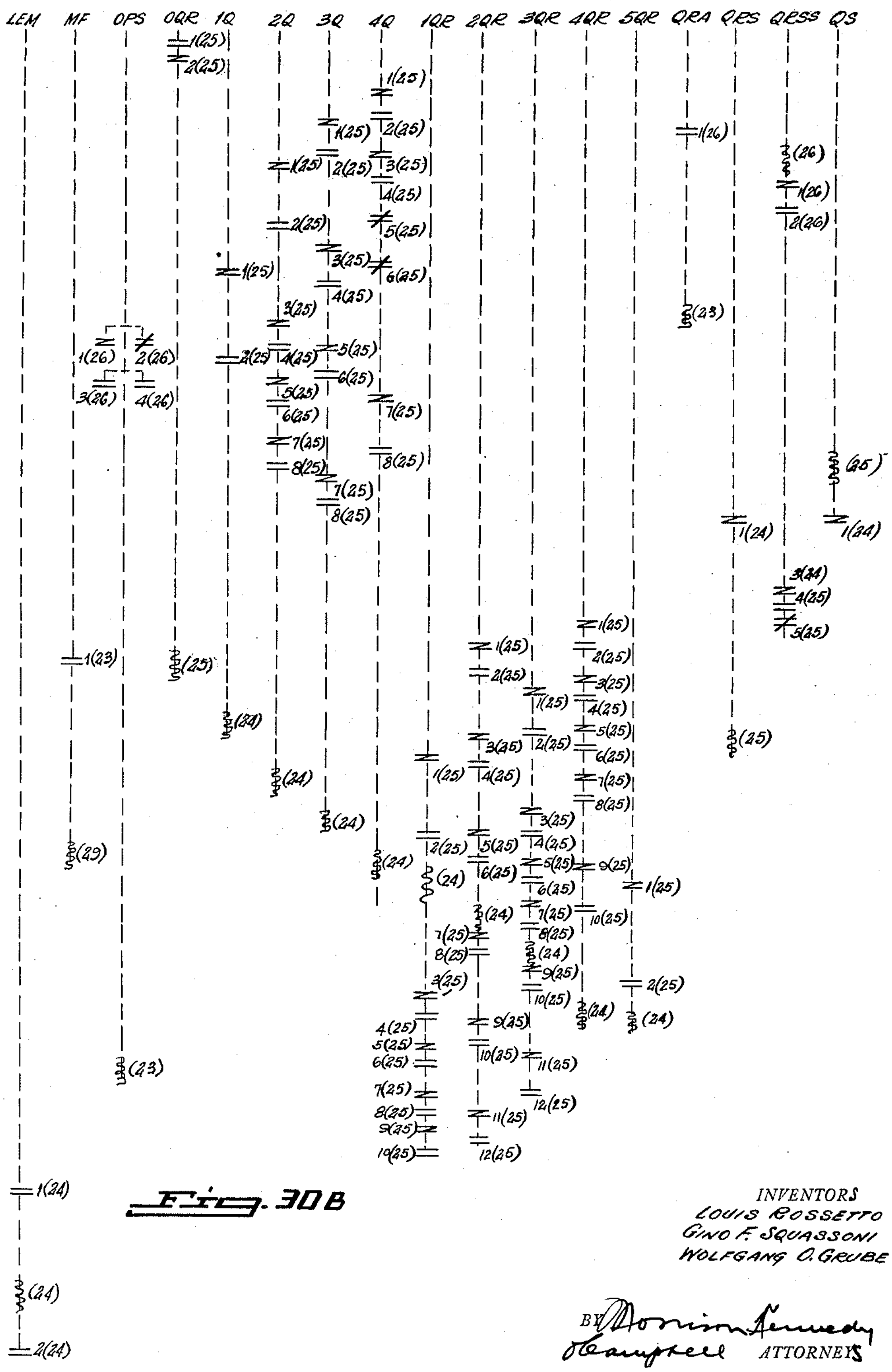

FIG. 30B

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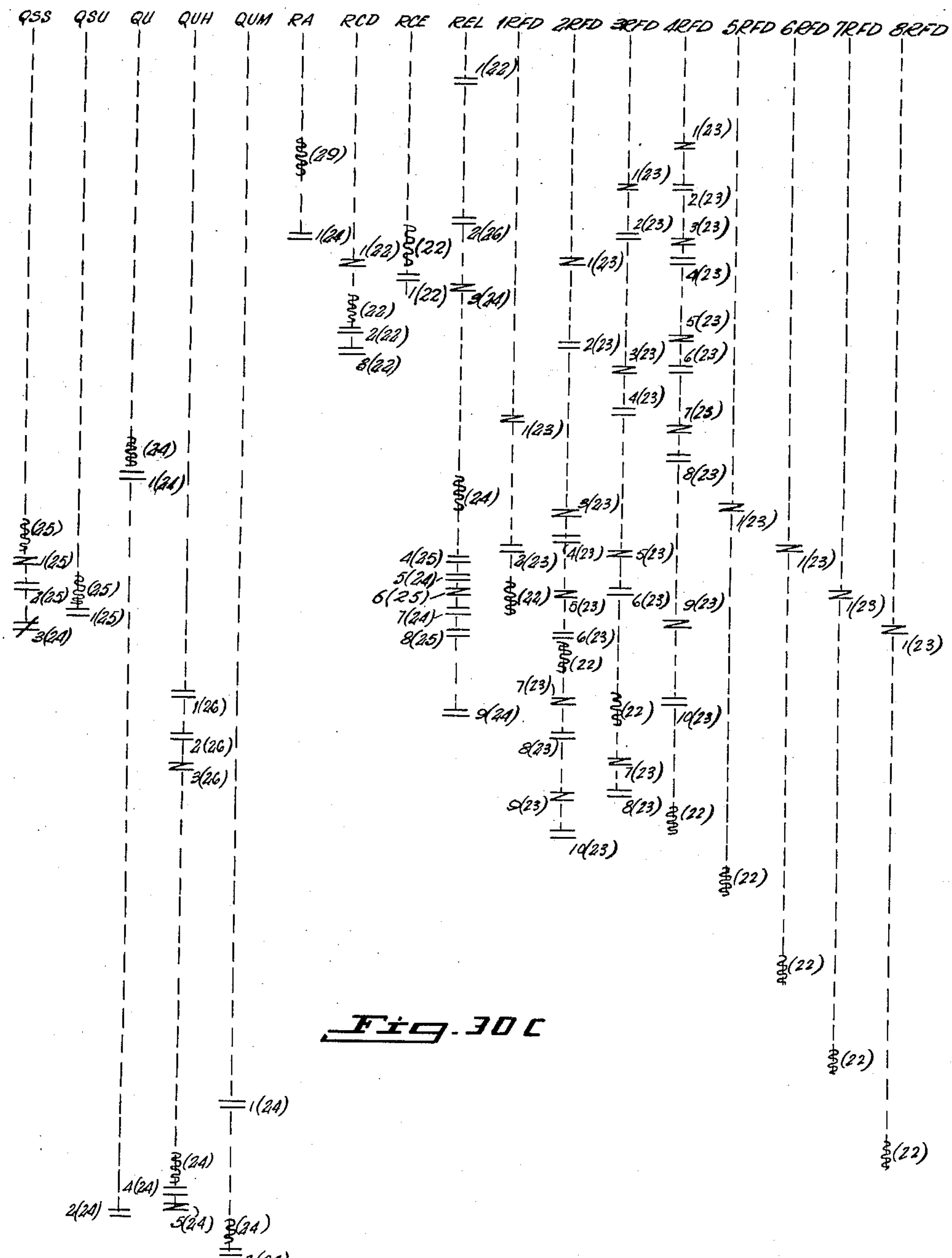

Fig. 30C

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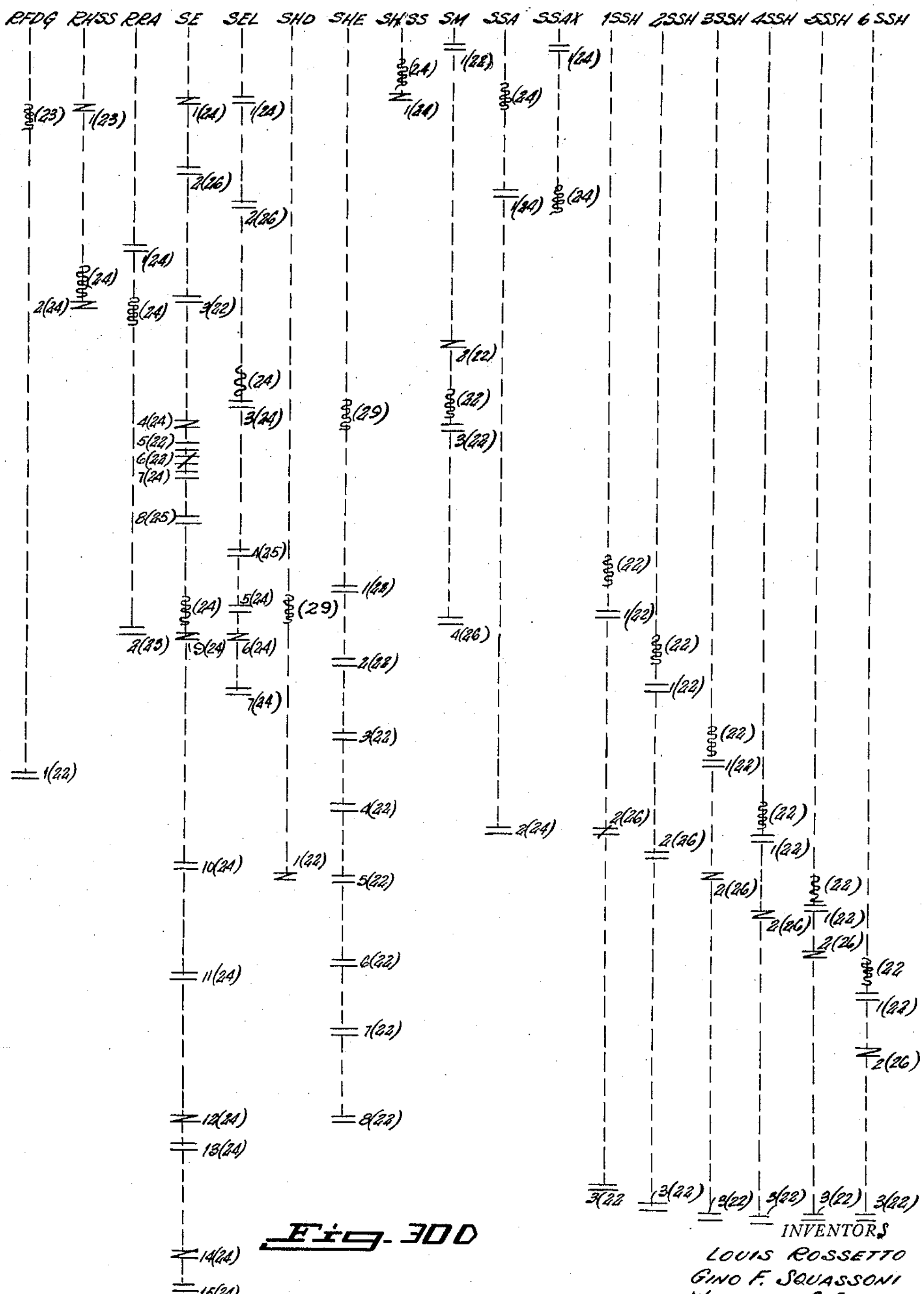

Fig. 30D

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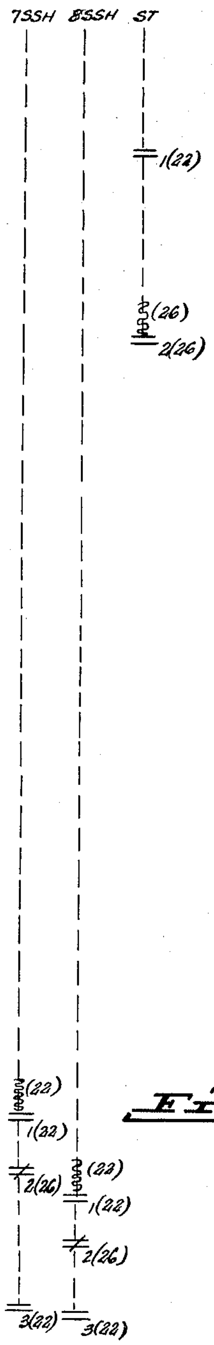

Fig. 30E

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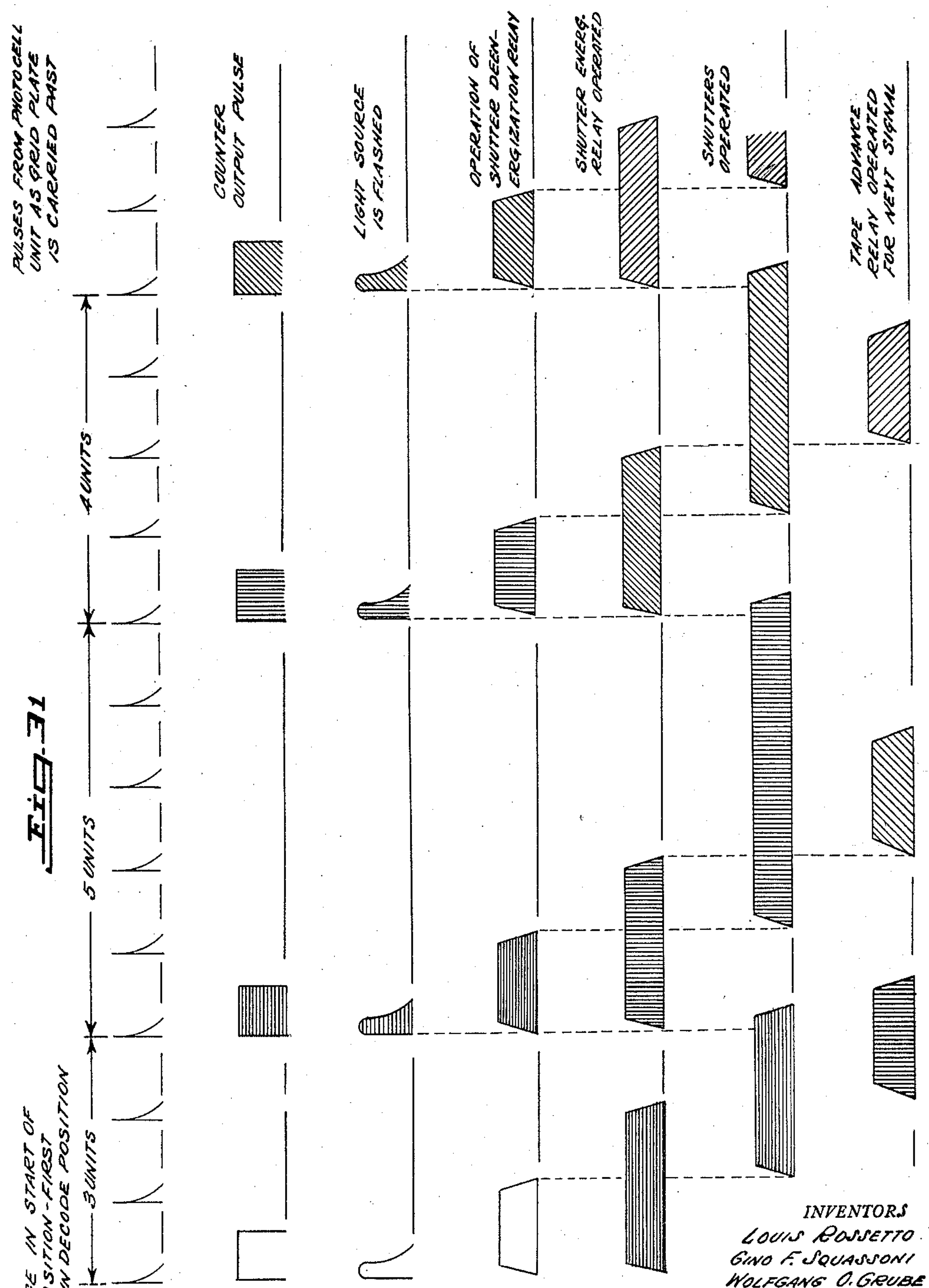

Fig. 31

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United States Patent Office

3,106,880
Patented Oct. 15, 1963

3,106,880

TYPOGRAPHICAL PHOTOCOMPOSING MACHINE

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Filed Mar. 26, 1954, Ser. No. 419,012
30 Claims. (Cl. 95—4.5)

This invention relates to an improved two-unit typographical photocomposing machine. The first unit is an input or key-controlled coding unit which produces a coded tape representing the type matter to be photocomposed. The present application is confined to the second unit of the machine and is in the form of an output or decoding unit which is controlled by the coded tape prepared by the first unit, as well as an optical system for photographing the type characters, one after another, in the order in which they are to appear in print.

The general scheme of the present invention is set forth in the Introduction which immediately follows the description of the drawings; and a rather complete summary is given under Operation at the end of the detailed specification. A further statement at this point, therefore, would serve no useful purpose and would be largely repetitious. The exact construction of the various parts and the manner in which they function can best be understood from the detailed description. However, it may be well to state here that the present machine, while capable of operating on any desired unit system, is herein shown and described as operating on a twelve-unit basis, that is to say, twelve units to the em, the characters and the inter-word spaces varying in width on that basis. It may also be noted that the invention does not require that the improved machine be made in two separate units, it being possible to combine the two units into one along the lines disclosed in the copending application Serial No. 342,156, filed March 13, 1953, now Patent No. 2,847,919.

In the drawings:

FIG. 1 is a schematic representation of the machine components;

FIG. 2 is a front elevation of the font plate and operating mechanism;

FIG. 3 is a side elevation of the parts shown in FIG. 2;

FIG. 4 is a fragmentary front elevation, with portions removed, to show the mechanism for locking the font plate in position;

FIG. 5 is a detail of the font contact mechanism;

FIG. 6 is a front elevation of the shutter unit;

FIG. 7 is a side elevation of the shutter unit;

FIG. 8 is a schematic view showing the aperture configurations for the various shutters;

FIG. 9 is a table showing the binary number values for the different character positions;

FIG. 10 is a side elevation of the point size changing lenses and the projection lens carriage with grid plate;

FIG. 11 is a plan view of the parts shown in FIG. 10;

FIG. 12 is a plan view of the projection lens carriage drive mechanism;

FIG. 13 is a front elevation of the carriage drive mechanism speed changer;

FIG. 14 is a side elevation, partly in section, of the grid plate and the photoelectric tube and light source;

FIG. 15 is a sectional view taken along the line 15—15 of FIG. 14;

FIG. 16 is a ray diagram for the optical system of the machine;

FIG. 17 is a front elevation of the decoding apparatus;

FIG. 18 is a front elevation of the tape drive;

FIG. 19 is an enlarged detail view showing the engagement of a decoding switch with the tape;

FIG. 20 is a plan view of a part of the decoding apparatus;

FIG. 21 is a schematic representation of the coded tape showing various code signals and their interrelationship;

FIGS. 22, 23, 24, 25 and 26 taken together constitute a simplified schematic wiring diagram of the relay circuits employed in the improved photocomposing machine herein disclosed;

FIG. 27 is a block diagram showing the relationship of the various electric circuit groups;

FIGS. 28 and 29 constitute a simplified schematic wiring diagram of the electronic circuits employed in the machine;

FIGS. 30^a to 30^e are key sheets which show the coils and contacts of the electromagnetic switches of FIGS. 22, 23, 24, 25, 26, 28 and 29 in spindle form; and

FIG. 31 is a pulse diagram which shows the time sequence of various machine operations.

INTRODUCTION

For a general understanding of the invention, reference may be had to FIG. 1 wherein various parts of the photocomposing machine chosen to illustrate the principles of the invention are shown schematically. To introduce the machine components and set forth their relationship, a summary description will first be given, tracing light from the light source through the machine components to the film where a character image is ultimately formed. Thereafter, a detailed description will be given of the various machine elements; which description will constitute a preferred arrangement of the machine embodying the principles of this invention. The electrical system which controls photocomposing will also be described in detail hereinafter but it will not enter into the general discussion of the machine elements.

Referring specifically to FIG. 1, a source of light **50** is shown positioned in front of a reflecting unit **51** which serves to concentrate and thus intensify the light energy in a direction forward of the source. The light then passes through a condensing lens **52** which distributes the light relatively evenly over the area directly in front of the lens. This area covers the entire character array of a type font which is arranged on a rotatable font plate **53**. As is shown, the plate **53** carries a plurality of type fonts and may be rotated to permit any desired font, e.g. **54^a**, to be selected for positioning in the light path. Rotation of the font plate is effected by a friction disk **55** which engages the rim of the plate and is in turn actuated by an electric motor **56**.

Light from the source passes through the entire font character array, the characters preferably being transparent and the background opaque. To selectively pass to the remaining machine components only the light passing through a single character, a selective shutter is employed. In the broader aspects of the invention the shutter may be of any suitable arrangement for passing the light from a single selected character, but by preference a binary shutter system **57** is utilized herein.

Located in front of the shutter is a lens board **60** which comprises a plurality of lenslets **60^a**, one for each character of the font. Thus the light, which the shutter system passes, is directed through an individual lenslet to an imaging lens **61** which then produces an image, in space, of the character selected for photographing. The image thus formed by the imaging lens becomes the object for the lens system which is termed the eyepiece, it comprising an eyepiece objective lens **62** and a turret eye lens **63**. The objective lens is adjustable mounted for positioning along the optical axis of the machine. The turret lens may be any selected one of a plurality of lenses 63^a to 63^f mounted in a turret **64** which is rotatable to bring the selected lens into position along the optical axis. The eyepiece reduces the divergence of the light rays from the imaging lens but its end function is to control the size of the finally produced film image of the photographed character. The light rays leaving the eyepiece next impinge on a mirror 65 which deflects the rays to a course at an angle to the optical axis and through a projection lens 66 to the film 67 where the image of the character is finally formed and recorded photographically.

As before stated, the above description traces the paths which the light rays travel during the photographing of a single character. Any of the characters of the font may similarly be photographed by operation of the shutter system in a predetermined manner which will be explained when the shutter system is considered. It is generally obvious that characters may be photographed successively to produce filmed composition. In what has been explained so far, the only additional item to be considered for film composition is the provision of mechanism for photographing the characters adjacent one another in line. In the preferred arrangement, this is accomplished by advancing the mirror and projection lens with reference to the film after each preceding character has been photographed. Thus, the mirror 65 and the projection lens 66 are mounted on a carriage 70 in a manner which permits a line of composition to be photographed as the carriage moves from a start-of-line position to an end-of-line position. A drive mechanism is provided for moving the carriage in a forward as well as in a reverse direction.

In the preferred embodiment, the motion of the carriage is continuous rather than intermittent. As the carriage is moved across the film, operation, of the shutter to expose the character selected for photographing and illumination of the light source are controlled so that the finally reproduced characters are spaced to provide a justified line of composition. This will be clearer after the several components have been considered and the complete operation of the machine described. To measure movement of the carriage in relation to the film so that each character may be photographed at the proper time, there is provided a grid plate 71 mounted on and movable with the carriage. The plate has inscribed thereon several rows of equally spaced parallel lines, the spacing in each row being dependent on the desired filmed image size. The grid plate is interposed between a fixedly mounted light source 72 and a peotocell 73 and consequently, as the carriage moves and carries the grid plate past the photocell unit, the light to the photocell is repeatedly interrupted. This action is utilized in the control circuits to control character illumination in a manner alluded to above and to be hereafter described.

Having proceeded with the generalized description of the machine, the several components will now be particularly described.

Font Plate

FIGS. 2, 3 and 4 detail the construction of the font plate and attention will now be directed thereto. The font plate shown carries five type fonts and is journaled in a mounting bracket 74 so that any one of the fonts may be selected for positioning on the optical axis. The font plate is removably secured to bracket 74 by threaded bolt 88 in order that font plates may be readily interchanged. To facilitate such change bracket 74 is provided with a mounting, such as hinge 89, whereby the font mechanism can be swung into a position convenient for changing fonts. In addition each font is individually mounted on the font plate by fixing its position with aligning pins 78 and clamping it with screwed on retaining brackets 79. A pair of set screws 75 and 76 permit alignment of the font plate to insure proper positioning of the selected font with respect to the remainder of the system. An extension 77 of the bracket provides support for an electric motor 56 and a plate driving disk 55 which are of unitary construction and are rigidly secured to one extremity of a link 80. The other extremity of the link is pivotally connected to the extension 77 by a pin 81 in order that the driving disk may be yieldingly urged against the periphery of the font plate, as by a spring 82. In this manner, even though wear may occur on the disk sufficient friction will exist between disk and plate to provide a positive drive.

Secured to the font plate are a plurality of abutments 83^a to 83^e, one for each font, which serve to maintain the font selected for composition in a fixed position. To accomplish this, the active abutment enters slot 84 in a lever 85 which is pivotally supported by pivot pin 86 on mounting bracket 74. The lever is urged upwardly to tightly engage the abutment by a tension spring 87. In order to change from one font to another, it is necessary to disengage the abutment associated with the font in use, so that the motor 56 may act to rotate the font plate. For this purpose, a rotary solenoid 90 is provided on the bracket extension 77 and its shaft is connected to the lever 85 by a pair of links 91 and 92. Energization of the solenoid depresses link 92 and rotates the lever counterclockwise to disengage the abutment. The motor can then freely rotate the font plate. Just prior to the newly selected font arriving in position on the optical axis, the solenoid is deenergized and the spring 87 acts to return the lever to a horizontal position. The motor continues to rotate the font plate and, as the next arriving abutment reaches the lever, it (the abutment) engages the upper surface thereof and cams the lever downwardly. Further movement of the font plate causes the abutment to engage the slot and thus stop continued font plate rotation. The motor can thereupon be deenergized.

Also journaled to the mounting bracket 74 and rotatable together with the font plate is the contact disk 93. The disk is provided with a contact 94, which completely encircles the disk, and a plurality of contact segments 95^a to 95^e, one for each font (see also FIG. 5). Each of the contact segments is electrically connected to the disk encircling contact. The contact segments are spaced circumferentially on the disk and in addition they are spaced longitudinally along the disk axis. Mounted on the bracket 74 are a plurality of contact fingers 96 and 97^a to 97^e, one for each contact segment and the disk encircling contact. The contact finger 96 and the disk encircling contact 94, of course, make contact constantly. However, a contact finger associated with a contact segment, say, finger 97^a and segment 95^a, make contact only when the font associated with the segment is in position on the optical axis. Thus a contact segment, e.g. 95^a, and the disk encircling contact 94, together with their respective contact fingers, serve as a mechanical switch is closed when the associated font is in position on the optical axis. The functioning of the "switches" will be described when the electrical control circuits are considered.

Shutter System

Reference will first be made to FIGS. 6 and 7 which disclose the structural details of the shutter system. In the arrangement shown, eight shutters 100^a to 100^h are used, four of which, 100^a, 100^b, 100^c, 100^d, are moved horizontally and the remaining four of which, 100^e, 100^f, 100^g, 100^h, are moved vertically. Inasmuch as each shutter is provided with similar parts, the discussion will be limited to a single shutter, e.g. shutter 100^a. The shutters are surrounded by an enclosure 101 which also serves as a support. On the inside bottom surface of the enclosure, there is a shutter guide 102 which comprises a block having a number of slots into which fit the four shutters adapted for horizontal movement. A similar block 102^a mounted on one of the side walls serves to guide the four shutters adapted for vertical movement. The shutter 100^a is also supported by a pair of parallel links 103 and 104 which pivot on pins 105 and 106 respectively, the pins in turn being mounted in a pin block **107** which is fastened to the enclosure by a plurality of screws **110**. A rotary solenoid **111** is provided to control movement of the shutter which, as will appear, may be held in either of two positions. The solenoid is supported by a bracket **112** which fastens to enclosure **101**. The shaft **113** of solenoid **111** is connected to shutter **100**^{a} by a pair of toggle links **114** and **115** and a fastening bracket **116**. With the links extended in a straight line, as shown by the solid lines in FIG. 6, the shutter is in one of its two controlled positions. When the solenoid is energized and its shaft rotated, the toggle links jacknife, as shown by the dotted lines in FIG. 6, and the shutter is moved toward the right to its other controlled position. Deenergization of the solenoid causes the solenoid and the shutter to be returned to neutral position through the action of the solenoid return spring (an internal member of the solenoid). Each of the other shutters adapted for horizontal movement, i.e. shutters **100**^{b}, **100**^{c}, **100**^{d}, are similarly arranged in enclosure **101** and are actuated similarly to shutter **100**^{a}. Likewise, the four shutters **100**^{e}, **100**^{f}, **100**^{g}, **100**^{h}, adapted for vertical movement are operated in the same way as shutter **100**^{a}.

As noted in the generalized description, a binary shutter system is employed. Reference will now be made to FIGS. 8 and 9 in which the aperture configurations for the various shutters are shown. In a binary number system, it is possible to represent a number by the sum of its component binary numbers; the latter being a geometric progression of numbers, e.g. 1, 2, 4, 8, 16, 32, 64 and 128. Thus, to represent the numeral 3, it is only necessary to add the binary numbers 1 and 2. Similarly, to represent the numeral 15, the binary numbers 1, 2, 4 and 8 are added. With the eight binary numbers specifically mentioned above, it is possible to represent any number from 1 to 255 by simply taking a binary number itself or the sum of a combination of the binary numbers.

It was observed that when each number in the arithmetic progression 0, 1, 2, 3, 4, 5, 6, 7, 8 . . . was represented by binary numbers 1, 2, 4, 8, 16, 32 . . . the binary number 1 appeared in every other representation, the binary number 2 appeared in every other two representations, the binary number 4 appeared in every other four representations, the binary number 8 appeared in every other eight representations, and the binary number 16 appeared in every other sixteen representations. With knowledge of this, various aperture configurations can be employed to obtain the desired result, but the ones illustrated were found to provide for the most characters in a minimum area when half of the shutters are moved horizontally and the other half moved vertically. Since a limited number of characters will be in each font and since that number is less than that which may be obtained from the binary numbers 1, 2, 4, 8, 16, 32, 64 and 128, only selected numbers from 1 to 255 represent the different character positions.

The photocomposing machine disclosed herein has the character array of each font disposed in a plane area in front of the light source and the purpose of the shutters is to expose one character to the film at a time. Each character position is assigned a numeral and by operating the shutters selectively, one character position is exposed at a time. To accomplish this, each shutter is assigned a binary number value and the aperture configuration of this shutter is determined accordingly. After the shutters are apertured and assigned the binary values as shown in FIG. 8, to expose a character, say a character in position **173**, shutters **100**^{h}, **100**^{f}, **100**^{d}, **100**^{c} and **100**^{a}, having, respectively, the binary values 128, 32, 8, 4 and 1 are actuated. As a further example, to expose the character in position **84**, shutters having the binary values 64, 16, and 4 are actuated.

Eyepiece

The eyepiece which comprises the eyepiece objective lens and the eyepiece turret lens will be considered with reference to FIGS. 10 and 11. Mounted in the optical system base **117** but spaced therfrom is a pair of racks **120** and **121**. A lens carriage **122** for the eyepiece objective lens **62** is adapted for horizontal movement and is provided with a pinion **123** adapted to engage the pair of racks **120** and **121**. The pinion is journaled in its support **124** and its rotation is effected by a knurled hand knob **125**. A point size scale **126** is fastened to rack supporting members **127** and **130**. A pointer **131** is provided on carriage **122** to be moved as the carriage is translated. By aligning the pointer with the proper point size numeral on the scale, the size of the reproduced characters can be accordingly selected. To insure correct positioning of the lens carriage, and consequently of the lens, and to avoid sight alignment of the pointer with the scale markings, a detent bar **132** is positioned on optical system base **117** to be spanned by the carriage. The bar has a number of V-shaped grooves **133**^{a}, **133**^{b}, **133**^{c}, therein in approximate alignment with the point size markings on the scale, but in exact optical position to provide the desired point size image on film. Adapted to engage these grooves is a plunger **134** carried by the carriage and urged downwardly by a compression spring **135**. Thus, to position the eyepiece objective lens to provide a certain point size on the finally produced film, knurled knob **125** is turned until, with pointer **131** approximately pointing to the desired size on the scale **126**, plunger **134** is seated in the appropriate V-shaped groove. It will be noted that the carriage positions for two of the point size settings are fairly close together, so much so, that two V-shaped grooves could not be spaced adjacent one another. To facilitate accurate positioning of the carriage when these point sizes are to be filmed, an additional block **136**, having two latching holes **137** and **140** therein, is provided and fastened to optical base **117**. The carriage is consequently provided with two aligning screws **141** and **142** for engagement in the latching holes when the carriage is positioned to film the point size for which they are provided.

In addition to the eyepiece objective lens mounting just discussed, there is also provided an eyepiece turret lens mounting. A turret bracket **143** is secured to optical base **117** and rotatably supported by it is the lens turret **64**. A plurality of lenses **63**^{a} to **63**^{f}, are spaced around the turret so that, as the turret is rotated by hand, the selected lens (say, **63**^{a}) is positioned on the optical axis. The turret also carries a plurality of pawls **144**^{a} to **144**^{f}, one for each lens. These pawls are adapted to be engaged by a bracket-mounted stop screw **145** which fits into a pawl opening and secures the turret in a fixed position.

By proper selection of a turret lens and horizontal movement of the objective lens, the filmed size of the characters of the font in use may be controlled within a limited range as determined by the lens system. This range is indicated in FIG. 10 as being 6 pt., 8 pt., 9 pt., 12 pt., 14 pt. and 16 pt., although of course it could be otherwise.

Character Recording Means and Drive Mechanism Therefor

The carriage which causes the character images to be formed, one by one, on the film in composing each line and the carriage driving means will be described with reference to FIGS. 10 to 12. The mirror **65** which diverts the light rays toward the film **67** and the projection lens **66** which transforms the light rays into an image on the film are shown secured to projection lens carriage **70**. The carriage is supported on the optical base **117** by two ball races **146** and **147**, which permit practically frictionless movement of the carriage along the base. Each ball race comprises a plurality of balls **150** which are maintained in position by a retaining form **151** but which are free to rotate. The balls are set in longitudinal V-grooves **152** of the base **117** and the carriage is positioned thereon with the carriage V-grooves **153** engaging the upper half of the balls. Vertical movement of the carriage away from the base is prevented by four rollers **154**^{a} to **154**^{d}, one located at each corner of the carriage, which bear against the underside of the base **117**. The rollers are pivotally connected to the carriage by links 155^a and 155^b, and they are urged against the underside of the base by tension springs 156^a and 156^b.

Also rigidly fastened to the carriage for movement therewith is a unit measuring device in the form of grid plate 71. This plate is translucent and is shown with four rows of opaque lines 157^a to 157^d, inscribed thereon. Each row comprises equally spaced lines, the different rows having their lines spaced different distances but in all cases there being twelve lines per em. The lines are utilized to measure units of movements of the carriage with respect to a fixed reference point, i.e. start-of-line position and thereby determine when a character is to be recorded. It may, under certain circumstances, be desirable to increase the number of lines per em from twelve to some multiple thereof, e.g. forty-eight. Thus a character having a set width of seven units of an em, would be photographed after the carriage has travelled past twenty-eight lines rather than seven. This expedient increases the accuracy in locating the position in which a character is photographed. The different rows of lines are resorted to when different point size characters are being composed, and the units of movement changed in proportion to point size of the filmed characters. The grid plate will again be considered when a photocomposing operation is described.

The carriage also has a pair of limit switch cams 160 and 161 adjustablly placed thereon for engagement with limit switch actuating rollers 162 and 163. Limit switch 161 serves to cause reversal of carriage motion when it returns to the start-of-line position, and the other limit switch 160 serves as a safety device which prevents overtravel of the carriage in the composing direction of travel.

The driving mechanism for the carriage is shown particularly in FIGS. 11 and 12. A unidirectional gear motor 164 furnishes the power for driving the carriage in both directions. When driving the carriage in the forward or composing direction, the motor output shaft 165 is connected to a speed changing unit 166 and thence to an electric clutch 167 which is energized to rotate bevel gears 170. An electromagnetic brake 171 is interposed between clutch 167 and gears 170. A forward drive shaft 172 connects these gears 170 to a rack pinion 173 which engages, from beneath, a carriage rack 174. The rack 174 and carriage 70 are connected by a universal joint 175. The rack itself is supported by and guided in a rack guide 176 and the latter in turn is supported above the optical base by a series of brackets 177^a, 177^b, 177^c.

A shaft 180 leading from the forward end of a gear motor 164 has a pulley 181 secured thereto. A second pulley 182, connected by a belt 181^a to the pulley 181, is secured to a shaft 182^a which drives a spur gear unit 183. This gear unit operates, through an electric clutch 184, a reverse drive shaft 185 having a pinion 186 meshing with the carriage rack 174.

It will be noted that both rack pinions 173 and 186, for the reverse and forward directions, engage the carriage rack at all times. The electric clutches 167 and 184 are controlled so that when one of them is energized the other one will be deenergized; hence, when the carriage is moved forward, the drive shaft 172 is positively driven by the motor 164 and reverse drive shaft 185 freewheels. The reverse conditions exists when the carriage is moved in a reverse direction by the drive shaft 185. It will also be noted that the speed changer unit 166 (FIG. 13), having a control handle 166^a, is included in the mechanism for driving the carriage in a forward direction and as a result the composing speed may be varied. The carriage is returned to start-of-line position at a constant speed and consequently a driving mechanism without speed changer is used.

Although the description discloses the carriage moving in a direction from switch 161 to switch 160 during photographing of a line, it is to be understood that line composition could take place when the carriage moved in the opposite direction by simply reversing the direction of rotation of motor 164.

Photocell Unit

The reference point past which the carriage moves and the means of measuring the extent of carriage movement is the photocell unit shown in FIGS. 14 and 15; the unit being placed at the start-of-line position. The light source 72 is enclosed in a light shade 187 which gives light directivity toward photocell 73. As is shown, the light source is mounted on a bracket 190 to one side of grid plate 71. Also mounted on the bracket but on the opposite side of the grid plate is the shielded photocell tube 73, the hood 191 of which extends from the tube to the grid to insure that only light from the light source will affect the tube. As was noted above, the light to the tube is repeatedly interrupted as the grid plate is moved past the photocell unit. Depending on the line spacing on the grid plate, the number of light interruptions will indicate the extent of carriage movement.

In order to position the photocell unit in alignment with any one of the various rows of lines on the grid plate, the stud 192, upon which the bracket is mounted, is provided with four holes 193^a to 193^d, spaced apart a distance equal to the spacings between the rows of lines on the grid plate 71. A pin 194 is adapted to be inserted manually in any one of the holes, e.g. the hole 193^a, and bracket 190 can then be moved vertically on the stud until it rests on the pin. A screw 195, threaded through the bracket, bears against an insert 196 and can be tightened to cause the insert to snugly grip the stud 192 and thus aid the pin in supporting the bracket 190.

Optical System

The photocomposing machine contemplated by this invention has so far been discussed generally and also by reference to the structural details of the machine. Reference will now be made to FIG. 16 for consideration of the optical system, and reference may also be had to copending application Serial No. 354,826, filed May 13, 1953, which discloses the same general system. The discussion will concern itself with the functions of the various optical components and the results which it is desired to obtain, it being understood that the end result (the image on film) may be obtained in other ways, as, for example, by using mirrors instead of the lenses described. The light passing through a single character will be considered; the character being located on the font plate and illuminated from a source (not shown) to the left of the diagram.

The character is located in the principal focal plane of a collimating lenslet associated therewith, each character in the character array being provided with an individual lenslet. With the character so located, light rays emanating from one point of the character leave the collimating lens in parallel rays even though they entered it as diverging rays. The characteristic of collimated light which makes it desirable to so collimate the light from the characters is that when such light passes through an imaging lens, an image of the character is formed in the focal plane of the imaging lens. In addition, it is of no consequence where the collimated light enters the imaging lens; the image is always formed in the lens focal plane and in a fixed position relative to the optical axis. Nor does it matter that the total light from a character enters only a portion of a zone of the imaging lens. Thus, light from one character near the top of the imaging lens would form a character image at the focal point, and light from another character entering the bottom of the imaging lens would form an image at the same point. Consequently, each character of a font positioned before the imaging lens (a lenslet for each character being interposed) can be imaged at the same position on the optical axis.

An eyepiece objective lens is positioned to intercept the light rays from the imaging lens before the image is formed and it refracts the light rays to form the image in space at a point which is closer to the imaging lens than if the eyepiece objective lens was not present. Principally, however, the objective lens serves to re-image the plane of the lenslet in the principal plane of the projection lens hereafter referred to. By longitudinally moving the eyepiece objective lens with respect to the imaging lens, but keeping it within the imaging lens focal distance, the position of the character image is varied. This is useful for varying the point size of the final image on film while maintaining the font characters at a constant point size. Continuing beyond the image, the light rays rapidly diverge, and it therefore becomes a function of the turret lens eye to converge them. In addition, if the image is focal distance from the turret lens, the turret lens will again collimate the light rays.

Although the light rays forming the character image are spoken of as collimated, it is known that they are a bundle of self-parallel rays, the envelope of which is not parallel but which has a point of least diameter known as the exit pupil. Since the exit pupil is the image of the system aperture stop, if it falls in the principal plane of the projection lens system, it permits maximum utilization of the free aperture of the projection lens. However, in the arrangement herein shown and described, a mirror is interposed between the turret lens and the projection lens and the two (the mirror and projection lens) are movable as a unit toward and from the turret lens in photocomposing a type line. Consequently, the distance which the light rays travel between the turret lens and the projection lens does not remain constant during composition of a line and the principal plane of the projection lens does not then coincide with the exit pupil for all positions of the mirror. In order to gather in all available light from the bundle of rays forming the character image, the free aperture of the projection lens is increased beyond that required if the projection lens position were held fixed and its principal plane coincided with the system exit pupil. To minimize the increase in the free aperture, the exit pupil (i.e. the image of the lenslet) is made to coincide with the mean position of the projection lens system. The collimated light entering the projection lens is then focused thereby to form a real image in the focal plane of the lens. The film strip is positioned in this plane and the character illuminated is recorded thereon.

Tape Decoder

In the present machine, it is contemplated that the matter to be composed on the film be introduced into the machine in the form of a coded tape. It is the function of the electrical system to interpret the coded information and to actuate the shutters, the projection lens carriage and the light source in accordance therewith. As the description of the system proceeds, special operations, such as quadding and line erasing, will be considered at appropriate times. As indicated at the outset, the coded tape is prepared in an input machine, to be made the subject of another application for patent.

Before describing the electrical circuits themselves, reference will be made to FIGS. 17, 18, 19 and 20 which show the mechanism by which the coded tape **205** is decoded or "read" in the machine. The tape is perforated across its width, as at **205**^{a}, to provide coded representations of the characters to be photocomposed. The tape is also provided with a series of feed holes **206** along each side thereof to facilitate advance of the tape through the decoding mechanism. The feed holes engage pins **207** of a "scan" head **210** and of a "read" head **211**, which heads are rotatably supported in end supporting members **212** and **213**. Each head is provided with a rotary stepping switch, which, when energized, causes the head associated therewith to rotate and advance the coded tape. Rotary switches **214** and **215**, for the respective heads **210** and **211**, are shown mounted on end supporting member **212**, to which are fastened switch frames **216** and pivotally supported switch armatures **217**. The switch armatures pivotally support rack engaging fingers **220**, which are urged by springs **221** toward the armatures. The armatures are also provided with locking fingers **222** which engage the racks. Compression springs **223** urge the armatures toward the racks **225** to thereby lock the racks and prevent rotation of the corresponding heads. Leaf springs **224** are mounted on the switch frames **216** in position to engage the racks **225**, in order to prevent reverse rotation of the heads. When the switch coils **226** are energized and the armatures consequently attracted toward a switch closed position, rack engaging fingers **220** and locking fingers **222** are removed from engagement with the racks. With the armatures in engaged position, tension springs **221** urge the rack engaging fingers **220** into the next succeeding rack groove. Thus, when the switch coils are deenergized, the compression springs **223** restore the armatures to their normal position and at the same time rotate the heads and advance the tape. By repeated energizations and deenergizations of the switch coils **226**, rapid advance of the coded tape may be obtained. Control of the switches will be explained hereafter.

The mechanism for decoding the coded information on the tape comprises a plurality of mechanically actuated switches **227**, these switches being arranged in two groups, one for the scan head **210** and one for the read head **211**. The switch movable contact arms **230** are independently supported, as by pivot rods **231**, which latter are in turn supported by the end support members **212** and **213**. One extremity of each contact arm is provided with a movable contact **232** which is spring-urged toward the stationary contact **233**, as by a compression spring **234**. The other extremity of each contact arm is provided with a rotatable star wheel **235** which bears against the coded tape and which ordinarily maintains the switch contacts separated. However, when a code perforation is advanced under the star wheel, a prong **236** of the wheel passes through the perforation, permitting the compression spring to rotate the movable contact arm and engage the contacts. To facilitate movement of a star wheel prong through the tape, the heads are each provided with a number of peripheral grooves **237**, one for each mechanical switch, over which the tape passes. It will be noted by reference to FIG. 20 that scan head **210** is provided with nine (9) mechanical switches and read head **211** with fourteen (14) mechanical switches. The number of grooves on each head need only correspond with the number of switches, but for purposes of standardization, each head will be provided with fourteen (14) grooves. A tape retainer **240** is provided for each head to maintain the tape in engagement with the pins **207** which engage the feed holes **206** to advance the tape. The retainer consists merely of a pivotal member **241** which conforms to the head perimeter and which is urged against the head by a tension spring **242**.

Coded Tape

A section of the tape, including the starting end thereof with schematic representations of typical coded information, is shown in FIG. 21. It is noted that an end-of-line signal is punched in the tape followed by ten blank spaces and then another end-of-line signal. A blank space is the degree of tape advance when a stepping switch is energized and deenergized once i.e. stepped one position. The ten blank spaces simply mean that it is necessary for the stepping switch to advance ten positions before the next coded information is brought up to position for reading. The number of blank spaces, above mentioned as ten, is of no significance, in and of itself, but it is merely great enough to permit the tape to span the gap between the scan head and the read head when an end-of-line signal is in reading position on both heads. For example, if the gap between the heads is greater than that assumed, a number of blank spaces greater than ten will be provided.

Following the second end-of-line signal, there is again provided ten blank spaces followed by character identification signals. After these signals, which represent a coded line of information, there is provided an end-of-line signal followed by a justification signal. Thereafter nine blank spaces followed by another set of character identification signals appear followed by a line-erase signal, a "meaningless" signal and nine blank spaces. Following are character identification signals, the latter in turn followed by a quad-signal, a "meaningless" signal and nine blank spaces. It will be noted that when a line-erase signal or a quad-signal is given after character identification signals, there is no end-of-line signal and ten spaces are interposed between the function signal and the next succeeding first character signal. If a justification signal follows a function signal, say, an end-of-line signal, then nine blank spaces follow the justification signal, or in other words, ten spaces follow the function signal before the first character signal. Although a certain sequence of line signals has been described for illustrative purposes, it is of course understood that an actual tape perforated in accordance with a line to be photocomposed will vary from that shown. In general, for each line to be photocomposed, character identification signals follow a number of blank spaces and are in turn followed by an end-of-line signal and a justification signal or a line-erase signal or a quad-signal.

FIG. 21 is a representation of the various code perforation locations in the tape and the use to which the perforations are put in the scan and read heads. In this connection, it will be noted that perforations which represent signals to be decoded in the scan head pass over the read head in the same positions as perforations which represent signals to be decoded in the read head and consequently will actuate the read head switches. The opposite condition is also true, that is, perforations which represent signals to be decoded in the read head pass over the scan head and actuate the scan head switches. Electrical interlocks, which will be described hereafter, prevent the scan head from decoding and utilizing read head signals and also prevent the read head from decoding and utilizing scan head signals.

Electrical System

FIGS. 22, 23, 24, 25 and 26 show the electrical circuits employed to control movement of the projection lens carriage and to control energization of the shutters to present the selected characters for photographing on the film. The circuits are shown in "straight" or "across-the-line" form in which the contacts of a switch are shown separated from the switch coil which operates them and arranged in the circuits which they control. Thus, it is possible to arrange each coil circuit in a "straight" line between parallel lines representing the power source. To facilitate locating contacts and relay coils referred to in the specification, there are provided a number of key or "spindle" sheets. On these sheets (FIGS. 30^a to 30^d), a vertical spindle is provided for each relay used in the electrical system. The spindles are identified by the relay designation for the relay associated therewith, the designations being arranged alphabetically across the top of the sheets. On each spindle, there is located representations of the relay coil and the relay contacts. The figure in which the coil or contact may be found is indicated parenthetically next to each coil or contact. In order to locate a contact on the straight or across-the-line diagram, it is merely necessary to place the spindle sheet containing the sought-after contact next to the indicated across-the-line diagram figure, whereupon the contact on the across-the-line diagram will be found in horizontal alignment with the contact on the spindle sheet. For example, to locate contact RHSS2, take the spindle sheet containing this contact, namely, FIG. 30D, locate the contact thereon and determine the figure in which contact RHSS2 appears. This is indicated by the numeral in parentheses next to the contact designation. Place the spindle sheet (FIG. 30D) next to the sheet containing FIG. 24, and contact RHSS2 on FIG. 24 will be in horizontal alignment with the contact on the spindle sheet.

In the across-the-line diagram the following electromagnetic switches will be found:

Brake clutch clearing relay	BCC
Capacitor discharge relay	CD
Counter output relay	CO
Font #1 relay	1F
Font #2 relay	2F
Font #3 relay	3F
Font #4 relay	4F
Font #5 relay	5F
Font change complete relay	FCC
Forward clutch deenergizing relay	FCD
Font change drive control relay	FD
Grating pulser gate relay	GPG
Interlock relay	I
Interline space stepping relay	ISS
Justification information relay	JI
Line-erase relay	LE
Line-erase holding relay	LEH
Line-erase memory relay	LEM
Output pulse simulator relay (time delay)	OPS
Zero quotient remainder relay	QQR
First quotient relay	1Q
Second quotient relay	2Q
Third quotient relay	3Q
Fourth quotient relay	4Q
First quotient remainder relay	1QR
Second quotient remainder relay	2QR
Third quotient remainder relay	3QR
Fourth quotient remainder relay	4QR
Fifth quotient remainder relay	5QR
Quotient remainder advance relay	QRA
Quotient remainder stepper relay	QRS
Quotient stepper relay	QS
Quotient subtractor relay	QSU
Quad left relay	QU
Quad left holding relay	QUH
Quad left memory relay	QUM
Read head advance relay	RA
Reverse clutch deenergizing relay	RCD
Reverse clutch energizing relay	RCE
Read end-of-line relay	REL
First read head function decoder relay	1RFD
Second read head function decoder relay	2RFD
Third read head function decoder relay	3RFD
Fourth read head function decoder relay	4RFD
Fifth read head function decoder relay	5RFD
Sixth read head function decoder relay	6RFD
Seventh read head function decoder relay	7RFD
Eighth read head function decoder relay	8RFD
Read head function decoder gate relay	RFDG
Read head rapid advance relay	RRA
Quotient search relay	SE
Scan end-of-line relay	SEL
Shutter deenergizing relay	SHD
Shutter energizing relay	SHE
Stop machine relay	SM
Scan head stepper advance relay	SSA
Auxiliary scan head stepper advance relay	SSAX
First shutter solenoid holding relay	1SSH
Second shutter solenoid holding relay	2SSH
Third shutter solenoid holding relay	3SSH
Fourth shutter solenoid holding relay	4SSH
Fifth shutter solenoid holding relay	5SSH
Sixth shutter solenoid holding relay	6SSH
Seventh shutter solenoid holding relay	7SSH
Eighth shutter solenoid holding relay	8SSH
Starting relay	ST
Voltage relay	V

Throughout the description which follows, these letters will be applied to the coils of the above designated relays. Also, with reference numerals appended thereto, they will be applied to the contacts of these relays. The electromagnetic switches are shown in deenergized condition.

In addition to the above electromagnetic switches, the following mechanically actuated switches are also located in the across-the-line diagram and are used to initiate certain machine functions or to decode the tape.

Start scan stepper switch	S1
Step read head switch	S2
Character identification switch (#1)	S3
Character identification switch (#2)	S4
Character identification switch (#3)	S5
Character identification switch (#4)	S6
Character identification switch (#5)	S7
Character identification switch (#6)	S8
Character identification switch (#7)	S9
Character identification switch (#8)	S10
Width identification switch (#1)	S11
Width identification switch (#2)	S12
Width identification switch (#3)	S13
Width identification switch (#4)	S14
One unit space switch	S15
Two unit space switch	S16
Font #1 detector switch	S17
Font #2 detector switch	S18
Font #3 detector switch	S19
Font #4 detector switch	S20
Font #5 detector switch	S21
Restart machine switch	S22
No tape signal (scan head) switch	S23
No tape signal (read head) switch	S24
Film magazine and film advance safety switch	S25
Out of film switch	S26
Quotient remainder switch (#1)	S27
Quotient switch (#1)	S28
Quotient switch (#2)	S29
Quotient switch (#3)	S30
Quotient switch (#4)	S31
Quotient remainder switch (#2)	S32
Quotient remainder switch (#3)	S33
Quotient remainder switch (#4)	S34
Quotient remainder switch (#5)	S35
Optical carriage safety switch	S36
Start of line switch	S37
Start machine switch	S38

The following stepping switches are also employed in the electrical system:

Quotient stepping switch	QSS
Quotient remainder stepping switch	QRSS
Scan head stepper	SHSS
Read head stepper	RHSS
Interline space stepper	ISSS

In the diagram, brushes on the stepping switches will be designated by the switch designation with the letter "B" appended thereto, and the contacts will be designated by the switch designation with the letter "C" appended thereto. For example, the brush on the quotient remainder stepping switch is QRSSB and the contacts thereon are QRSSC. If necessary for purposes of description, contacts on a single stepping switch will be differentiated by numerals e.g. QRSSC1, QRSSC2. Each of the stepping switches has a single level of contacts except the quotient stepping switch QSS which is a multi-level switch. Brush designations on this switch will consequently be QSSB1, QSSB2, etc. Contacts contacted by brush QSSB1 will be designated QSSC11, QSSC12, QSSC13, etc., while those contacted by brush QSSB2 will be designated QSSC21, QSSC22, QSSC23, etc. Other brushes and contacts will be similarly designated.

In addition to the above electromagnetic switches, mechanical switches and stepping switches, the wiring diagram includes the following solenoids:

First shutter solenoid	L1
Second shutter solenoid	L2
Third shutter solenoid	L3
Fourth shutter solenoid	L4
Fifth shutter solenoid	L5
Sixth shutter solenoid	L6
Seventh shutter solenoid	L7
Eighth shutter solenoid	L8
Film advance control solenoid	L9
Font change control solenoid	L10

To inaugurate operation of the machine, the tape 205 is placed on the scan head 210 and the read head 211 such that the first end-of-line signal is positioned between the two heads and the second end-of-line signal is positioned on the remote side of the scan head; the tape to be advanced in a direction such that it first passes the scan head and then the read head. Preparatory to advancing the tape, the power supply (not shown) is connected to the circuits shown in the wiring diagram and immediately a circuit is completed for justification information relay coil JI from line WI through contacts SEL6, SE9, coil JI to line W2. With the relay in operated condition, contacts JI3 are engaged and contacts JI1 and JI2 separated. With the tape positioned as described, toggle tape start scan stepper switch S1 is closed. Closure of switch S1 completes a circuit from line W1 through switch S1, coil SSA of scan head stepper advance relay, contacts SE1 and contacts SHSS1 to line W2, thus energizing coil SSA to engage contacts SSA1 and SSA2.

Contacts SSA1 complete a circuit to energize auxiliary scan head stepper advance relay coil SSAX from line W1, through switch S1, coil SSAX and contacts SSA1 to line W2, thus engaging contacts SSAX1. Engagement of contacts SSAX1 completes a circuit from line W1, through switch S1, contacts SSAX1 and scan head stepping switch coil SHSS to line W2, thus energizing the switch and separating contacts SHSS1. Separation of contacts SHSS1 interrupts the circuit for coil SSA, thus separating contacts SSA1 which in turn interrupt the circuit for coil SSAX. Deenergization of coil SSAX results in contacts SSAX1 separating to deenergize coil SHSS and advance the scan head stepping switch one position to move the tape one space. When coil SHSS is deenergized contacts SHSS1 again engage to complete a circuit for coil SSA. It is thus seen that the above circuits are consecutively energized in the described manner to advance the tape over the scan head.

The scan head stepping switch continues to advance the tape over the scan head until the end-of-line signal is brought to decoding position on the head. The end-of-line signal comprises perforations in the tape which cause quotient switches S28, S29 and S31 to be actuated. Switch S28 completes a circuit for first quotient switch coil 1Q from line W1, through switch S28, coil 1Q and contacts SSA2. Contacts 1Q2 thus engage while contacts 1Q1 separate. Similarly, switch S29 completes a circuit for second quotient switch coil 2Q to engage contacts 2Q8, and switch S31 completes a similar circuit for fourth quotient switch coil 4Q to engage contacts 4Q8. In tracing these circuits, it will be remembered that the tape was advanced to bring the end-of-line signal to decoding position when coil SHSS was deenergized and coil SSA energized, the latter coil maintaining contacts SSA1 and SSA2 engaged.

Engagement of contacts 1Q2, 4Q8, and 2Q8 completes a circuit for the scan end-of-line relay coil SEL which is traced from line W1, through contacts 5QR1, 1QR1, 3QR1, 2QR1, 1Q2, 4Q8, 3Q7, 2Q8, coil SEL and contacts SE4 to line W2. Energization of coil SEL results in contacts SEL1, SEL2, SEL3, SEL4, SEL5 and SEL7 engaging and contacts SEL6 separating. Contacts SEL1 are in parallel with contacts SHSS1 and consequently when coil SHSS is energized and contacts SHSS1 separated, a circuit is maintained for coil SSA through contacts SEL1 to keep it energized. Likewise, continued energization of coil SSA maintains a circuit for coil SSAX, through contacts SSA1, keeping contacts SSAX1 engaged and coil SHSS energized. It is thus clear that the stepping switch SHSS stops stepping, and the advance of the tape over the scan head is halted. The stepping switch is stopped with its coil in an energized condition for a reason which will be apparent hereafter. Immediately after the end-of-line signal is decoded and relay SEL operated, justification information relay JI is returned to non-operative condition to engage contacts JI1 and JI2 and to separate contacts JI3. This is accomplished by separating contacts SEL6 in relay coil JI circuit. The reason for this will be apparent hereafter when information is being photocomposed and is to be justified.

After the second end-of-line signal is brought to decoding position on the scan head, the first end-of-line signal which is at that time between the two heads is brought to decoding position on the read head. To accomplish this, there is provided a push button type step read head switch S2. Manual closing of switch S2 completes a circuit for read head rapid advance relay coil RRA from line W1, through switch S2, coil RRA contacts RHSS2 and REL3 to line W2 thereby engaging contacts RRA1 and RRA2. Engagement of contacts RRA1 completes a circuit for read head stepping switch coil RHSS from line W1, through switch S2, contacts RRA1, coil RHSS and contacts REL3 to line W2. Contacts RHSS2 thereupon separate to deenergize coil RRA and separate contacts RRA2. The latter in turn deenergizes coil RHSS to step the switch one position and engage contacts RHSS2. Engagement of contacts RHSS2 again completes a circuit for coil RRA to provide for continued alternate energization of coils RRA and RHSS to step switch RHSS. Continued pressure on the push button advances the tape over the read head until the first-end-of-line signal is brought to reading position on the head, at which time further movement of the tape is prevented.

The perforations which constitute the end-of-line signal are positioned to actuate character identification switches S3, S4 and S6. Switch S3 completes a circuit for first read head function decoder relay coil 1RFD from line W1, through switch S3, coil 1RFD and contacts RFDG1 to line W2, the coil RFDG having been energized when coil RHSS was deenergized to advance the tape one position and contacts RHSS1 engaged. Energization of coil 1RFD causes contacts 1RFD2 to engage and contacts 1RFD1 to separate. Switch S4 similarly completes a circuit for second read head function decoder relay coil 2RFD to engage contact 2RFD8. In like manner, switch S6 completes a circuit for fourth read head function decoder relay coil 4RFD and contacts 4RFD10 are engaged. Engagement to contacts 1RFD2, 2RFD8 and 4RFD10 complete a circuit for read end-of-line relay coil REL from line W1, through contacts RRA2, contacts 8RFD1, 7RFD1, 6RFD1, 5RFD1, 1RFD2, 4RFD10, 3RFD7, 2RFD8, coil REL and contacts SE4 to line W2. When coil REL is energized contacts REL3 separate. Separation of contacts REL3 results in continued pressure on push button type switch S2 being ineffectual to further advance the tape over the read head and, therefore, the button is released to deactivate switch S2.

With the first end-of-line signal in decoding position on the read head and the second end-of-line signal in decoding position on the scan head, the tape is ready to be automaitcally fed through the machine and in fact such operation takes place when the above prescribed conditions are fulfilled. However, before proceeding further with the description of the automatic operation, it is thought best to summarize the description so far given to the extent of indicating the relays which are now in energized condition.

Coil 1Q energized—contacts 1Q2 engaged—contacts 1Q1 separated.

Coil 2Q energized—contacts 2Q2, 2Q4, 2Q6, 2Q8 engaged—contacts 2Q1, 2Q3, 2Q5, 2Q7 separated.

Coil 4Q energized—contacts 4Q2, 4Q4, 4Q8 engaged—contacts 4Q1, 4Q3, 4Q5, 4Q6, 4Q7 separated.

Coil SEL energized—contacts SEL1, SEL2, SEL3, SEL4, SEL5, SEL7 engaged—contacts SEL6 separated.

Coil REL energized—contacts REL1, REL2, REL4, REL5, REL7, REL8, REL9 engaged—contacts REL3, REL6 separated.

Coil SHSS energized—contacts SHSS1 separated.

Coil SSA energized—contacts SSA1, SSA2 engaged.

Coil SSAX energized—contacts SSAX1 engaged.

Coil 1RFD energized—contacts 1RFD2 engaged—contacts 1RFD1 separated.

Coil 2RFD energized—contacts 2RFD2, 2RFD4, 2RFD6, 2RFD8, 2RFD10 engaged—contacts 2RFD1, 2RFD3, 2RFD5, 2RFD7, 2RFD9 separated.

Coil 4RFD energized—contacts 4RFD2, 4RFD4, 4RFD6, 4RFD8, 4RFD10 engaged—contacts 4RFD1, 4RFD3, 4RFD5, 4RFD7, 4RFD9 separated.

Coil RFDG energized—contacts RFDG1 engaged.

Coil SHD energized—contacts SHD1 engaged.

The first end-of-line signal is in decoding position on the read head and relay REL in operated condition to engage contacts REL9 and the second end-of-line signal is in reading position on the scan head and relay SEL in operated condition to engage contacts SEL7. Engagement of contacts SEL7 and contacts REL9 complete a circuit for the film advance control solenoid L9 from line W1, through solenoid L9, contacts SEL7, REL9 and LEH3 to line W2. Energization of the solenoid causes the film to be advanced one line. It will be first assumed that neither quotient stepping switch QSS nor quotient remainder stepping switch QRSS is in its home position and, as a result, contacts QSS2 are engaged and contacts QRSS2 are engaged, respectively. These contacts remain engaged until the switches reach home position, at which time they separate. A circuit for quotient stepping switch coil QSS can be traced from line W1, through coil QSS, contacts QSS1 (an interrupter contact which facilitates stepping of the switch), contacts QSS2, SEL4 and REL4 to line W2. When the switch reaches its home position, contacts QSS2 separate to interrupt the stepping circuit. Similarly a circuit for quotient remainder stepping switch coil QRSS can be traced from line W1, through coil QRSS; contacts QRSS1 (also an interruption contacts), contacts QRSS2, SEL2, and REL2 to line W2. When switch QRSS reaches its home position, contacts QRSS22 separate to interrupt the stepping circuit. A circuit for search relay coil SE is thereupon completed from line W1, through coil SE, contacts QSS3, QRSS3, SEL5, and REL7 to line W2. Energization of coil SE causes contacts SE2, SE3, SE5, SE7, SE8, SE10, SE11, SE13 and SE15 to engage and contacts SE1, SE4, SE6, SE9, SE12 and SE14, to separate. It is to be observed that the making contacts SE7 engage before the breaking contacts SE4 separate; the remaining contacts operating in a normal manner i.e. the breaking contacts separate before the making contacts engage. Engagement of contacts SE7 provide a self-holding circuit for coil SE which can be traced from line W1, through coil SE, parallel contacts QS1 and QRS1, and contacts SE7 to line W2. Separation of contacts SE1 interrupts the circuit for coil SSA and as a result thereof contacts SSA1 separate to deenergize coil SSAX. Contacts SSAX1 separate to deenergize coil SHSS and advance the stepping switch one position, at the same time engaging contacts SHSS1. It is still assumed that contacts SE1 are separated so that continued stepping of switch SHSS is prevented. This assumption is only made to permit description of other circuit operations which occur simultaneously to those just outlined. Engagement of contacts SE5 complete a charging circuit for capacitor QI (FIG. 22) from line W1, through resistor RI which limits the initial inrush current to the capacitor, contacts SE5 and capacitor QI to line W2. Separation of contacts SE4 interrupts the circuit for end-of-line relays REL and SEL, thus returning these relays to their normal or deenergized position.

A review of FIG. 21, which schematically represents the coded tape, shows that although the scan head stepping switch SHSS has advanced one position, there are no perforations to represent a coded signal and consequently none of the quotient or quotient remainder switches S27 to S35 will be operated nor will the quotient relays 1Q to 4Q or the quotient remainder relays 1QR to 5QR be energized. Therefore, all of the contacts in contact tree circuits associated with the quotient stepping switch QSS and the quotient remainder stepping switch QRSS will be in their normal positions as shown in the wiring diagram. Although a circuit for quotient remainder stepping switch coil QRSS will be completed from line W1, through coil QRSS interrupter contacts QRSS1 and contacts SE2, the coil will not be energized to cause stepping of the switch insofar as a short circuit exists around the coil. The latter circuit being traced from line W1, through contacts JI2, 4QR1, contacts QRSSC1, brush QRSSB, rectifier QRRF, to interrupter contacts QRSS1. A circuit is also completed from line W1, through contacts JI2, contacts 4QR1, and coil OQR to line W2 to energize zero quotient remainder relay OQR and thus engage contacts OQR1 and separate contacts OQR2. In addition, a further circuit is completed from line W1, through contacts JI2, contacts 4QR1, contacts QRSSC1, brush QRSSB, and coil QRS to line W2, thus energizing quotient remainder stepper relay QRS and separating contacts QRS1.

Similar to the above circuits are those associated with the quotient stepping switch QSS. Although a circuit is completed for quotient stepping switch coil QSS from line W1, through coil QSS, interrupter contacts QSS1 and contacts SE8 to line W2, the coil QSS is not energized to cause the switch to step insofar as the coil is shorted out. The short circuit may be traced from line W1, through contacts JI2, 1Q1, 2Q1, 3Q1, 4Q1, contact QSSC2, brush QSSB2, contacts QQR1, rectifier QFR, to interrupter contact QSS1. A circuit is also completed for quotient stepper relay coil QS from line W1, through contacts JI2, 1Q1, 2Q1, 3Q1, 4Q1, contact QSSC21, brush QSSB2, contacts OQR1, and coil QS to line W2, thus separating contacts QS1. Separation of contacts QS1 and QRS1 interrupt the self-holding circuit for coil SE. Deenergization of coil SE separates contacts SE5 to disconnect charged capacitor QI from the power supply and engagement of contacts SE6 completes a circuit to permit the capacitor to discharge through interlock switch coil I to pulse the switch to its energized position thus engaging contacts I1. Engagement of contacts I1 initiates stepping interline space stepping switch by completing a circuit for interline space stepping switch coil ISSS, which circuit is traced from line W1, through contacts I1, coil ISSS, and contacts ISS2 to line W2. Immediately the switch steps one position to engage contacts ISSS2 which remain engaged until the switch again reaches its home position. Contacts ISSS2 are connected in parallel with contacts I1 and it is therefor required that relay I remain energized only long enough for the interline space stepping switch to advance one position to engage contacts ISSS2. Energization of coil ISSS also closes contacts ISSS3 to complete a circuit for interline space stepping relay coil ISS, the circuit being traced from line W1, through contacts ISSS2, coil ISS and contacts ISSS3 to line W2. Completion of this circuit separates contacts ISS2 to deenergize the circuit for coil ISSS and separate contacts ISSS3. Separation of contacts ISSS3 interrupts the circuit for coil ISS thus engaging contacts ISS2 to complete a circuit for coil ISSS.

It is thus apparent that the relay and the stepping switch are alternately operated and this will continue until the stepping switch again reaches home position, at which time contacts ISSS2 separate to interrupt the circuit to both coils ISS and ISSS. Each time coil ISS was energized, contacts ISS1 engaged to complete a circuit for the read head stepping switch coil RHSS from line W1 through contacts ISS1, coil RHSS and contact REL3 to line W2. Thus, each time interline space stepping switch ISSS advances one position, read head stepping switch RHSS advances one position. The circuit comprising the interline space stepping switch ISSS and the interline space stepping relay ISS, therefore, serves merely to produce electric pulses to step the read head stepping switch past the blank spaces heretofore referred to in describing the perforated tape. As now being considered, the tape will advance over the read head until the second end-of-line signal is in reading position on the read head. The circuit is only operative when the blank spaces are positioned before the read head, and an end-of-line signal is being read by the read head. As will hereafter be seen, a justification signal will be interposed between the end-of-line signal and the blank spaces. Although a complete cycle for the interline space stepping switch operation has been described, it is to be understood that the following circuit sequences occur before the cycle is completed.

It has been shown that the advance of the tape through the read head followed directly upon deenergization of search relay SE and the separation of contacts SE5 and the engagement of contacts SE6. Although the description covered a considerable movement of tape over the read head, it is of course understood that the tape was being simultaneously advanced over the scan head, the advance also being directly attributed to the deenergization of search relay SE and the resulting engagement of contacts SE1. Engagement of contacts SE1 completes a circuit for relay SSA from line W1, through switch S1, coil SSA, contacts SE1, and SHSS1 to line W2. It will be remembered that contacts SHSS1 had previously engaged. Energization of coil SSA engages contacts SSA1 to complete a circuit for coil SSAX. Contacts SSAX1 complete a circuit for coil SHSS and the relay is moved to energized position and contacts SHSS1 separate to deenergize coil SSA. The circuit operation for advancing the tape over the scan head is now the same as previously described, and, as before, the advance will continue until the next end-of-line signal (i.e. the third signal in the tape) is brought to reading position on the scan head and scan end-of-line relay SEL is again energized to engage contacts SEL1 to stop stepping of the scan head stepping switch.

At the instant that the third end-of-line signal is on the scan head and the second end-of-line signal is on the read head, the identical circuit conditions as above set forth with regard to the relays in energized positions prevails. However, instead of blank spaces appearing on the tape positioned between the two heads as before, now in addition to the blank spaces, a number of signals representing the characters which go to make up the first line to be photocomposed are positioned between the heads. In addition, just beyond the scan head and to be decoded when the scan head stepping switch is advanced one position, is a justification signal. Moreover, stepping switches QSS and QRSS are in the home position.

Before proceeding to a further description of the electric circuits, the significance of the terms quotient and quotient remainder as referred to in the circuits presently under consideration will be explained. The complete significance of the terms will be apparent as the Width Information Circuits are hereafter considered.

When information is being reproduced on a typewriter, there is a normal or standard spacing between words and there is a space between the last word and the right-hand margin, a so-called marginal space. To provide a justified line of the reproduced information, it is desirable to divide the space at the right-hand margin equally among the spaces between the words. In the present machine, a full or justified line comprises a fixed number of unit spaces. The width of each character to be reproduced comprises a number of unit spaces (it will differ among different characters) and the standard word space comprises a number of unit spaces. It is apparent that with standard word spaces between each word, the space remaining at the right-hand margin will comprise a number of unit spaces (equal to the number of unit spaces in a justified line minus the number of unit spaces taken up by the characters in the line and the number of unit spaces taken up by the normal word spaces between words), and that the number of unit spaces in this space may not be divisible by the number of word spaces to produce a whole-number quotient. Thus, for example, if the margin space is forty-seven (47) units and there are six (6) word spaces, the quotient will be a mixed number i.e. 7⅚. Insofar as there is a unit space whereby measurements are made, it is not desirable to attempt to increase each word space by 7⅚ unit spaces. The division of the margin space, in the above example, is then allocated as follows. Each of the first five word spaces is increased by seven plus one (or eight) unit spaces, and the remaining word space is increased by seven unit spaces. In this example, the quotient is seven and the quotient remainder is five. The concept of quotient and quotient remainder will be clearer later on but it will suffice for now to know that the tape is perforated to provide a justification signal and that this signal will comprise a quotient and quotient remainder signal.

The mechanism for "storing" the justification information after it is decoded is the quotient stepping switch QSS and the quotient remainder stepping switch QRSS. It will be recalled that quotient stepping switch QSS is a multi-level switch and it is this switch which indicates the number of unit spaces which are to be added to the normal interword spacing to produce a justified line. In counting the number of spaces to be added to the normal word spacing, a binary system of numbers is used. Hence, one contact level, e.g. the level containing contact QSSC31 (see FIG. 26) is assigned the value one (1); a second contact level, e.g. that containing contact QSSC41, is assigned the value two (2); a third contact level, e.g. that containing contact QSSC51, is assigned the value four (4); and a fourth contact level, e.g. that containing contact QSSC61, is assigned the value eight (8). It is apparent from FIG. 26 that when the switch is stepped such that the brushes are on the contacts nearest the top of the sheet, they will complete circuits representing the value of one plus two or three. As the brushes are stepped downwardly, they successively complete circuits representing the values four, five, etc., up to and including twelve. These circuits lead to the electronic counter (FIG. 27) which in turn leads to the Time Sequence Circuit and hence will be considered hereafter.

To return to the conditions set forth above, with an end-of-line signal in decoding position on both scan and read heads, a circuit is completed for coil SE from line W1, through coil SE, contacts QSS3, QRSS3, SEL5 and REL7 and line W2; contacts SE2, SE3, SE5, SE7, SE8, SE10, SE11, SE13 and SE15 engaging and contacts SE1, SE4, SE6, SE9, SE12 and SE14 separating. Separation of contacts SE1 deenergizes coil SSA to ultimately deenergize coil SHSS and advance the scan head stepping switch one position, to bring the justification signal into reading position on the scan head. It will now be assumed thatt he signal comprises perforations to cause actuation of switches S28, S29, S27, S32, and S35 (FIG. 24). Switch S28 completes a circuit for coil 1Q to engage contacts 1Q2 and separate contacts 1Q1. Switch S29 completes a circuit for coil 2Q to engage contact 2Q4. Switch S27 completes a circuit for coil 1QR to engage contacts 1QR2, 1QR4, 1QR6, 1QR8 and 1QR10 and separate contacts 1QR1, 1QR3, 1QR4, 1QR7 and 1QR9. Switch S32 completes a circuit for coil 2QR to engage contact 2QR10, and switch S35 completes a circuit for coil 5QR to engage contact 5QR2.

Engagement of contacts SE9 completes a circuit for quotient stepping switch coil QSS from line W1, through coil QSS, contacts QSS1 and SE9 to line W2. Switch QSS immediately starts to step and will continue to do so until brush QSSB1 engages contact QSSC15, at which time a circuit from line W1, through contacts JI2, 1Q2, 4Q7, 3Q5, 2Q4, contact QSSC26, QSSC15, brush QSSB1, contacts OQR2 and rectifier QRF to ocntact QSS1 short circuits coil QSS, thus preventing further stepping of the switch. A circuit for quotient stepper relay QS is also completed to separate contacts QS1. The circuit is traced through the relay tree and includes the contacts used to short circuit coil QSS.

Engagement of contacts SE2 similarly completes a circuit for quotient remainder stepping switch coil QRSS from line W1, through coil QRSS, contacts QRSS1 and SE2 to line W2. Immediately, switch QRSS starts to step and it will continue to do so until brush QRSSB engages contact QRSSC19, at which time a circuit from line W1, through contacts 5QR2, 3QR11, 2QR12, 1QR6, contact QRSSC20, brush QRSSB and rectifier QRRF to contacts QRSS1 and contacts SE2 short circuits coil QRSS to prevent further stepping of the switch. A circuit for quotient remainder stepper relay QRS is also completed to separate contacts QRS1. This latter circuit is traced through the relay tree and includes the contacts which short circuit coil QRSS.

In the example given above, in which the first five normal word spaces will be increased by eight unit spaces and the remaining word space by seven units spaces, the justification signal was such that the quotient stepping switch stepped until the brushes made contact to complete a circuit representing the value eleven i.e. three plus eight. The quotient remainder stepping switch stepped until its brush made contact five spaces short of its home position.

Separation of contacts QS1 and contacts QRS1 interrupts the holding circuit for coil SE and the search relay thereupon returns to its deenergized position, engaging contacts SE1, SE4, SE6, SE9, SE12 and SE14 and separating contacts SE2, SE3, SE5, SE7, SE8, SE10, SE11, SE13 and SE15. Engagement of contacts SE9 completes a circuit for coil J1 (contacts SE16 had engaged when relay SE was energized to interrupt the circuit for scan end-of-line relay coil SEL), thus causing contacts JI1 and JI2 to separate and contacts JI3 to engage. Contacts JI2 interrupt the circuit for coil QS to engage contacts QS1.

Return of search relay SE to its deenergized state and the engagement of contacts SE1 cause scan head stepping switch to step as before described. The switch will step to advance the tape over the scan head until the next end-of-line signal appears in reading position, at which time the switch will stop stepping. The engagement of contacts SE6 causes the interline space stepping switch to step as before described. When the switch reaches its home position and contacts ISSS2 separate, the read head stepping switch will have stepped until the first character signal is in reading position on the read head. At this time, the circuit for read head stepping switch coil RHSS is deenergized and contacts RHSS1 and RHSS2 engage and the perforations representing the signal for the first character are then in position to actuate any of the switches S3 through S16. Engagement of contacts RHSS1 completes a circuit for read head function decoder gate relay coil RFDG from line W1, through coil RFDG, and contacts RHSS1 to line W2. As a result contacts RFDG1 engage.

It will be assumed, referring to FIG. 9, that the first signal is that for a character to be photographed and that the character is found in the position indicated as 173. In the binary shutter scheme, this means that shutters assigned the binary values 128, 32, 8, 4 and 1 will be actuated as before explained. The tape will be punched for this character so that switches will be actuated to operate the shutters. In the arrangement disclosed, switch S10 first completes a circuit for eighth read head function decoder relay coil 8RFD from line W1, through switch S10, coil 8RFD and contacts RFDG1 to line W2 thus separating contacts 8RFD1. Switch S8 similarly completes a circuit for sixth read head function decoder relay coil 6RFD and contacts 6RFD1 separate. Circuits for the fourth, third and first read head function decoder relay coils 4RFD, 3RFD and 1RFD are similarly completed by operation of switches S6, S5 and S3 respectively. Contacts 4RFD2, 4RFD4, 4RFD6, 4RFD8, 4RFD10, 3RFD2 3RFD4, 3RFD6, 3RFD8 and 1RFD2, thereupon engage and contacts 4RFD1, 4RFD3, 4RFD5, 4RFD7, 4RFD9, 3RFD1, 3RFD3, 3RFD5, 3RFD7 and 1RFD1 separate. Separation of contacts 6RFD1 and 8RFD1 insure that a circuit will not be completed for one of the machine function signals, i.e. end-of-line and line-erase signals, and the non-completion of these circuits "tells" the machine that the signal represents a character to be photographed. It will be noted from FIG. 9 that each of the characters is represented by a binary number exceeding sixteen (16) and consequently if a character is to be photographed, the tape will be perforated to operate at least one of switches S7, S8, S9 or S10 which, as will be seen hereafter, operate the shutters corresponding to the binary numbers 16, 32, 64 and 128, respectively.

After it has been determined that the signal represents a character to be photographed and not a machine function, shutter energizing relay coil SHE is energized (to be considered with the Time Sequence Circuits) to engage contacts SHE1, SHE2, SHE3, SHE4, SHE5, SHE6, SHE7 and SHE8. The engagement of contacts SHE1 completes a circuit for first shutter solenoid holding relay coil 1SSH from line W1, through switch S3, contacts SHE1, coil 1SSH and contacts SHD1 to line W2, thus engaging contacts 1SSH3. Similarly, contacts SHE3 completes a circuit for third shutter solenoid holding relay coil 3SSH from line W1, through switch S5, contacts SHE3, coil 3SSH and contacts SHD1 to line W2, thus engaging contacts 3SSH3. Circuits for coils 4SSH, 6SSH and 8SSH are similarly completed and contacts 4SSH3, 6SSH3, and 8SSH3 are closed respectively. Engagement of the indicated contacts on the shutter solenoid holding relays completes circuits for the shutter solenoids as follows: contacts 1SSH3 complete a circuit for solenoid L1 from line W1, through contacts 1SSH3 and solenoid L1 to line W2; contacts 3SSH3 complete a circuit for solenoid L3 from line W1, through contacts 3SSH3 and solenoid L3 to line W2; contacts 4SSH3 complete a circuit for solenoid L4 from line W1 through contacts 4SSH3 and solenoid L4 to line W2; contacts 6SSH3 complete a circuit for solenoid L6 from line W1, through contacts 6SSH3 and solenoid L6 to line W2; and contacts 8SSH3 complete a circuit for solenoid L8 from line W1 through contacts 8SSH3 and solenoid L8 to line W2. Energization of the shutter solenoids as explained will operate the shutters to expose the character represented by the numeral 173 in FIG. 9. At the same time that switches S3, S5, S6, S8 and S10 (FIG. 22) are operated to energize shutters to expose a character, switches S11 to S14 (FIG. 26) will be operated singly or in combination to signal the character width for the exposed character. The function of these latter switches, S11 to S14, will be more fully explained when the Width Information Circuits are considered. For the time being, it will be assumed that the light source had been flashed when the character was exposed and the character thereby photographed on the film.

In the arrangement described, push button type starting button S38 is depressed to start movement of the projection lens carriage. The relationship betwen movement of the carriage and flashing of the light source will be considered hereafter. As is shown in the wiring diagram, the carriage drive motor (not shown in the electric circuits) is of the universal type and is connected directly across an alternating current power supply. This power supply is connected to the circuits at the same time that the direct current power supply is connected to the D.C. circuits. With the motor operating, it is only necessary to energize the electric clutch in order that the carriage move. Pressure on push button type starting switch S38 directly completes a circuit for starting relay coil ST to engage contacts ST1 and ST2. The contacts ST2 are connected in parallel with switch S38 to provide a self-holding circuit for the relay. Thereafter shutter deenergizing relay coil SHD is energized to separate contacts SHD1 and read head advance relay coil RA is pulsed to engage contacts RA1. Separation of contacts SHD1 interrupts the circuits for all of the shutter solenoid holding relays and, as a result, all of the shutters revert to their normal position in which all of the characters are shielded from the film. Engagement of contacts RA1 completes a circuit for read head stepping switch coil RHSS and then as coil RA is deenergized (it only having been pulsed) and contacts RA1 separate, the read head steps one position and advances the tape to reading position. Thus the next signal is presented and the character represented thereby is photographed in an operation similar to that described for the first character signal. The read head is thus stepped to intermittently advance the tape and signals representing characters to be photographed to reading position on the head.

After the signals for the characters which go to make up a word, there appears on the tape a signal representing a space between words. This signal consists of a single perforation which actuates the switch S4. Operation of this switch completes a circuit for the second read head function decoder relay coil 2RFD from line W1, through switch S4, coil 2RFD and contacts RFDG1 to line W2, thus engaging contact 2RFD2. Contacts 2RFD2 complete a circuit for quotient remainder advance relay coil QRA, from line W1, through contacts MF1, 8RFD1, 7RFD1, 6RFD1, 5RFD1, 1RFD1, 2RFD2, 3RFD3, 4RFD5 and coil QRA to line W2 to engage contacts QRA1. The contacts remain engaged only as long as the signal remains in reading position on the read head, but when the contacts are engaged, a circuit is directly complete for quotient remainder stepping switch coil QRSS (FIG. 26) and hence when the contacts separate and coil QRSS is deenergized, the stepping switch advances one position. It is clear that each time a signal for a word space appears on the coded tape, stepping switch QRSS advances one step nearer its home position.

In the example cited above to explain justification, brush QRSSB was assumed to be five positions away from its home position so that, consequently, after five word space signals brush QRSSB will have been returned to its home position and switch QRSS is then in its home or normal condition, at which time contacts QRSS2 and QRSS4 engage and contacts QRSS5 separate. Separation of contacts QRSS5 disconnects capacitor QQSU from across lines W1 and W2 from whence it had been fully charged, and engagement of contacts QRSS4 connects the capacitor to quotient subtractor relay coil QSU to permit it to discharge into the coil to pulse relay QSU on and then, as the charge is dissipated, off. The momentary energization of relay QSU engaged contacts QSU1 to directly complete a circuit for quotient stepping switch coil QSS. When the contacts separated, quotient stepping switch QSS advanced one position and its brushes moved from contacts representing one unit space value to contacts representing a unit space value one less than the previous number or in the specific illustrative example, from a value of eleven to one of ten. It is thus apparent that, after eight unit spaces were added to the normal word spacing for the first five word spaces, only seven unit spaces will be added to the last word space in order to produce a justified line.

The photocomposing operation continues until all the characters making up the line are photographed, whereupon the next signal advanced to reading position is an end-of-line signal. The end-of-line signal, as above noted, includes perforations which actuate switches S3, S4 and S6. As before, the end-of-line signal results in read end-of-line relay REL being operated to engage contacts REL1. Engagement of contacts REL1 completes a circuit for forward clutch deenergizing relay coil FCD from line W1, through contacts REL1, coil FCD, contacts BCC1, ST1, and switch S22 to line W2. Energization of coil FCD engages contacts FCD1, FCD2, FCD5, FCD6 and FCD7 and separates contacts FCD3 and FCD4. Separation of contacts FCD3 and contacts FCD4 disconnect the forward drive clutch FC from the power line to stop forward movement of the carriage. Contacts FCD2 and contacts FCD5 complete a circuit for clutch FC of opposite polarity from that previously considered. This circuit is to reduce hysteresis in the clutch and may be traced from line W1, through contacts FCD5, clutch FC, contacts FCD2 and resistance RFC to line W2. Contacts FCD6 complete a circuit for reverse clutch energizing relay coil RCE, which circuit extends from line W1, through contacts FCD6, coil RCE, contacts BCC1, ST1 and switch S22 to line W2. It will be noted that the relay is timed in moving to its energized position in order that the carriage may slow down in its forward movement prior to the reverse clutch being energized. After the time delay, contacts RCE1 engage to complete a circuit for reverse clutch RC, the circuit leading from line W1, through contacts RCD1, RCE1, clutch RC, contacts BCC1, ST1 and switch S22 to line W2. Energization of clutch RC causes the carriage to return to its start-of-line position, at which place start-of-line switch S37 is moved to an operated position. This completes a circuit from line W1, through switch S37, coil RCD and contacts FCD7 to energize reverse clutch deenergizing relay RCD, thus separating contacts RCD1, and engaging contacts RCD2 and RCD3. Engagement of contacts RCD3 completes a circuit for brake clutch clearing relay coil BCC from line W1, through contacts ISSS1, switches S26 and S25, contacts RCD3, SM2, coil BCC, contacts LEH2, SE3 and FCD7 to line W2. Relay BCC is of the time delay type and consequently it is not operated immediately upon its coil being energized. Separation of contacts BCC1 interrupts the circuits for coil FCD, coil RCE, and clutch RC. Deenergization of coil RCD, and the consequent separation of contacts FCD7, interrupts the circuit for coil RCD and coil BCC. Deenergization of coil BCC, and the subsequent engagement of contacts BCC1, sets the carriage for movement in a forward direction, the circuit for forward drive clutch FC being traced as before from line W1, through contacts FD2, FCD3, clutch FC, contacts FCD4, BCC1, ST1, and switch S22 to line W2. It is thus seen that the steps described above for the composition of a line of information can now be repeated for the next line and any lines which follow.

While the projection lens carriage was being returned to the start-of-line position, the circuit sequence, before described, was taking place. That is, an end-of-line signal was in reading position on the read head and an end-of-line was in reading position on the scan head. Read end-of-line relay REL was in energized condition and scan end-of-line relay SEL was in energized condition. A circuit was thereupon completed for the advance of the film in the film holder; the circuit energizing film advance solenoid L9 and being traced from line W1, through solenoid L9, contacts SEL7, REL9 and LEH3 to line W2. The quotient stepping switch QSS and the quotient remainder stepping switch QRSS also step to their respective home positions. Search relay SE was then operated and the scan head stepping switch was advanced to read the justification signal. This signal caused the quotient stepping switch and the quotient remainder stepping switch to step to positions in accordance with the signal given. When the stepping switches QSS and QRSS had reached their justification signal positions, search relay SE was deenergized to permit the scan head stepping switch to step and advance the tape until the next end-of-line signal appeared in reading position on the scan head. Also when relay SE was deenergized, the interline space stepping switch advanced the tape to bring the first character signal into reading position on the read head. The tape was stopped in this position until the carriage had returned to the start-of-line position and started to again move in the forward direction. When the carriage so moved, the first character was photographed in an operation similar to that described above. The photographing of succeeding characters proceeds as above described until the complete line is composed, at which time the complete process is again repeated.

Line-Erase

In addition to the circuits provided for the photocomposing of a line as above set forth, there are numerous other conditions for which provision has to be made. For example, if while the coded tape is being perforated a mistake is detected, provision is made for a line-erase signal to be punched in the tape. When this signal appears in reading position on the scan head in place of the end-of-line signal, only switch S28 is actuated to complete a circuit for energization of coil 1Q. Contacts 1Q2 then engage and contacts 1Q1 separate. Engagement of contacts 1Q2 completes a circuit from line W1, through contacts 5QR1, 1QR1, 3QR1, 2QR1, 1Q2, 4Q7, 3Q5, 2Q3, JI3, coil LE and contacts SE4 to line W2 for line-erase relay coil LE. Energization of coil LE engages contacts LE1 and LE2. Contacts LE1 provide a self-holding circuit for coil LE. Connected in parallel with coil LE by means of rectifier LERF is coil SEL, and consequently coil SEL is energized with coil LE and it also is maintained in an energized state by means of contact LE1.

When the preceeding line has been protocomposed and an end-of-line signal has been advanced to reading position on the read head, and read end-of-line relay REL is energized, the coded information between the two heads is to be "erased" or in other words, disregarded. Therefore, provision is made for advancing the tape rapidly over the two heads until the next end-of-line signal is in decoding position on the scan head and the line-erase signal is in decoding position on the read head. After the erased line has passed over the read head and the next line is ready to be photocomposed, the film advance solenoid is prevented from operating by means of contacts LEH3 which are separated, thus preventing an additional movement of the film, it already having been advanced in preparation for photographing the next line when the line-erase signal was "read" and caused the line to be bypassed.

The energization of the scan end-of-line relay SEL and the read end-of-line relay REL causes contacts SEL2, SEL3, SEL4, SEL5, SEL7, REL1, SEL4 and REL4 to engage. Engagement of contacts REL4 and REL2 and REL2 and SEL 2 causes stepping switches QSS and QRSS to step to their home positions respectively, thus engaging contacts QSS3 and QRSS3 which complete a circuit for search relay coil SE as above described. Energization of coil SE engages contacts SE2, SE3, SE5, SE7, SE8, SE10, SE11, SE13, and SE15 and separates contacts SE1, SE4, SE6, SE9, SE12 and SE14.

The engagement of contacts SE15 completes a circuit for line-erase memory relay coil LEM from line W1, through contacts SE15, LE2, coil LEM, and contacts LEH5 to line W2 and thereby engages contacts LEM1 and LEM2. Contacts LEM2 are connected in parallel with contacts SE15 and LE2 and consequently provide a self-holding circuit for coil LEM. The engagement of contacts SE5 completes a charging circuit for capacitor QI on (FIG. 22).

Separation of contacts SE1 causes the scan head stepping switch to advance one position, but the justification signal read is of no significance and the quotient stepping and quotient remainder stepping switches step to some arbitrary position depending on the "signal." Separation of contacts SE4 interrupts the circuits for coils LE, SEL and REL and these switches revert to their deenergized positions. When relays SEL and REL are deenergized, contacts SEL5 and REL7 separate, thus interrupting the circuit for coil SE. When the stepping switches QSS and QRSS reached the "signal" positions, relays QS and QRS became energized as before described thus separating contacts QS1 and QRS1 and interrupting the self-holding circuit for coil SE. Contacts SE1, SE4, SE6, SE9, SE12 and SE14 now engage and contacts SE2, SE3, SE5, SE7, SE8, SE10, SE11, SE13 and SE15 separate.

Engagement of contacts SE1 (contacts SEL1 being separated) immediately causes the scan head stepping switch to advance the tape until an end-of-line signal is again brought to reading position on the scan head at which time the stepping switch movement is stopped as described above.

Engagement of contacts SE14 completes a circuit for line-erase holding relay coil LEH from line W1, through contacts SE14, coil LEH and contacts LEM1 to line W2 to engage contacts LEH1 and LEH4 and separate contacts LEH2, LEH3 and LEH5. Contacts LEH4 being connected in parallel with contacts LEM1 provide a self-holding circuit for coil LEH. Contacts LEH5, which separate after contacts LEH4 engage, interrupt the circuit for coil LEM to return the relay to its normal position.

Engagement of contacts SE6 permits capacitor QI to discharge into interlock relay coil I to initiate stepping of interline space stepping switch ISSS and read head stepping switch RHSS as above described. Engagement of contacts LEH1 completes a circuit for read head rapid advance relay coil RRA from line W1, through contacts LEH1, coil RRA contacts RHSS2 and REL3 to line W1. Contacts RRA1 thereupon engage to complete a circuit for coil RHSS from line W1, through contacts LEH1, RRA1, coil RHSS and contacts REL3 to line W2. Contacts RHSS2 then separate to deenergize coil RRA and separate contacts RRA1. Separation of contacts RRA1 deenergizes coil RHSS to again engage contacts RHSS2 and complete the circuit for coil RRA. It is thus apparent that the coils RRA and RHSS will be alternately energized, thus stepping the read head stepping switch, until an end-of-line signal is brought into decoding position on the read head and end-of-line relay coil REL is engaged to separate contacts REL3. In this instance, the coded signal will be for line-erase and as was noted before the signal included a single perforation. When this signal arrives at the read head, the circuit for coil REL can be traced from line W1, through contacts RRA2, 8RFD1, 7RFD1, 6RFD1, 5RFD1, 1RFD2, 4RFD9, 3RFD5, 2RFD3, coil REL and contacts SE4 to line W2, the perforation being positioned to actuate switch S3 and consequently complete the circuit for coil 1RFD.

While the coded information already punched in the tape was traversing the read head, switches S3, S4, etc. were being actuated as were the shutters. However, the line-erase holding relay LEH remains energized and contacts LEH2 are separated. This prevents coil BCC from being energized and thus the forward clutch deenergizing relay FCD is energized and a circuit for the forward clutch FC is therefore not completed and the carriage remains in its start-of-line position. Consequently there are no photocell pulses produced and the light source is not flashed to photograph the characters being exposed.

When the end-of-line signal (sic-line-erase signal) is in decoding position on the read head and the next end-of-line signal is in decoding position on the scan head, a circuit for search relay SE is completed to separate contacts SE14 and thus deenergize line-erase holding relay coil LEH and cause the relay return to normal position. Having again reached a point where an end-of-line signal is in reading position on both the scan head and the read head, the machine will proceed to photocompose the next line in the manner previously described.

Quad Left

In addition to the line-erase function, there is another machine function which is to be considered, and that is, the quad-left function. In the type composing art, when the type matter is to be included in only a portion of the available line space, the line is said to be quadded or, in other words, to include a number of blank spaces after the last word composed. Such a condition arises at the end of a paragraph. Under such circumstances, when setting type, the line is not justified. In a photo-composing machine, this means that the spacing between words will be of normal width, i.e. not justified. FIG. 21 indicates that when a line is to be quadded, a quad signal follows the character signals and again there is a meaningless justification signal for that line which latter "signal" is stored in the quotient and quotient remainder stepping switches but is ignored in the remaining circuits through the separation of contacts QUH3.

The quad signal comprises punchings which will actuate switches S28, S30 and S31. When this signal appears in reading position on the scan head, circuits will be completed for quotient relay coils 1Q, 3Q and 4Q respectively. Energization of these coils engages contacts 1Q2, 3Q8 and 4Q8. A circuit can then be traced from line W1, through contacts 5QR1, 1QR1, 3QR1, 2QR1, 1Q2, 4Q8, 3Q8, coil QU and contacts SE4 to line W2 to complete a circuit for quad-left relay coil QU. Contacts QU1 and QU2 thereupon engage. Rectifier QURF and coil SEL are connected in parallel with coil QU and consequently when the circuit for coil QU is completed, coil SEL is also energized to move relay SEL contacts to operated position. As was already noted, when relay SEL is operated the scan head stepping switch SHSS stops stepping and the advance of the tape over the scan head halts.

When photographing of the preceding line is completed, an end-of-line signal is in reading position on the read head and relay REL is energized to stop the read head stepping switch from further stepping. Now, as before, with both the read end-of-line relay REL and the scan end-of-line relay SEL energized, the film advance solenoid L9 is energized to advance the film in the holder. Also, the quotient stepping switch QSS and the quotient remainder stepping switch QRSS return to their home positions. When the switches are in home position, a circuit is completed for search relay coil SE and contacts SE2, SE3, SE5, SE7, SE8, SE10, SE11, SE13 and SE15 engage and contacts SE1, SE4, SE6, SE9, SE12 and SE14 separate. Engagement of contacts SE13 completes a circuit for quad-left memory relay coil QUM which is traced from line W1, through contacts SE13, QU2, coil QUM and contacts QUH5 to line W2; contacts QUM1 and QUM2 engaging. Engagement of contacts QUM2 complete a self-holding circuit for coil QUM, the contacts being connected in parallel with contacts SE13 and QU2.

Separation of contacts SE4 interrupts the circuits for coils QU, SEL and REL, thus returning the relays to their normal or deenergized position. Separation of contacts SE1 causes scan head stepping switch SHSS to step one position. The signal there found, although meaningless, causes the quotient and quotient remainder stepping switches to step to some position in the manner previously described. Thus coils QS and QRS are energized to separate contacts QS1 and QRS1, respectively.

Separation of contacts QS1 and QRS1 interrupts the circuit for coil SE to return relay SE and its contacts to normal position. Engagement of contacts SE12 completes a circuit for quad-left holding relay coil QUH from line W1, through contacts SE12, coil QUH and contacts QUMI to line W2. Contacts QUH1, QUH2 and QUH4 engage and contacts QUH3 and QUH5 separate. Contacts QUH4 complete a self-holding circuit for coil QUH, they being in parallel with contacts QUM1. Contacts

QUH5 interrupt the circuit for coil QUM, thus causing relay QUM to return to normal position. Additional contacts of relay QUH will be found in the Width Information Circuit and will be identified when this circuit is considered. Engagement of contacts SE1 causes scan head stepping switch to step until the next end-of-line signal is brought to decoding position on the scan head, at which time scan end-of-line relay SEL will be energized to halt the stepping switch and the advance of the tape over the scan head. Engagement of contacts SE6 provides a discharge path for capacitor QI to pulse interlock relay coil I and to initiate stepping of the interline space stepping switch ISSS as above described.

As the characters in the quadded line are photographed, contacts RA1 are intermittently operated to cause the read head stepping switch to be stepped. Stepping of the switch continues until an end-of-line signal appears in reading position on the read head, at which time motion of the switch is stopped. An end-of-line signal is now read on both of the heads and any of the above described operations may now be repeated.

Stop Machine

In type composing work, it is often desirable to provide for characters of different point size particularly when new lines are being prepared. In the present machine, the production of filmed images of varying point size is accomplished by changing the optical system, as by varying the distance between the various lens components and by varying the particular lenses in use as heretofore described. To facilitate adjustment of the lens system, provision is made for stopping movement of the projection lens carriage when it arrives at the start-of-line position. A stop machine signal is punched in the tape in position to actuate switches S5 and S6. This signal is punched in place of the end-of-line signal preceding the characters to be filmed in a different point size, and it may be noted that the stop signal is immediately followed by a justification signal.

When the stop machine signal is advanced to decoding position on the read head, a circuit is completed for stop machine relay coil SM from line W1, through contacts MF1, 8RFD1, 7RFD1, 6RFD1, 5RFD1, 1RFD1, 2RFD1, 3RFD2, 4RFD4, coil SM, contacts BCC1, ST1 and switch S22 to line W2. Energization of coil SM engages contacts SM1, SM3 and SM4 and separates contacts SM2. A circuit from line W1, through contacts MF1, 8RFD1, 7RFD1, 6RFD1, 5RFD1, 1RFD1, 2RFD1, 3RFD2, 4RFD4, rectifier SMRF, coil REL and contacts SE4 to line W2 is also completed for coil REL to engage contacts REL1, REL2, REL4, REL5, REL7, REL8 and REL9 and separate contacts REL3 and REL6. By the time the stop machine signal arrived in decoding position on the read head, the next following end-of-line signal had been in decoding position on the scan head and had energized the scan end-of-line relay to stop stepping of the scan head stepping switch. Consequently, when read end-of-line relay REL was energized by the stop machine signal, circuits were completed to cause the quotient and the quotient remainder stepping switches to step to their home positions. The arrival of the switches in the home positions completes a circuit for search relay SE to prepare for the photographing of the next line.

It will be recalled from the foregoing description that contacts REL1 completed a circuit for coil FCD to reverse the direction of movement of the projection lens carriage and return it to the start-of-line position. In addition to contacts REL1, contacts SM1 also complete a circuit for coil FCD. The reversing of carriage motion from the forward to the reverse direction is accomplished through the circuit sequence previously described. However, with the stop machine signal being read, relay SM is energized and contacts SM2 separated. These contacts prevent coil BCC from being energized. Nonenergization of coil BCC and the continued engagement of contacts BCC1 prevents the deenergization of coil FCD and consequently the forward drive clutch cannot be energized. Therefore the carriage remains in the start-of-line position until the circuit for coil FCD is interrupted, as by pressure on push button type restart switch S22. The resulting deenergization of coil FCD starts the carriage in a forward direction as previously described. While the carriage was stopped in its start-of-line position, the machine operator may make any desired adjustments in order to, for example, change the point size setting for the lenses. Also, while the carriage was halted, circuits were operated to cause the scan head stepping switch to step and advance the tape to the next end-of-line signal; the justification information being read and stored after the scan head stepping switch advanced the tape one position from its original stopped position. At the same time, the interline space stepping switch ISSS is stepped to cause read head stepping switch to advance the tape to bring the signal representing the first character of the new line to decoding position on the read head. The read head will not, however, be automatically stepped until the carriage begins its movement in a forward direction as by the pressure on restarting switch S22. After the desired adjustments are made, the restarting switch is depressed, deenergizing coil FCD so that when switch S22 recloses, the carriage is again moved in a forward direction and photographing of successive characters takes place in a manner similar to that previously described.

Safety Switches

It is apparent from the wiring diagram that operation of read head no-tape switch S24 will operate coil SM in the same manner that stop machine signal energized the coil. Also safety switch S36, which operates when the projection lens carriage reaches its extreme end-of-line travel, will complete a circuit for stop machine relay coil SM to return the carriage to the start-of-line position and stop further movement thereof until the restart button is actuated. Film magazine and film advance safety switch S25, which operates when the film is being advanced in the holder, and out-of-film switch S26, which operates when the film in the magazine is exhausted, are connected in series with brake clutch clearing relay coil BCC so that if either of the two conditions under which the switches operate arises, the BCC coil circuit is prevented from being energized and the projection lens carriage will again be stopped after it returns to its start-of-line position.

Font Change

In describing the machine components, reference was made to FIG. 1, wherein was shown a rotatable font plate comprising five fonts of characters; the reason for the plurality of fonts being that in composing type for printed information it may be desirable to change from one style of type face to another, e.g., from standard text type to bold face type or to italics, and the characters of one style of type are located in a single font. The range of type styles may exceed the number disposable on one font plate and thus a plurality of font plates may be associated with each machine. In such case though, the font plates are manually interchanged. The present description will cover the automatic change from one font to another on the font plate.

The font change signal is punched in the tape, similarly to the stop-machine, line-erase, end-of-line, etc. signals, and it is therefore "read" by the operation of combinations of read head function decoder relays 1RFD to 8RFD. The machine will start with one font in photographing position and it is immaterial for purposes of this description which font is so positioned. It will now be assumed that it is desired to change fonts, and that the signal representing the next font from which characters will be photographed is advanced to reading position on the read head. It will be further assumed that the selected font is to be font #4; the signal for which comprises punchings which will actuate switches S3 and S6. Operation of these switches will complete circuits for first and fourth read head function decoder relay coils 1RFD and 4RFD respectively, thus engaging contacts 1RFD2 and 4RFD10. Contacts 1RFD2 and 4RFD10 complete a circuit for font #4 relay coil 4F from line W1, through contacts MF1, 8RFD1, 7RFD1, 6RFD1, 5RFD1, 1RFD2, 4RFD10, 3RFD7, 2RFD7, coil 4F and contacts FCC1 to line W2. Energization of the coil causes contacts 4F1 and 4F2 to engage. Contacts 4F2 complete a self-holding circuit for the coil from line W1, through contacts 4F2, coil 4F and contacts FCC1 to line W2. A circuit is also completed for font change drive control relay coil FD and output pulse simulator relay coil OPS at the time the circuit for coil 4F is completed. The circuit for coils FD and OPS are from the common point between coil 4F and contacts 2RFD7 through rectifier 4FRF and coils FD and OPS (the coils being in parallel) and contacts FCC1 to line W2. Contacts FD9 complete a self-holding circuit for coils FD and OPS, they being connected therefrom to line W1. It will be noted from the diagram that each time a font relay coil is energized a circuit similar to that just traced will be completed for coils FD and OPS.

Before energization of coil OPS, contacts OPS1 and OPS2 completed a circuit for capacitor QOPS across lines W1 and W2, thus maintaining the capacitor in a fully charged state. Resistor ROPS is simply a current limiting device to control the charging current of the capacitor. Upon contacts OPS1 and OPS2 separating and contacts OPS3 and OPS4 engaging, the fully charged capacitor is disconnected from lines W1, W2 and connected between ground and terminal XI (FIG. 29) to discharge through the electronic circuits and thereby simulate a counter output pulse to advance the tape over the read head to bring the next character signal to decoding position. The pulsing circuit for advancing the tape will be considered hereafter.

Contacts FD2 separate to interrupt the circuit for forward clutch FC, thus disconnecting the projection lens carriage from its motor driven source. At the same time contacts FD4 and FD6 separate to interrupt the circuit for energizing the brake circuit for a dragging brake, and contacts FD3 and FD5 engage to complete a circuit from line W1, through contacts FD3, brake coil BR, contacts FD5, BCC1, ST1 and switch S22 to line W2. This latter circuit energizes the brake coil so that full brake force is exerted. Contacts FD8 complete a circuit for energization of font change control solenoid L10 to remove the detent holding the font plate in position (see dotted lines in FIG. 4) and permit the font plate to rotate freely under the influence of the font drive motor. Contacts FD1 complete a circuit for the energization of the shaded pole font drive motor and consequently the font plate rotates to bring the selected font into position whereby the characters thereon can be photographed. When the font reaches its desired position, switch S20 operates to complete a circuit for font change completed relay coil FCC from line W1, through switch S20, contacts 4F1, coil FCC and contacts FD7 to line W2. The resulting separation of contacts FCC1 interrupts the circuit for coils 4F, FD and OPS which in turn interrupt the circuits for the font drive motor, the font change control solenoid L10 and the font change completed relay FCC. The font change circuits are in their normal condition and the photographing of the line can continue until it is again desired to change the font, at which time a new tape signal will be advanced to reading position on the read head and the newly selected font will be rotated to photographing position through energization of circuits similar to those above, the only change being in the particular circuit through the relay tree and the font relay coil.

Width Information Circuits

In the preceding section, the electrical mechanism for reading the coded tape, actuating the shutters to expose a font character, operate the projection lens carriage and perform other sundry machine functions, was considered in detail. It further was pointed out that the extent of movement of the projection lens carriage was measured by the number of times the light beam between the photocell tube and its light source was interrupted, as by the passage of the grid plate carried by the carriage. The present section will present the circuits which interrelate the shutter and tape advance sequence operations and the flashing of the light source to photograph an exposed character.

Before proceeding to the detail description of the circuits, attention will be directed to that portion of FIG. 26 marked "to counter" and to which reference is now made. Perusal of these circuits will manifest the following three parallel circuits:

(*a*) A circuit from B+ through any combination of character width switches S11, S12, S13 and S14 to the counter.

(*b*) A circuit from B+ through the serially connected contacts 8SSH2, 7SSH2, 6SSH2, 5SSH2, 4SSH2, 3SSH2, 2SSH2 and 1SSH2 to contacts QUH3 and the contacts and brushes of the quotient stepping switch QSS (depending on the position of the stepping switch as above described) to the counter.

(*c*) A circuit from B+ through the serially connected contacts 8SSH2, 7SSH2, 6SSH2, 5SSH2, 4SSH2, 3SSH2, 2SSH2 and 1SSH2 to contacts QUH1 and QUH2 to the counter.

(*d*) A circuit from B+ through any combination of unit space switches S15 and S16 to the counter.

Each of the leads to the counter is assigned a binary value as shown and, consequently, when a circuit is completed to the counter through one of the above enumerated circuits, the circuit represents a certain numerical value. The significance of this value will now be explained.

When composing a line of type photographically, in accordance with the present invention, every character reproduced and every interword space in the line has a numerical value associated therewith which is equivalent to the width of the character or to the width of the interword space. Each character is of a particular width, which is constant, and the character width can therefore be coded and the width information placed on the coded tape together with the character information. Circuit (*a*), above described, is the means whereby the character width information is transmitted to the counter circuits. As is apparent, this information may represent any value from one to sixteen, even though in general the narrowest character, e.g. "*i*," will have a width value of three, and the widest character, e.g. "W," will have a width value of twelve.

Circuit (*a*) may also be used independently of a character identification signal to provide a thin space, an en space or an em space by perforating the tape to complete circuits to the counter having values of three unit spaces, six unit spaces and twelve unit spaces respectively. This is particularly useful when it is desired to indent the composed text matter as in the first line of a paragraph.

The interword space width, rather than being a constant value as are the character widths, is a varying quantity, the value of which is determined to produce a justified line. Even so, as heretofore noted, the interword space may even vary within one line. Circuit (*b*) is the means whereby the interword space width information is transmitted to the counter circuits. Included in the circuit are contacts and brushes of quotient stepping switch QSS. It is the position of these brushes on the contacts which determines the width value information transmitted to the counter. It was above described how the justification information on the coded tape actuated the quotient stepping switch to cause it to assume a position which results in a justified line. The interword space width may be of any value from three to twelve.

In the composition of a line, the two circuits above referred to would ordinarily be sufficient to provide information to the counter insofar as the information transmitted by such circuits includes character width information and interword space information, which information is sufficient to complete a line. However, when a line is quadded, the interword space is not increased as in justifying, but is maintained at a normal or standard value. Circuit (*c*) provides for the interword space information in a quadded line to be directed to the counter. It will be noted that circuit (*c*) is traced through the circuit of serially connected contacts, which immediately indicates that a space is being provided for. The previous discussions with reference to the relay circuits disclosed that when a line is to be quadded, quad-left holding relay QUH is energized, engaging contacts QUH1 and QUH2 and separating contacts QUH3. Separation of contacts QUH3 interrupts the circuit through quotient stepping switch QSS contacts and brushes, and engagement of contacts QUH1 and QUH2 completes a circuit to transmit the value three to the counter for an interword space in a quadded line, three being the width value of a normal or standard interword space.

In typographical work it often is desired to letterspace characters either for typographical layout reasons or to justify a line in which there are not sufficient interword spaces to permit justification through normal means and therefore circuit (*d*) above is resorted to to provide letterspacing. In this connection provision is made for either one or two unit spaces to be inserted between characters. The means for accomplishing letterspacing are internal to the counter and consequently a detail description thereof will not be given. However, it can be considered generally. If it is desired to letterspace two characters, it is obvious that the first character must be produced, or in the present photocomposing machine, photographed, and the second character photographed in spaced relation thereto. The two characters are represented herein by two successive signals on the tape and the amount of spacing between the characters is represented by a "signal" opposite the second character signal. In providing the mechanism to decode the tape signals in the read head, the unit space decoding switches S15 and S16 are positioned such that they are operated when the first character signal is being decoded. (See FIG. 20.) The unit space information is introduced to the counter and utilized in a manner illustrated by the following example. Assume the first character already photographed and the second character to have a set width of seven units. Further assume that the letterspacing is to be two units. With this information in the counter, the counter output pulse and consequently the flashing of the source of light for the second character does not occur until after the carriage has traversed nine unit spaces after photographing of the first character.

Time Sequence Circuits

The preferred arrangement for carrying out the present invention includes mechanism, heretofore described, for exposing a single character at a time to be photographed, mechanism including a continuously moving carriage for causing the consecutively exposed character images to be disposed adjacent one another on the film, and a source of light for illuminating the characters to image them on film and so photograph them. The carriage is provided with a grid plate which causes a beam of light in a photocell unit to be intermittently interrupted as the carriage moves continuously past the photocell unit. Each time the carriage moves a unit distance, the light beam is interrupted and the photocell unit produces an output voltage pulse. It has been stated above that each character to be photographed has a characteristic width associated therewith and each interword space has a particular width associated therewith. Each of these widths is in terms of a unit distance, e.g. the value three for the character "i" means that this character is three unit distances wide. Thus, assuming that the character "i" is to be the first one photographed, the shutters are actuated to expose the letter, the carriage is caused to move and when it has traversed three unit distances, the source of light is flashed and the character is photographed. The carriage moves at a continuous speed, and, assuming the next character to have a characteristic width of seven, the character will be exposed by the shutters and when the carriage traverses seven unit distances after the letter "i" was photographed, the source of light is again flashed to photograph the second character. The process is continued until the complete line is photographed. It is to be kept in mind that the carriage moves at a continuous speed, without interruption, from its start-of-line position to its end-of-line position.

The mechanism whereby the above described desired results are accomplished by the preferred embodiment of the invention will now be disclosed. An electronic counter (FIG. 27) is utilized to compare the width information which is transmitted thereto as above set forth with the travel of the carriage and when the value of the width information corresponds with the number of unit distances traversed by the carriage, the counter produces an output voltage pulse which triggers the flashing of the light source to photograph an already exposed character. The voltage pulse also initiates stepping of the read head stepping switch to bring the next coded tape signal into reading position on the head and to deenergize the shutters and prepare them for exposing the character next to be photographed.

FIGS. 28 and 29, to which reference is now made, disclose the electronic control circuits to which the counter output voltage pulse is fed. Portions of the circuits are well known in the electronic art and they are consequently shown but will not be referred to in the description. This is particularly so with regard to filament heater circuits, transformers and rectifier tubes.

In the electronic circuits to be described, the various resistors, capacitors and inductors have the following values which have been found satisfactory.

Resistors:

R1	megohms	1
R2	ohms	100
R3	do	100
R4	do	5,000
R5	do	150,000
R6	megohms	1
R7	ohms	47
R8	do	47
R9	do	68,000
R10	megohms	1
R11	do	1
R12	do	1
R13	ohms	270,000
R14	do	33,000
R15	do	62,000
R16	do	22,000
R17	do	220,000
R18	do	10,000
R19	megohms	5.5
R20	ohms	62,000
R21	do	22,000
R22	do	220,000
R23	do	10,000
R24	megohms	5.5
R25	do	1
R26	ohms	62,000
R27	do	22,000
R28	do	220,000
R29	do	10,000

Resistors—Continued

R30	megohms	5.5
R31	do	1
R32	do	1
R33	ohms	50,000
R34	megohms	6.2
R35	ohms	12,000
R36	do	39,000
R37	do	470,000

Capacitors:

CQ1	mfd	14
CQ2	mfd	8
CQ3	mfd	.02
CQ4	mfd	1
CQ5	mfd	.01
CQ6	mfd	.01
CQ7	mfd	.01
CQ8	mfd	.005
CQ9	mmfd	50
CQ10	mfd	.01
CQ11	mfd	.02
CQ12	mmfd	50
CQ13	mfd	.01
CQ14	mfd	.01
CQ15	mfd	.02
CQ16	mmfd	50
CQ17	mfd	.01
CQ18	mfd	2
CQ19	mfd	.5
CQ20	mfd	.01
CQ21	mfd	8

Inductors:

L1	henrys	16
L2	do	20

Electron tubes:

RF	Two type 5557
HRF	Type 816
CT	Type 816
PS	Type 504
VC	Type 6AS7
GB	Type 6AU6
BD	6H6
TT	Type 12AU7
TSHD	Type 12AU7
TSHE	Type 12AU7
TRHA	Type 12AU7
BDI	Type 6H6
TLST	Type 2050
VR1–VR7	Type 0A2
VR8	Type 5651

The circuits are all supplied from an alternating current source which leads, by lines L1 and L2, directly to knife switch KS. Fuses FS are provided to protect against overloads which might otherwise damage the equipment. A mechanically actuated safety switch SS is also provided to disconnect the circuits from the power source in the event that the door of the cabinet in which the electronic equipment is mounted is opened. In this manner, all the high voltages which would otherwise be present on various components are removed. A toggle-type by-pass switch BP is, however, provided in order to permit servicing of the machine. The circuit then extends to a time delay circuit unit, the purpose of which is to prevent power being applied to the plate circuit of the mercury vapor tubes which form the full wave power rectifier RF until the mercury therein vaporizes. The time delay unit comprises a coil TDC connected across lines L1 and L2 and which is consequently energized when knife switch KS is closed. Approximately one minute after energization of the coil, contacts TDC1 engage to connect the rectifier transformer TRF to lines L1 and L2. Also connected to lines L1 and L2, but immediately preceding the contacts TDC1, is filament transformer TF by which the filaments F of the rectifier tubes are heated to vaporize the mercury. Engagement of contacts TDC1, in addition to energizing transformer TRF, also energizes capacitor discharge relay coil CD to separate contacts CD1 and energizes voltage relay coil V to engage contacts V1. Engagement of the latter contacts connects circuits, hereafter to be considered, to the power supply. A pilot lamp PL is provided to visually indicate that the alternating current source is connected to rectifier transformer TRF.

The output circuit of rectifier RF includes capacitor QLS and the light source lamp electrodes LSP and LSK. As will later be seen, when the light source lamp is triggered, the rectifier will have been disconnected therefrom and the illumination energy will be solely that supplied from capacitor QLS. The rectifier, therefore, will immediately begin to charge capacitor QLS when contacts TDC1 engage. In order to control the light energy emitted by the light source lamp and thus control the exposure of the character being photographed, it is desirable to charge the capacitor to a fixed voltage under all circumstances and thereby insure that the energy stored in the capacitor be a fixed value. The rectifier output voltage exceeds the desired capacitor voltage, e.g. 1,000 volts, by many hundreds of volts but a regulator is provided to bias the rectifier to cut off when the capacitor voltage reaches 1,000 volts.

Connected to one terminal of transformer TRF secondary is half wave rectifier HRF which supplies a half wave voltage of approximately 2,000 volts to filter FIL. The filter output leads to the serially connected voltage regulator tubes VR1, VR2, VR3, VR4, VR5, VR6 and VR7. Each of the tubes is rated at 150 volts and consequently the group of them provides a regulated voltage of 1,050 volts at terminal VRT. To this terminal is connected the cathode of cut-off tube CT which is therefore maintained at a potential of 1,050 volts. It is obvious that the plate of tube CT is connected through resistor R1 to capacitor QLS and the plate will have a potential applied thereto equal to the voltage across the capacitor. When this voltage (plate voltage) exceeds 1,050 volts, tube CT begins to conduct current and there is a resulting voltage drop across resistor R1. The voltage drop reduces the grid potential of the rectifier RF tubes below that of the cathode potential and the rectifier is biased to cut-off. The capacitor QLS is charged to full voltage and it is connected across the plate-cathode circuit of the light source lamp. When the light source lamp is triggered, the lamp becomes conducting and the capacitor will dissipate its charge in the lamp to provide the illumination requirements for photographing of a character. It was noted before that the light requirements differ when two different point sizes are produced on film. To provide for the various point sizes which it is contemplated to produce on this machine, capacitor QLS is made a variable and its value of capacitance at any one time will be dependent on the point size image being filmed.

FIG. 29, which details the trigger circuit for lamp LS, includes a direct current power supply comprising a rectifier transformer TPS and a full wave rectifier tube PS. The output of tube PS is fed to an L-type filter which reduces the ripple of the output voltage. To regulate the voltage and maintain it approximately constant under various load conditions, there is provided voltage control tube VC and its associated circuit including grid bias tube GB. The plate-cathode circuit of tube VC is serially connected in the positive power line. It is obvious that the flow of current through tube VC can be regulated by exercising control over the grids VCG of tube VC. The regulatory action of the tube can be understood as follows: As the B+ voltage decreases from its desired value, the voltage drop across resistor R5 decreases to decrease the potential of grid GBG. The cathode potential is maintained at a constant value by voltage regulator tube VR8 and consequently by decreasing the grid potential, the plate current is decreased. Decrease of the plate current results in a decrease of the voltage drop across resistor R6, thus bringing the potential of grids VCG nearer to the cathode potential of tube VC. If it is assumed that the original grid bias was negative, reduction of the bias voltage results in an increase of current in the plate-cathode circuit to restore the B+ voltage to its desired value. On the other hand, if the B+ voltage increases beyond its desired value, the regulatory action of tube VC reduces the voltage to the normal value. Perusal of the circuits and the foregoing description makes it clear that, under these circumstances, the plate current of tube GB increases to increase the voltage drop across resistor R6 and thereby increase the negative bias of tube VC, thus reducing the plate-cathode current of tube VC and providing the desired B+ voltage at the output terminal. The regulated power supply provides a constant voltage source for the flip flop circuits now to be considered.

Before proceeding with the description of the particular application of the quasi-stable flip flop, these circuits will be described generally. For convenience, shutter deenergization relay coil tube SHDT circuit will be referred to when reference characters are mentioned. In addition, certain voltage values will be referred to, but these are intended as illustrations and may not conform to voltage values encountered in actuality. When the power supply is connected to the circuit, the circuit including plate P1 and cathode K1 immediately becomes conducting. The IR drop in resistor R18 is 60 volts and the cathode is thus maintained at a potential, with respect to ground, of 60 volts. Grid G1 also draws a current and the IR drop in resistor R19 is 240 volts. Assuming a B+ voltage of 300 volts, the grid is therefore at a potential of 60 volts, with respect to ground, or at the same potential as the cathode. The tube drop P1—K1 is approximately 40 volts and plate P1 is therefore at 100 volts, i.e. cathode potential of 60 volts plus tube drop of 40 volts.

The circuit through plate P2 and cathode K2 is not conducting current, but the tube elements do have certain potentials by virtue of the interconnections with the conducting elements of the tube. Thus cathode K2 is maintained at a potential of 60 volts. Plate P2 is at B+ potential or 300 volts. Grid G2 is in a voltage divider circuit between plate P1 and ground and its potential is 30 volts with respect to ground or −30 volts with respect to the cathode. This negative bias is sufficient to keep this half of the tube from firing which is the assumption made above, i.e. that the circuit through plate P2 and cathode K2 is not conducting.

Referring now to capacitor CQ8, it is observed that the plate connected to plate P2 is at a potential of 300 volts and the plate connected to grid G1 is at a potential of 60 volts and the potential difference between the two capacitor plates is 240 volts. If now the plate potential of plate P2 is reduced to 150 volts, as by the introduction of a negative pulse directly to the plate, the plate of the capacitor connected thereto immediately acquires a voltage of 150 volts. The charge stored in the capacitor is such as to maintain a potential of 240 volts between capacitor plates and consequently the terminal of capacitor CQ8 connected to grid G1 has an instantaneous potential value of 90 volts. This grid bias is sufficient to cut off the current flowing between plate P1 and cathode K1. Therefore plate P1 acquires a potential of 300 volts i.e. B+ potential. Hence the potential of grid G2 is increased in value by virtue of it being connected in the voltage divider circuit between plate P1 and ground. The increase in grid G2 potential is sufficient to cause conduction to take place between plate P2 and cathode K2. While what is being described is occurring, the negative pulse applied to plate P2 is removed, thus restoring full voltage of 300 volts to plate P2 and facilitating initiation of conduction between plate P2 and cathode K2. When conduction takes place, plate P2 drops to a potential of 150 volts, so that there is a potential drop of 150 volts across shutter deenergizing relay coil SHD, sufficient to operate the relay. When conduction takes place, capacitor CQ8 begins to discharge through a circuit from one terminal thereof, through rectifier RF1, resistor R19 and grid G1 back to the rectifier. As the discharge takes place, the voltage on grid G1 gradually increases from its original cut-off value of 90 volts. When the voltage on the grid G1 increases to a point where the grid potential approximately equals the cathode potential of cathode K1, conduction again takes place between plate P1 and cathode K1 and the conduction between plate P2 and cathode K2 is extinguished. The tube TSHD is now in its stable state and remains so operating until it is again triggered. When the tube was conducting current between plate P2 and cathode K2, and not between plate P1 and K1, the tube is said to be in its quasi-stable state. The time in which a tube is conducting in its quasi-stable state is dependent on the value of capacitor CQ8. The reason for this is obvious in that the greater the capacity, the greater the time constant of the discharge circuit and the longer it takes grid G1 to return to a voltage value approximately equal to the cathode voltage. When this condition occurs, the tube reverts from its quasi-stable to its stable state. After the positive pulse from the counter is removed, capacitor CQ5 discharges through tube BD.

The operation of the flip flop circuits will now be considered in their applications to the present photocomposing machine. When the main line switch KS is initially closed, only the right-hand portion of each of the tubes TSHD, TSHE and TRA will be conducting, and consequently shutter deenergizing relay coil SHD will be deenergized, as will shutter energizing relay coil SHE and read head advance relay coil RA. The tubes will remain in this state until an output pulse is received from the counter. It will now be assumed that a square wave pulse is produced by the counter to energize a counter output relay coil and thereby engage contacts CO1. Contacts CO1 connect the electronic circuits input terminal to B+ and thereby pulse the flip flop circuits. At the same time the electronic circuits are pulsed, machine function relay coil MF is energized to engage contacts MF1. Thus each time a pulse is instituted to photograph an exposed character, a circuit is completed through contacts MF1 to determine whether or not the next signal, which is already in decoding position on the read head, is for a character to be photographed or a machine function to be performed. In the latter instance circuit sequences are initiated to perform the functions as heretofore described.

Prior to the introduction of the square wave pulse into the flip flop circuits, trigger tube TT was non-conducting insofar as its grids were negative with respect to its cathodes. Plate P3 of trigger tube TT is connected to plate P2 of tube TSHD and consequently to B+, thus it has a potential of 300 volts. Plate P4 also has a potential of 300 volts insofar as it is connected to plate P5 of tube TSHE. However, when the square wave input pulse is fed to the terminal, capacitor CQ5 in charging passes the inrush current to raise the grid potential of trigger tube TT and fire both sections of the tube. Immediately the plate potential of plates P3 and P4 decrease from 300 volts to 150 volts and the effect is to introduce a negative pulse to each of the plates P2 and P5. As was described above, this will cause each of the tubes TSHD and TSHE to transfer from its stable state to its quasi-stable state and energize coils SHD and SHE respectively. Energization of these coils results in the performance of functions described when the relay circuits were considered. Capacitor CQ11 has a greater capacity value than capacitor

CQ8 and therefore coil SHD will be deenergized and tube TSHD revert to its stable state prior to coil SHE being deenergized and tube TSHE reverting to its stable state.

When tube TSHE was in its stable state, plate P6 was at a potential of 100 volts, and the terminal of capacitor CQ13 connected thereto was also at a potential of 100 volts. The other terminal of capacitor CQ13, being connected to B+ through resistor R25, is at a potential of 300 volts, and the potential across the capacitor terminals is 200 volts. When the tube TSHE is triggered as above described so that conduction between plate P6 and cathode K6 is extinguished, the plate potential jumps from 100 volts to 300 volts. As it does so, the potential of the plate of capacitor CQ13 connected thereto jumps to 300 volts. The other plate of the capacitor increases in potential to 500 volts since the potential between terminals remains at 200 volts. The blocking diode BD1 prevents this pulse from triggering tube TRA. However, the positive pulse resulting from plate P6 changing its potential from 100 to 300 volts pulses the light source trigger tube TLST to cause the light source to flash. In flashing, capacitor QLS discharges through the light source lamp to photograph an exposed character.

The positive pulse which triggers the light source increases the grid voltage of tube TLST to decrease the negative grid bias and permit the tube to fire. In firing the plate voltage decreases from its B+ value to some lower value, thus negatively pulsing the primary of transformer TRAN. A negative pulse in the primary winding results in a high voltage positive pulse in the secondary, of a value sufficient to trigger the light source lamp. It is thus clear that when the output pulse from the counter was introduced into the flip flop circuits, relays SHD and SHE were energized and the light source lamp was flashed.

When tube TSHE reverted to its stable state and plate P6 voltage decreased from 300 volts to 100 volts, capacitor CQ13 reverted to its lower voltage values i.e. 100 volts on the terminal connected to plate P6 and 300 volts on the other terminal, a negative voltage pulse was introduced to the plate of read head advance relay coil tube TRA to trigger the tube to operate in its quasi-stable state. Operation of the tube in the quasi-stable state energizes coil RA to advance the coded tape to bring the next coded signal to reading position on the read head. At the expiration of a time delay depending on the time constant of the circuit comprising capacitor CQ15 rectifier RF3 and resistor R30, tube TRA reverts to stable operation.

Each of the tubes TSHD, TSHE and TRA is operating in the stable state and the machine awaits the next output pulse from the counter at which time the foregoing described operations are repeated.

OPERATION

In operation, a coded tape representing the intelligence to be photocomposed is introduced into the machine. The tape is provided with a plurality of distinct signals, each of which represents either a character to be photographically recorded or a machine function which is to be performed. A machine function signal will, depending on the desired function, either perform it automatically or stop the machine to permit adjustment of some machine component.

After being set in the machine, the tape is advanced on the scan head by manually closing a toggle type start scan stepper switch, until an end-of-line signal appears in the scan head decoding position, at which time further tape advance is halted. A leading section of the tape is thus placed between the scan head and the read head and it is then advanced over the read head by repeated pressings on a push button type read head stepper switch until an end-of-line signal appears in decoding position, at which time further advance is prevented even though actuation of the push button read head stepper switch is continued. With an end-of-line signal in decoding position on each head, the scan head stepping switch operates to advance the tape until the next end-of-line signal (which follows a number of character signals) is in decoding position thereon, at which time the advance of the tape is again halted. Immediately after the tape began movement over the scan head, the read head stepping switch was actuated to advance the tape until an end-of-line signal was in decoding position on the read head. At this time, the signals representing the first line of intelligence to be photographed are on that portion of the tape positioned between the two heads, and immediately following the end-of-line signal on the scan head, there is a justification signal.

Now with an end-of-line signal in each decoding position, the scan head is stepped one position to bring into decoding position the justification signal for the first line of intelligence to be photocomposed. When this has been accomplished and the justification information decoded and stored in the quotient stepping switch and the quotient remainder stepping switch, the scan head stepping switch is again actuated to bring the next end-of-line signal into the scan head decoding position. The read head stepping switch is actuated to bring the first signal into decoding position. Further automatic advancement of the tape over the scan head and the read head is temporarily interrupted. The projection lens carriage is moved to its start-of-line position and a starting button is then pressed to start the carriage moving continuously at a constant speed which is not interrupted until the carriage reaches its end-of-line position.

As the carriage carries the grid plate past the photocell unit light beam, the passage of each opaque line produces an electric pulse which is introduced to the electronic counter. The first pulse produced by the photocell unit results in a counter output pulse which operates the machine function relay MF to connect a circuit which determines whether the first signal represents a character to be photocomposed or a machine function. It will be assumed that the signal is a character signal, as will all the signals in the first line of intelligence. This very same counter output pulse also flashes the light source lamp but since the shutters are not in actuated positions at this time, the flashing of the lamp does not affect the film. However, the counter pulse does initiate a series of events which do actuate the shutters to expose the first character to be photographed. The signal which determines the shutters to be actuated also includes information as to the width of the character, which for purposes of explanation will be assumed to be five unit distances. The width information is introduced to the counter which compares the information with the number of pulses coming from the photocell unit. When the number of photocell pulses, excluding the very first one, equals the number representing the character width, the counter produces an output pulse which flashes the lamp to photograph the exposed character and which initiates preparing the shutters to expose succeeding characters to be photographed. Each time a character is exposed, but before it is photographed, the tape is advanced to bring the next signal to decoding position on the read head. When the characters is photographed as by the production of a counter output pulse, the machine function relay MF is energized to engage contacts MF1 and thereby determine whether the next signal, which already had been advanced to decoding position, is for a machine function or for a character. The machine function relay, therefore, is energized every time a counter pulse is produced or in other words prior to the signals being decoded in the read head. The sequential operation is controlled by the electronic circuits described under the heading "Time Sequence Electronic Circuits." It may further be understood by reference to FIG. 31. The operations described are repated until all characters which go to make up the first line are photographed, after which an end-of-line signal appears in the decoding position on the read head and the intermittent stepping of the tape momentarily halts. The end-of-line signal causes the lens carriage motion to reverse and while the carriage is being returned to its start-of-line position, the justification information for the next line to be photographed is stored and the scan head stepping switch actuated to bring the next end-of-line signal into position on the scan head. In addition, the film solenoid is energized to advance the film in the film holder to prepare for photographing of the next line. The read head is also stepped to bring the signal representing the first character into decoding position. When the carriage arrives at its start-of-line position, its motion is reversed and it immediately starts forward again at a constant speed. The first pulse from the photocell unit initiates the operations as above described and photographing of the line continues. The operations described are repeated automatically and without interruption for all lines.

It sometimes happens that a mistake occurs during the coding of the tape and provision has to be made for passing the tape over the read head without photographing the error. When this is to be done, the portion of the tape in which the error occurs is passed over the read head without the signals representing the entire line containing the error causing the photographing of any characters. To accomplish this end, a line-erase signal is punched on the tape when the error is detected. Thus when the line-erase signal arrives in decoding position on the scan head, the signals representing the line to be "erased" are in position between the scan head and the read head. When the preceding line has been photocomposed, the line-erase signal prevents the carriage, after it has arrived at its start-of-line position, from being moved in its forward or composing direction of travel. The tape can thereupon be stepped over the read head without the filming of any character from the erased line. This is because actuation of the shutters and flashing of the light source are controlled by the electronic counter output pulses which in turn result from the passage of the carriage grid plate past the photocell unit. After the signals representing the erased line have passed over the read head, the carriage is again driven in a forward direction and the normal photocomposing of succeeding lines is again commenced. The interruption in the operation due to a line-erase function is momentary and consumes only the time during which the tape is rapidly stepped over the read head.

Another machine function is that termed "stop machine." It generally occurs when it is desired to change the point size of the filmed character images. Again the machine function is represented by a coded signal on the tape. The signal serves as an end-of-line signal on the scan head and when it reaches the read head decoding position it serves its particular function. When in this position on the read head, the line to be photocomposed in a different point size is represented by the signals between the two heads. The signal, when decoded by the read head, serves simply to stop forward motion of the carriage when it arrives at its start-of-line position. While the carriage is thus stopped, the machine attendant may make any desired lens adjustment to provide a different point size character image on film. After the adjustments have been accomplished, the attendant momentarily depresses the restart button after which the carriage moves forward and photocomposing of the line takes place. If a number of lines of the different point size reproduction are to be photocomposed, the machine automatically photocomposes one line after another. It is only when succeeding lines are to be of different point size that a stop machine signal is inserted on the tape between the signals representing the two point sizes.

Still another machine function is provided for circumstances under which it is desired to change fonts to provide a different type face style, e.g. italics. When a signal representing font change is brought to decoding position on the read head, the forward driving mechanism for the carriage is disconnected, that is, the forward electric drive clutch is deenergized and the brake is applied to insure the rapid arrest of carriage motion. The signal also includes information as to the font selected for photographing and while the carriage motion is being halted, the font plate is being automatically actuated to bring the desired font into position along the optical axis. When the selected font is in position, the carriage is again started forward and photocomposing continues as before. Here again, the machine operation continues automatically without interruption until it is desired to again institute a change in type face style or point size.

It is not intended to set forth all the variations that may be made, but it is contemplated that many of the features of the invention disclosed may be carried out in other ways and may be used in connection with apparatus and circuits different from those specifically described, and that many widely different embodiments of the invention can be made without departure from the spirit and scope of the invention. Thus the movement of the lens carriage may take place intermittently and at high speed rather than continuously, or the film may be transported to photograph the characters adjacent one another. In fact, both the film and the carriage may move with reference to each other for line composition. In addition, means other than the grid plate and photocell unit may be employed to measure the relative motion between the film and optical system, e.g. a precision gear train. It is therefore intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A phototypographical machine comprising, in combination, intermittently operated means for feeding therethrough step by step a pre-coded tape having thereon a succession of code signals representative of a justified composed line, means for decoding the signals in the tape as it is fed through the machine, a stationary font plate presenting an array of type characters arranged in different positions thereon and varying in set widths on a unit basis, means for photographing different selected characters, one after another, for composition in line, a light sensitive film on which the characters are recorded in the order in which they are photographed, means for producing a continuous relative movement between the light sensitive film and the photographic means for line composition, a unit measuring device for measuring each unit distance of travel of the line composing movement and controlled in its operation by such movement, intermittently operated means responsive to decoded character identification signals in the coded tape to control the selection of the type characters to be photographed, means responsive to decoded character width signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the time of photographic action for the successive characters being composed in accordance with unit variations in set widths of said characters, and means responsive to decoded word space signals in the coded tape and to decoded justification signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the extent of the line composing movement for the successive word spaces in the line in accordance with unit variations in justified set widths of said spaces.

2. A phototypographical machine according to claim 1, wherein the intermittently operated character selecting means include a shutter for exposing to light the different selected characters, and wherein the photographic means include a stationary first imaging lens system common to all the characters of the array in photographic position for imaging the exposed characters at a predetermined common position regardless of their position

on the font plate, and a movable second imaging lens system for projecting the images one after another as they are produced by the stationary first imaging lens system onto the light sensitive film.

3. A phototypographical machine according to claim 2, wherein the photographic means include a light flash source common to all of the exposed characters, and wherein the shutter is operated in advance of the light flash.

4. A phototypographical machine according to claim 1, wherein the light sensitive film is stationary, and wherein the second imaging lens system is movable continuously with reference to the stationary film for line composition.

5. A phototypographical machine according to claim 4, wherein said continuously movable second imaging lens system is arranged at an angle to the main optical axis and is movable forward and backward along said axis in traversing the film for line composition.

6. A phototypographical machine according to claim 4, wherein the second imaging lens system is mounted on a reciprocatory carriage which produces the continuous line composing movement, and including automatic means for returning the carriage to its starting position after the composition of each line.

7. A phototypographical machine according to claim 6, including automatic means for reinaugurating the continuous line composing movement of the second imaging lens carriage after its return to starting position.

8. A phototypographical machine according to claim 6, wherein the means for effecting the continuous line composing movement of the second imaging lens carriage and the means for effecting the return movement of the carriage include a common continuously driven electric motor, separate driving connections between said motor and the carriage, and separate electrically actuated clutches to make and break said driving connections.

9. A phototypographical machine according to claim 6, wherein the unit measuring device is actuated by the continuous line composing movement of the second imaging lens carriage.

10. A phototypographical machine according to claim 9, wherein the unit measuring device comprises a photoelectric cell, a light source therefor, and an intermediate grid mounted on and movable with the second imaging lens carriage, said grid being light transmitting and formed with a series of opaque markings spaced apart at a one-unit distance to interrupt the light beam and activate the photo-electric cell.

11. A phototypographical machine comprising, in combination, means for feeding therethrough a pre-coded tape having thereon a succession of code signals representative of a justified composed line, means for decoding the signals in the tape as it is fed through the machine, a stationary font plate presenting an array of type characters arranged in different positions thereon and varying in set widths on a unit basis, said stationary font plate carrying a plurality of different arrays of type characters and rotatably mounted for adjustment to bring any selected array into the stationary photographic position, means for photographing different selected characters, one after another, for composition in line, a light sensitive film on which the characters are recorded in the order in which they are photographed, means for producing a continuous relative movement between the light sensitive film and the photographic means for line composition, a unit measuring device for the line composing movement, means responsive to decoded character identification signals in the coded tape to control the selection of the type characters to be photographed, means responsive to decoded character width signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the time of photographic action for the successive characters being composed in accordance with unit variations in set widths of said characters, and means responsive to decoded word space signals in the coded tape and to decoded justification signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the extent of the line composing movement for the successive word spaces in the line in accordance with unit variations in justified set widths of said spaces.

12. A phototypographical machine according to claim 11, including means responsive to a decoded font change signal in the coded tape for rotatably adjusting the font plate in changing from one to another array of type characters.

13. A phototypographical machine according to claim 12, wherein the decoded font change signal temporarily suppresses the photographic action and temporarily arrests the continuous line composing movement.

14. A phototypographical machine according to claim 13, including means activated when the new character array is brought into the stationary photographic position for reinitiating the photographic action and the continuous line composing movement.

15. A phototypographical machine comprising, in combination, means for feeding therethrough a pre-coded tape having thereon a succession of code signals representative of a justified composed line, means for decoding the signals in the tape as it is fed through the machine, said signal decoding means comprising two decoding heads arranged in tandem and over which the tape is successively advanced with the signals arranged in the order in which they are produced, the first head reading and executing justification signals in the coded tape which appear last in the successive lines of signals, and the second head reading and executing character identification signals, character width signals and word space signals in the coded tape which appear ahead of the justification signals, a stationary font plate presenting an array of type characters arranged in different positions thereon and varying in set widths on unit basis, means for photographing different selected characters, one after another, for composition in line, a light sensitive film on which the characters are recorded in the order in which they are photographed, means for producing a continuous relative movement between the light sensitive film and the photographic means for line composition, a unit measuring device for the line composing movement, means responsive to decoded character identification signals to control the selection of the type characters to be photographed, means responsive to decoded character width signals as well as to said unit measuring device during the continuous line composing movement for varying the time of photographic action for the successive characters being composed in accordance with unit variations in set widths of said characters, and means responsive to decoded word space signals and to decoded justification signals as well as to said unit measuring device during the continuous line composing movement for varying the extent of the line composing movement for the successive word spaces in the line in accordance with unit variations in justified set widths of said spaces.

16. A phototypographical machine according to claim 15, wherein the first decoding head reads quad signals in the coded tape which appear after the character identification signals, character width signals and word space signals to provide normal unjustified word spacing for the line to be quadded and wherein the second decoding head also reads said quad signals to arrest the continuous line composing movement after the last character in the line has been photographed.

17. A phototypographical machine according to claim 15, wherein the first decoding head reads line-erase signals in the coded tape which appear after the character identification signals, character width signals and word space signals to allow coded lines to pass over the second decoding head without a photographic reading of the coded line.

18. A phototypographical machine according to claim 15, wherein the first decoding head reads end-of-line sig-

nals in the coded tape to stop the advance of the tape over said first head, and wherein the second decoding head reads said end-of-line signals to stop the advance of the tape over said second head as well as to arrest the continuous line composing movement.

19. A phototypographical machine according to claim 15, wherein the advance of the tape over the decoding heads is controlled by signals in the tape.

20. A combination according to claim 1, wherein the means for varying the time of photographic action for the successive characters being composed as well as the means for varying the extent of the line composing movement for the successive word spaces in the line include an electric unit counter controlled and operated conjointly by the input pulses of the character width signals and the justification signals in the coded tape as well as by the input pulses of the unit measuring device, said counter being activated to produce an operational output pulse when the number of units measured by the unit measuring device equals the number of units represented by the width of each successive character and by the width of each successive justified word space.

21. A phototypographical machine comprising, in combination, intermittently operated means for feeding therethrough step by step a coded tape having thereon a succession of code signals representative of a justified composed line, means for decoding the signals in the tape as it is fed through the machine, a stationary font plate presenting an array of type characters arranged in different positions thereon and varying in set widths on a unit basis, means for photographing different selected characters, one after another, for composition in line, a light sensitive film on which the characters are recorded in the order in which they are photographed, means for producing a continuous relative movement between the light sensitive film and the photographic means for line composition, a unit measuring device for measuring each unit distance of travel of the line composing movement and controlled in its operation by such movement, intermittently operated means responsive to decoded character identification signals in the coded tape to control the selection of the type characters to be photographed, means responsive to decoded character width signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the time of photographic action for the successive characters being composed in accordance with unit variations in set widths of said characters, and means responsive to decoded word space signals in the coded tape and to decode justification signals in the coded tape as well as a said unit measuring device during the continuous line composing movement for varying the extent of the line composing movement for the successive word spaces in the line in accordance with unit variations in justified set widths of said spaces, characterized in that the light sensitive film is stationary and in that the photographic means include a projection lens system mounted on a reciprocatory carriage which moves said lens system continuously with reference to the stationary film for line composition, and including automatic means for returning the carriage to its starting position after the composition of each line, and automatic means for reinaugurating the continuous line composing movement of the lens carriage after its return to starting position, the two said automatic means including a common continuously driven electric motor, separate driving connections between said motor and the carriage, and separate electrically actuated clutches to make and break said driving connections, the clutch which controls the continuous line composing movement of the lens carriage being deactivated and the clutch which controls the carriage return movement being activated by a decoded signal in the coded tape.

22. A phototypographical machine comprising, in combination, intermittently operated means for feeding therethrough step by step a coded tape having thereon a succession of code signals representative of a justified composed line, means for decoding the signals in the tape as it is fed through the machine, a stationary font plate presenting an array of type characters arranged in different positions thereon and varying in set widths on a unit basis, means for photographing different selected characters, one after another, for composition in line, a light sensitive film on which the characters are recorded in the order in which they are photographed, means for producing a continuous relative movement between the light sensitive film and the photographic means for line composition, a unit measuring device for measuring each unit distance of travel of the line composing movement and controlled in its operation by such movement, intermittently operated means responsive to decoded character identification signals in the coded tape to control the selection of the type characters to be photographed, means responsive to decoded character width signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the time of photographic action for the successive characters being composed in accordance with unit variations in set widths of said characters, and means responsive to decoded word space signals in the coded tape and to decode justification signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the extent of the line composing movement for the successive word spaces in the line in accordance with unit variations in justified set withs of said spaces, characterized in that the light sensitive film is stationary and in that the photographic means include a projection lens system mounted on a reciprocatory carriage which moves said lens system continuously with reference to the stationary film for line composition, and including automatic means for returning the carriage to its starting position after the composition of each line, and automatic means for reinaugurating the continuous line composing movement of the lens carriage after its return to starting position, the two said automatic means including a common continuously driven electric motor, separate driving connections between said motor and the carriage, and separate electrically actuated clutches to make and break said driving connections, the clutch which controls the lens return movement being deactivated and the clutch which controls the continuous line composing movement of the lens carriage being activated by an electric switch which is energized by the return movement of the carriage.

23. A phototypographical machine comprising, in comprising, in combination, intermittently operated means for feeding therethrough step by step a coded tape having thereon a succession of code signals representative of a justified composed line, means for decoding the signals in the tape as it is fed through the machine, a stationary font plate presenting an array of type characters arranged in different positions thereon and varying in set widths on a unit basis, means for photographing different selected characters, one after another, for composition in line, a light sensitive film on which the characters are recorded in the order in which they are photographed, means for producing a continuous relative movement between the light sensitive film and the photographic means for line composition, a unit measuring device for measuring each unit distance of travel of the line composing movement and controlled in its operation by such movement, intermittently operated means responsive to decoded character identification signals in the coded tape to control the selection of the type characters to be photographed, means responsive to decoded character width signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the time of photographic action for the successive characters being composed in accordance with unit variations in set widths of said characters, and means

responsive to decoded word space signals in the coded tape and to decoded justification signals in the coded tape as well as to said unit measuring device during the continuous line composing movement for varying the extent of the line composing movement for the successive word spaces in the line in accordance with unit variations in justified set widths of said spaces, characterized in that the light sensitive film is stationary and in that the photographic means include a projection lens system mounted on a reciprocatory carriage which moves said lens system continuously with reference to the stationary film for line composition, and including automatic means for returning the carriage to its starting position after the composition of each line, and wherein the unit measuring device is actuated by the continuous line composing movement of the lens carriage and comprises a photoelectric cell, a light source therefor, and an intermediate grid mounted on and movable with the lens carriage, said grid being light transmitting and formed with a series of opaque markings spaced apart at a one-unit distance to interrupt the light beam and activate the photo-electric cell.

24. In a phototypographical machine, the combination of an array of type characters each having a characteristic width which is a multiple of a typographical em unit, a light sensitive film, means for projecting the type characters, one after another, onto the film for line composition, said film and projecting means being movable one relatively to the other in effecting line composition, and means for measuring each unit distance of travel of the line composing movement and transmitting such measurement to a control unit for the character projection, said means including a pulse generating grid plate formed with a series of opaque markings to interrupt a light beam from a light source to a photo-cell unit and partaking of the line composing movement, said markings being spaced apart at a distance corresponding to the width value of the aforesaid typographical em unit, said grid plate being formed with a plurality of series of opaque markings, one series for each different point size of type characters to be photographed, and the spacing of said markings in the different series varying according to point size.

25. In a phototypographical machine, the combination of an array of type characters each having a characteristic width which is a multiple of a typographical em unit, a light sensitive film, means for projecting the type characters, one after another, onto the film for line composition, said film and projecting means being movable one relatively to the other in effecting line composition, and means for measuring each unit distance of travel of the line composing movement and transmitting such measurement to a control unit for the character projection, said means including a pulse generating grid plate formed with a series of opaque markings to interrupt a light beam from a light source to a photo-cell unit and partaking of the line composing movement, said markings being spaced apart at a distance corresponding to the width value of the aforesaid typographical em unit, said grid plate being formed in addition to said series of opaque markings with a functional opaque marking located beyond the normal range of operation of the unit measuring device and which conditions the machine for the start of line composition.

26. A combination according to claim 20, including means actuated by each operational output pulse of the counter for detecting the nature of the next signal in the tape to be decoded.

27. In a typographical photocomposing machine equipped with a pre-coded tape having a succession of code signals divided into spaced apart groups representative of a series of justified or unjustified composed lines, the combination of means for feeding the tape endwise step by step through the machine, means having a fixed location in the machine for decoding signals in the tape as it is fed endwise through the machine, a support for a sensitized sheet, a support for a number of characters to be projected while in fixed position, optical means adapted to project any character to a common fixed image position, continuously moving mechanism for causing the images of successive characters to be formed on successive portions of the sheet, a flash illumination device for illuminating the characters, shutter means actuated by decoded character identification signals in the coded tape to permit only a selected character to be projected to said position, a counter, impulse generating means operating in timed relation to said continuously moving mechanism to step the counter, means responsive to a character width signal in the coded tape for storing in the counter a number corresponding to the width of a selected character, means responsive to a decoded word space signal in the coded tape during the composition of an unjustified composed line for storing in the counter a number corresponding to the width of a word space, means responsive to a justification end-of-line signal in the coded tape as well as to a justification quotient and quotient remainder signal in the coded tape for storing in a memory unit the information represented by said justification quotient and quotient remainder signal, said memory unit, means actuated during the composition of a justified composed line by a decoded word space signal in the coded tape and by the memory unit for storing in the counter a number corresponding to the justified width of each successive word space in the line, and a circuit connected to the counter to operate said illumination device at substantially the instant when the counter receives a number of impulses proportional to said character width, said unjustified word space width, or said justified word space width, as the case may be.

28. A combination according to claim 27, wherein the memory unit comprises a justification quotient storage means and a justification quotient remainder storage means which are pre-set by the justification quotient and quotient remainder signals in the coded tape.

29. A combination according to claim 28, wherein the justification quotient remainder storage means is in the form of a stepping switch which is stepped back to home position under control of word space signals in the coded tape during line composition.

30. A typographical photocomposing machine equipped with a pre-coded tape having a series of code signals representing a line of type characters and word spaces followed by a justification end-of-line signal and a justification quotient and quotient remainder signal, the combination of means for feeding the coded tape endwise step by step through the machine, a scanning head for decoding the justification end-of-line signal and the justification quotient and quotient remainder signal, a read head for decoding the type character signals and the word space signals, means for stepping the scan head, means for arresting operation of the scan head when a justification end-of-line signal for a line to be composed is decoded thereby, means for stepping the read head, means for arresting operation of the read head when a justification end-of-line signal for a previously composed line is decoded thereby, the arrangement being such that the type character signals and the word space signals for the line to be composed are between the two decoding heads at the time the two justification end-of-line signals are in decoding position thereon, means for detecting the simultaneous decoding of the two justification end-of-line signals, means responsive to the two justification end-of-line signals being simultaneously decoded for operating the scan head to bring the justification quotient and quotient remainder signal for the line to be composed into decoding position thereon, means for decoding and storing said justification quotient and quotient remainder signal, means responsive to storage of said justification quotient and quotient remainder signal for operating the read head to bring the type character signals and the word space signals sequentially into decoding position

thereon, and means responsive to the decoding of said type character and word space signals for recording a composed justified line of type.

References Cited in the file of this patent

UNITED STATES PATENTS

1,317,406	Siemens	Sept. 30, 1919
1,603,953	Hunter	Oct. 19, 1926
1,732,049	Hunter	Oct. 15, 1929
1,893,158	Chiveix	Jan. 3, 1933
1,950,166	Durholz	Mar. 6, 1934
2,178,379	Spievak	Oct. 31, 1939
2,180,417	Huebner	Nov. 21, 1939
2,229,689	Westover	Jan. 28, 1941
2,241,263	Koppe	May 6, 1941
2,298,666	Whitelaw	Oct. 13, 1942
2,388,961	Elliott	Nov. 13, 1945
2,389,087	Schubert	Nov. 13, 1945
2,392,224	Bryce	Jan. 1, 1946
2,441,899	Ogden	May 18, 1948
2,515,862	Carlton	July 18, 1950
2,600,168	Klyce	June 10, 1952
2,646,732	Offeman	July 28, 1953
2,646,733	Ackerman	July 28, 1953
2,663,232	Drillick	Dec. 22, 1953
2,670,665	Caldwell	Mar. 2, 1954
2,682,814	Higonnet	July 6, 1954
2,699,101	Ferguson	Jan. 11, 1955
2,714,842	Hooven	Aug. 9, 1955
2,786,400	Peery	Mar. 26, 1957

FOREIGN PATENTS

182,887	Great Britain	July 7, 1922
200,047	Great Britain	June 25, 1923
200,532	Great Britain	July 10, 1923
411,617	Germany	Mar. 27, 1925