

Nov. 6, 1956

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2,769,379

CHARACTER POSITIONING MECHANISM

Filed May 22, 1952

6 Sheets-Sheet 1

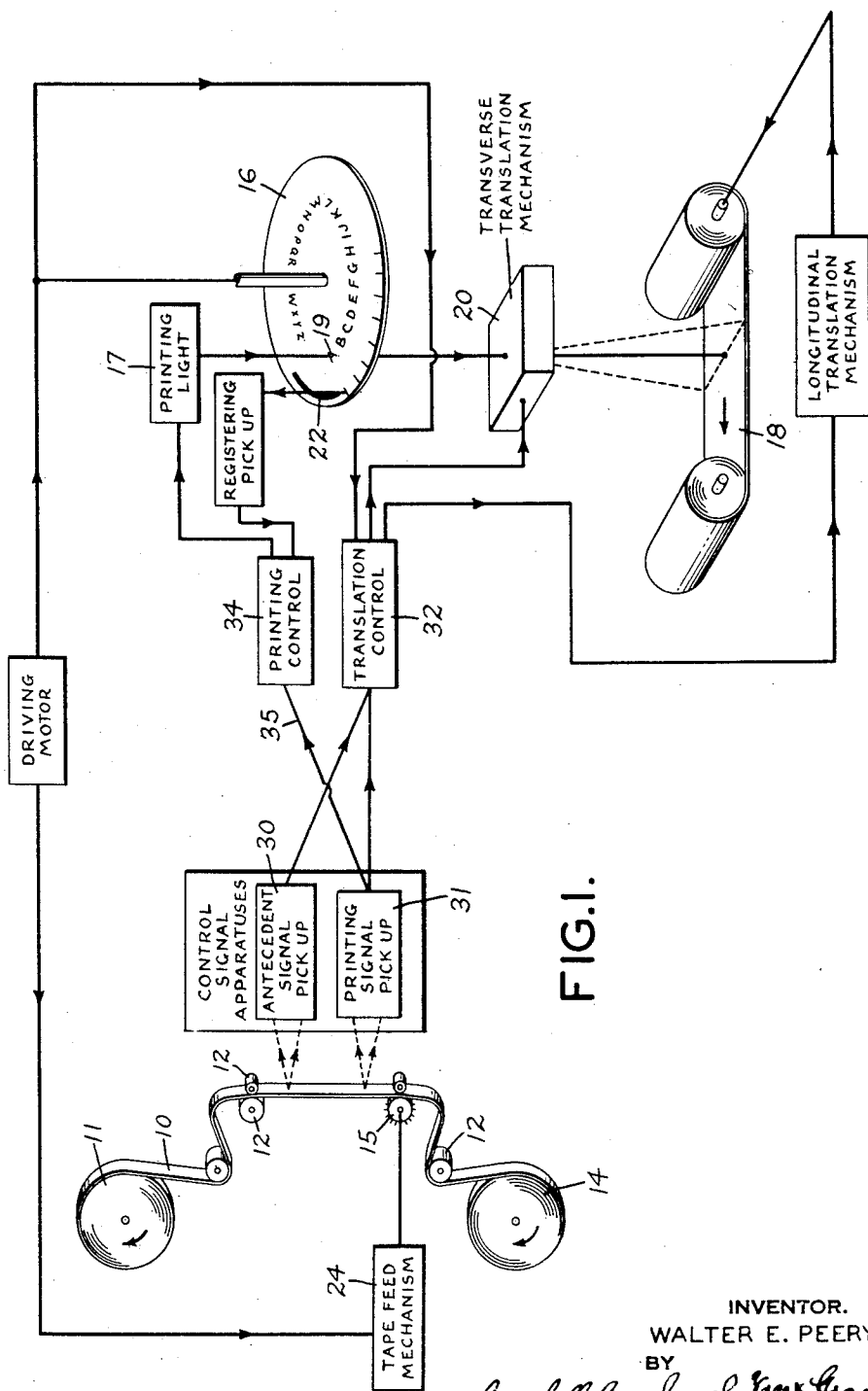


FIG. 1.

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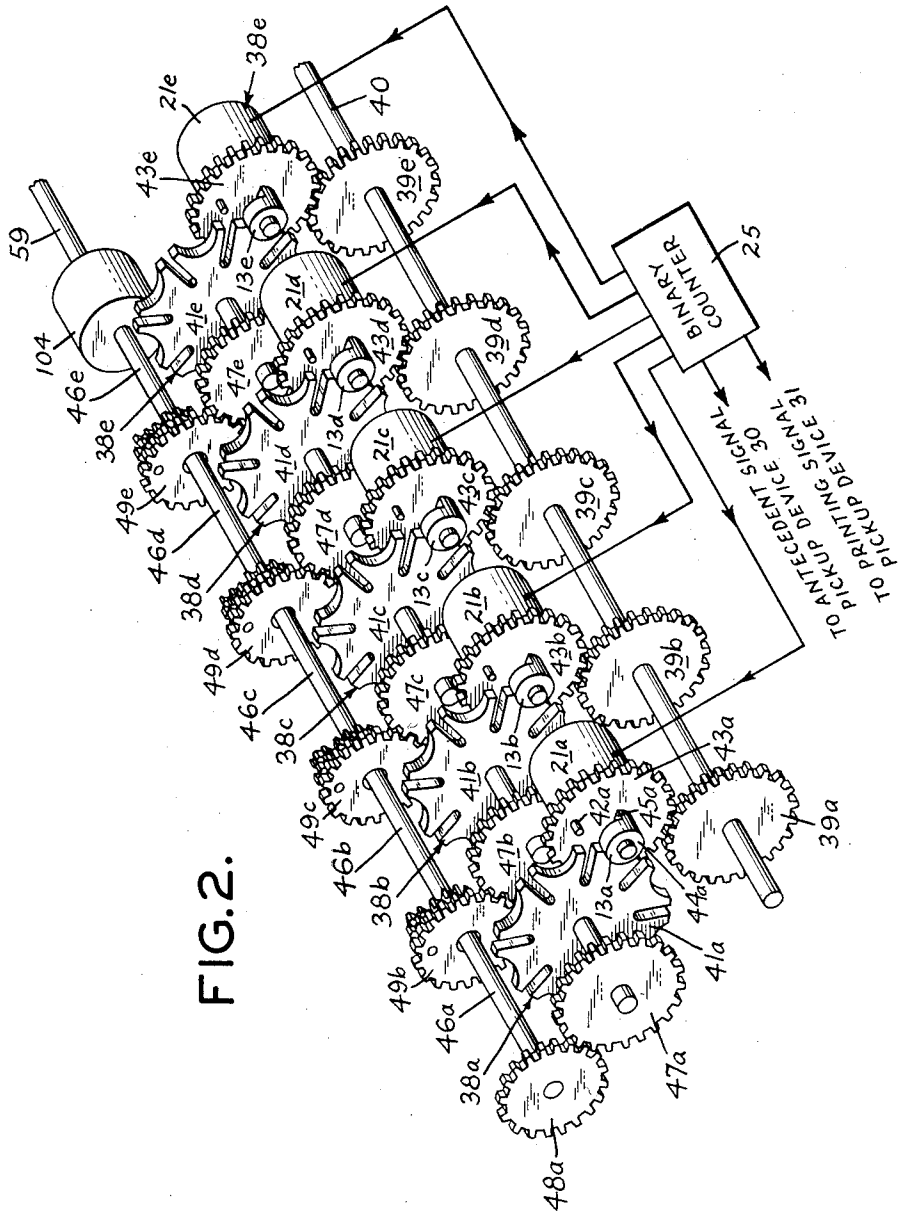
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## CHARACTER POSITIONING MECHANISM

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6 Sheets-Sheet 2



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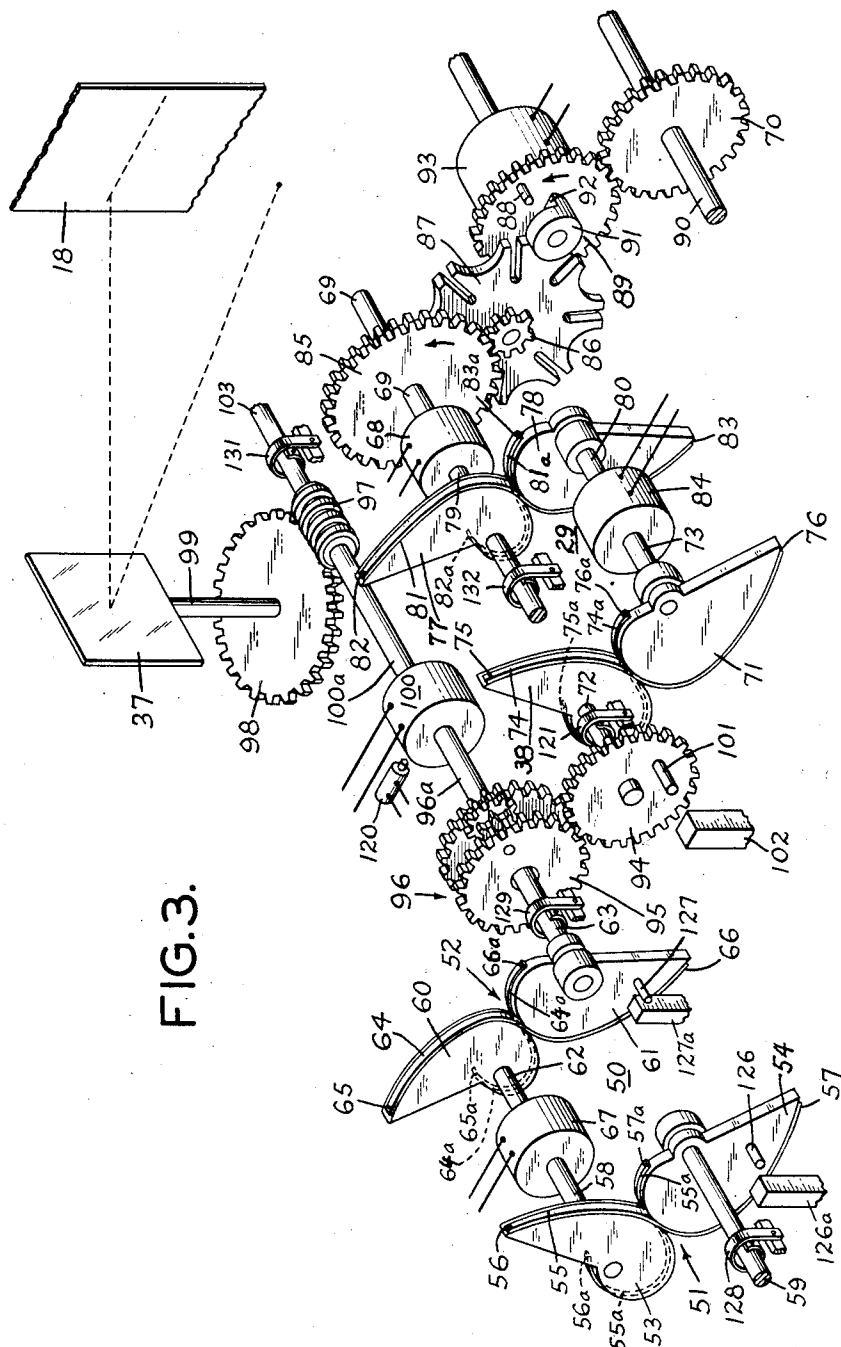
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## CHARACTER POSITIONING MECHANISM

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6 Sheets-Sheet 3



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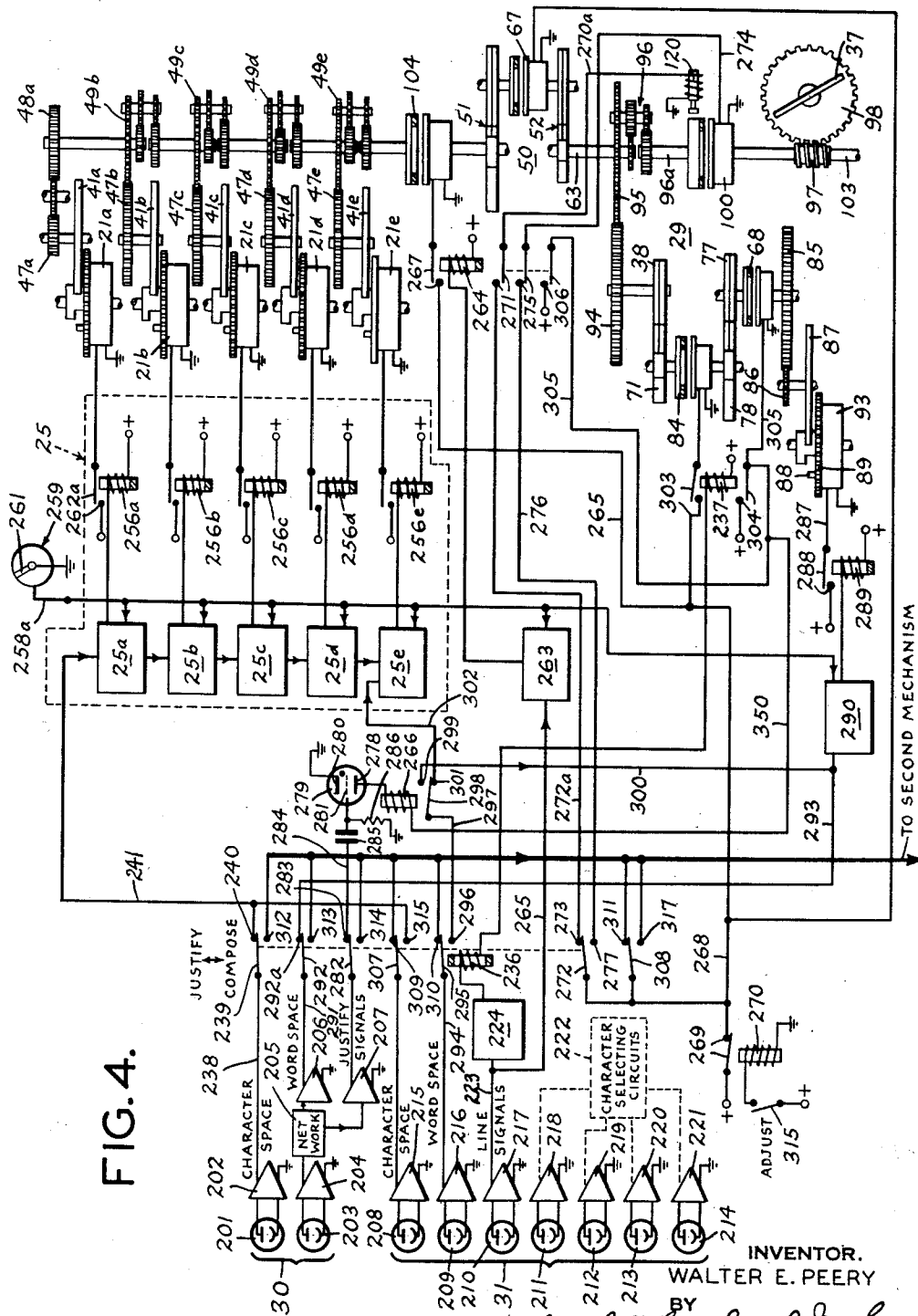
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## CHARACTER POSITIONING MECHANISM

Filed May 22, 1952

6 Sheets-Sheet 4



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CHARACTER POSITIONING MECHANISM

Filed May 22, 1952

6 Sheets-Sheet 5

FIG. 5.

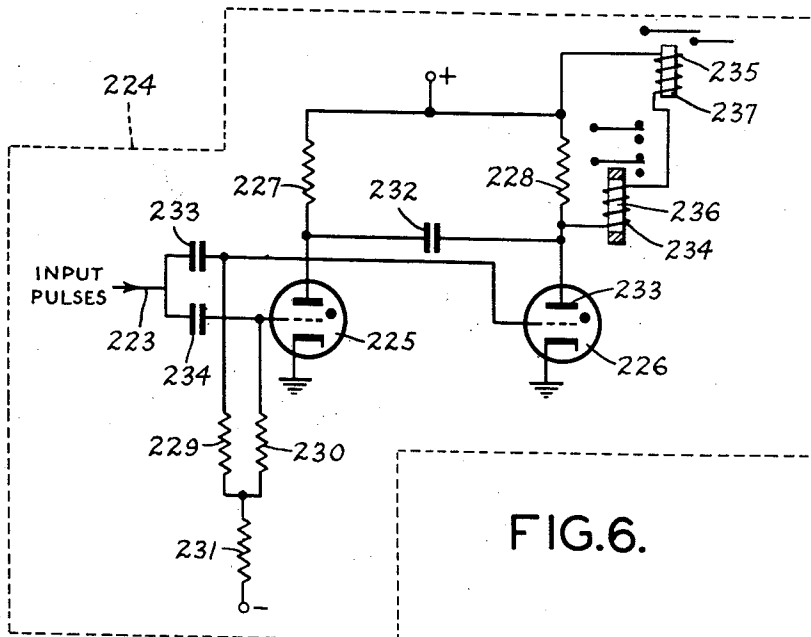
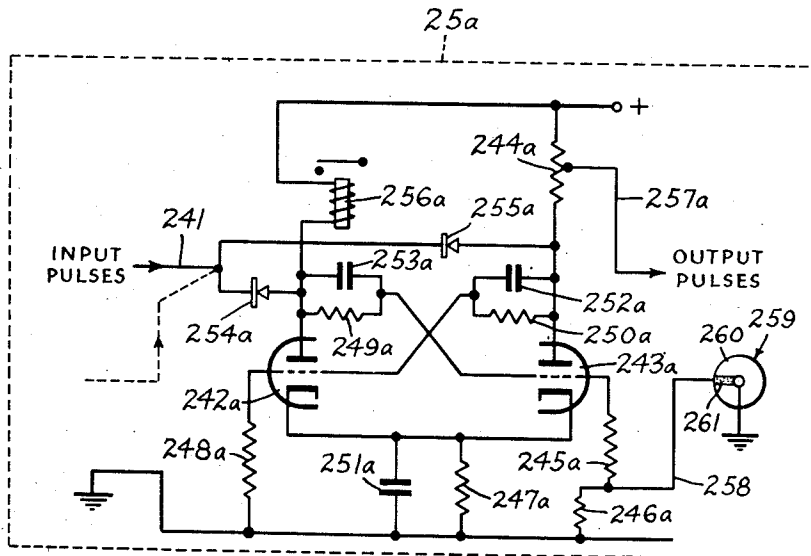


FIG. 6.

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CHARACTER POSITIONING MECHANISM

Filed May 22, 1952

6 Sheets-Sheet 6

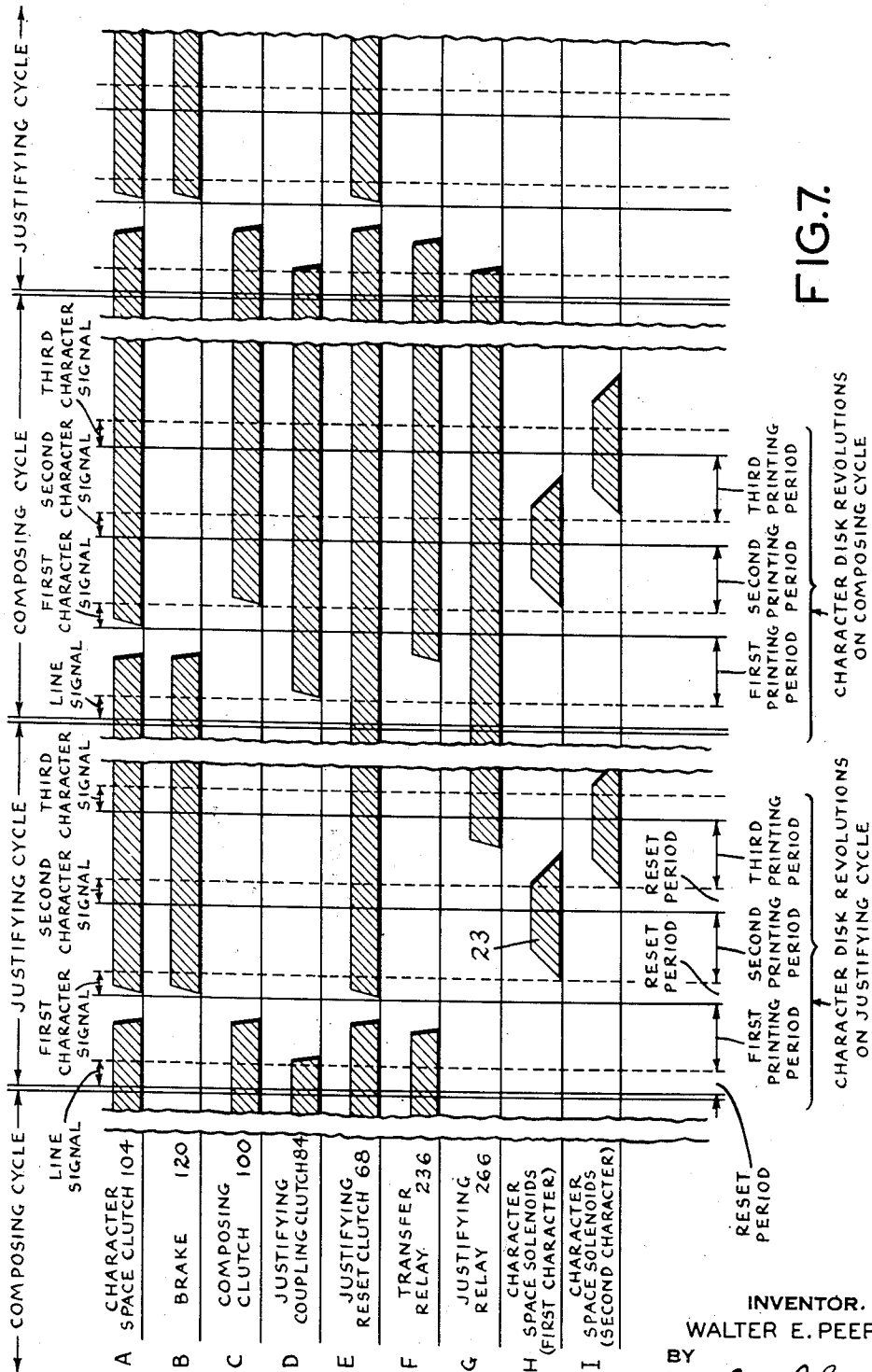


FIG. 7

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## CHARACTER POSITIONING MECHANISM

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Application May 22, 1952, Serial No. 289,411

21 Claims. (Cl. 95—4.5)

The present invention relates to typesetting apparatus and the like. More specifically, it has to do with novel and highly effective means for reproducing characters on a medium in justified lines.

The applicant's copending application Serial No. 41,318, filed July 29, 1948, for "Electronic Photo-Typecomposing System," discloses a photo-typecomposing machine in which the positions of characters projected on a photosensitive emulsion are controlled by a rotatable reflector disposed in the projection path. The machine is adapted to respond to code signals on a record strip which may represent characters, character widths, word spaces, line endings, etc. Each portion of the record strip is scanned twice, viz., once in an antecedent scanning operation in which electronic means determines the word space required for justification, and secondly in a printing operation which utilizes the information derived as a result of the antecedent scanning to print selected characters in justified lines.

The present application is directed to novel mechanical justifying and character positioning mechanism which may be employed effectively in a photo-typecomposing system of the kind disclosed in the aforementioned copending application, although it is not limited to such use.

It is an object of the invention to provide new and improved mechanical means for controlling the positioning of characters to be printed in a line on a medium such that justified lines of characters will be produced.

Another object of the invention is to provide new and improved mechanical justifying and character positioning means which is capable of accommodating variable widths and different point sizes for the characters, and which also embodies means for adjusting the length of a line of characters being composed.

A further object of the invention is to provide new and improved mechanical justifying and character positioning means of the above character which may be controlled in response to signals derived from code elements on a control tape or the like.

These and other objects of the invention are attained by providing justifying apparatus comprising gear train mechanism having an infinitely adjustable ratio of output to input within limits. Prior to composing a line of characters, the gear train mechanism is adjusted in accordance with inputs representing, respectively, the spaces occupied by the characters in the line and the number of word spaces in the line to give a ratio of output to input which represents the word spacing required for proper justification of the line to be composed. Subsequently, when the line of characters is being composed, the pre-adjusted gear train mechanism is actuated in response to inputs representing word spaces to cause the insertion between adjoining words in the line being composed of the proper space required for justification.

The positioning of the several characters in the line being composed requires the displacement of a member in accordance with the widths of the successive characters. Such displacements are adapted to be produced,

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according to the invention, by imparting to a displaceable member incremental displacements which may represent in magnitude one or more of a plurality of binary digits forming a binary number representing the width of a character. The incremental displacements may be produced by gearing actuated by means such as a plurality of Geneva movements adapted to be indexed, respectively, in response to signals derived from code elements on a control tape or the like.

Gear train mechanism of infinitely adjustable ratio may be interposed between the displaceable member and the justifying mechanism so as to enable different point sizes of characters to be accommodated.

The invention may be better understood from the following detailed description of a typical embodiment thereof, taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic diagram of a typical photo-composing system in which the novel justifying mechanism of the invention may be employed;

Fig. 2 illustrates schematically a portion of the justifying mechanism in the apparatus of Fig. 1 which is adapted to provide displacements proportional to the widths of characters;

Fig. 3 is a schematic diagram of another portion of the apparatus of Fig. 1 which includes the justifying mechanism proper and mechanism for accommodating different point sizes of characters;

Fig. 4 is a schematic diagram of a typical control system for the justifying mechanism shown in Figs. 2 and 3;

Fig. 5 illustrates schematically a binary counting circuit that may be employed in the control system of Fig. 4;

Fig. 6 is a schematic diagram of a flip-flop circuit which may form part of the control system of Fig. 4; and

Fig. 7 is a graph illustrating a typical sequence of operations in the system shown in Fig. 4.

While the character positioning and justifying mechanism of the invention may be used with a wide variety of reproducing systems, it will be described herein in relation to a photocomposing system of the type disclosed in the aforementioned copending application Serial No. 41,318. As shown schematically in Fig. 1, a photocomposing system of this type comprises a pair of signal pick-up devices 30 and 31 which are adapted to scan code elements on a control tape 10. The pick-up device 30 is adapted to scan the tape 10 one line in advance of the signal pick-up device 31 and is, therefore, designated the antecedent signal pick-up. The signal pick-up device 31 is called the printing signal pick-up because it provides the signals used in printing a line of characters.

The control tape 10, which contains on its surface in code form the characters to be printed, is fed from a reel 11 through guide means 12 to a reel 14. A sprocket or other device 15 propels the tape as required past the signal pick-up devices 30 and 31.

Signals produced by the printing signal pick-up device 31 are fed over a channel 35 to a printing control apparatus 34 for controlling the flashing of a printing light 17 which is adapted to project selected characters 19 on a continuously rotating disc 16 to a moving photosensitive emulsion 18. The positions of the characters projected from the character disc 16 to the film 18 are adapted to be controlled by a transverse translation mechanism 20 in response to signals from a translation control 32 which in turn is responsive to the antecedent pick-up device 30 and to the printing signal pick-up device 31.

In the photocomposing system disclosed in the aforementioned copending application Serial No. 41,318, the translation control system 32 and transverse translation

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mechanism 20 are mainly electronic in character. The present application is directed to new and improved translation control apparatus in which mechanical means serves to control the angular position of a reflecting member in the transverse translation mechanism 20 so as to compose the several characters in the copy to be printed in correctly justified lines on the photosensitive emulsion 18.

Referring now to Fig. 3 of the drawings, images of selected characters on the character bearing disc 16 of Fig. 1 are directed to the reflector 37 in the transverse translation mechanism 20 and from the reflector 37 to the photosensitive emulsion 18. The reflector 37, in its initial position, directs the first character to the beginning of a line on the photosensitive emulsion 18 and it is adapted to be rotated by mechanism to be described, to position subsequent characters at different positions along the line, leaving sufficient space between adjacent words to insure the production of correctly justified lines.

#### *The character space generating mechanism*

Fig. 2 shows the portion of the character positioning and justifying mechanism of the invention which generates the character space information. It may comprise, for example, a plurality of shiftable Geneva mechanisms 38a, 38b, 38c, 38d and 38e, adapted to be driven by gears 39a, 39b, 39c, 39d, and 39e, respectively, carried on a common shaft 40 which may be driven in synchronism with the tape feed mechanism 24 (Fig. 1). The shiftable Geneva mechanisms are all substantially identical in construction and it will be necessary, therefore, to describe only one of them in detail, like parts in the others being designated by like reference characters with appropriate subscripts.

The shiftable Geneva mechanism 38a comprises the usual Geneva wheel 41a and driving pin 42a. The driving pin 42a is mounted on a gear 43a which is in driving engagement with the gear 39a on the continuously rotating shaft 40. The driving gear 43a also carries a locking hub 44a having a cylindrical outer portion 13a and a portion 45a adjacent the gear 43a which is slotted halfway through, as shown. The driving gear 43a is mounted for axial sliding movement and it is normally maintained by suitable means such as a spring (not shown) with the cylindrical outer portion 13a of the locking hub 44a in engagement with one of the curved edges of the Geneva wheel 41a so that the latter is locked against rotation. While in this position, the driving pin 42a moves in a path which is displaced laterally from the Geneva wheel 41a so that it is incapable of indexing the latter.

The driving gear 43a is adapted to be shifted axially to the indexing position by suitable means such as a conventional solenoid 21a, for example, which may be energized in response to signals received from the antecedent signal pick-up device 30 or from the printing signal pick-up device 31, as will be described later. This moves the cylindrical outer portion 13a of the locking hub 44a laterally out of engagement with the curved edge of the Geneva wheel 41a and brings the latter opposite the slot 45a in the hub 44a so that the wheel can now be indexed. Simultaneously, the driving pin 42a on the gear 43a is moved to a position in which it can enter a slot in the Geneva wheel 41a to index the same once for each complete revolution of the driving gear 43a.

If the Geneva wheel 41a has eight slots, for example, the driving pin 42a will be in engagement with the wheel 41a only during 135° of the revolution of the driving gear 43a. During the remainder of the revolution, the wheel 41a is locked by the locking hub 44a. The driving gear 43a carrying the hub 44a and the pin 42a may be shifted into or out of engagement with the Geneva wheel 41a during this 255° of rotation. The ratio of the arc of engagement to the arc of dwell is important in that it allows a considerable portion of the total revolution in which the driving gear 43a can be shifted in or out of engagement with the wheel 41a.

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The Geneva wheels 41a-41e, inclusive, and their driving mechanisms 43a-43e, inclusive, are identical in construction. Each time any Geneva wheel is indexed, it imparts unit motion to an associated output gear which, except for the gear 47a, meshes with a gear which delivers one input to a mechanical differential device. Thus, the Geneva wheel 41e, and its associated gear 47e, for example, deliver one mechanical input to a conventional differential 49e. The differential 49e is also adapted to receive a second mechanical input from the shaft 46d to which is delivered the output of the preceding differential 49d. The output of the differential 49e is delivered to a shaft 46e. The differentials 49b-49e, inclusive, are of the usual type in which the mechanical output is one-half the sum of the two mechanical inputs.

The indexing of any of the eight slot Geneva wheels shown in Fig. 2 will impart to the wheel and to its associated gear an angular rotation of 45°. If the wheel 41e is indexed, a rotational input of 45° will also be imparted to the differential 49e. The differential output shaft 46e, however, will rotate only 22½°. If the wheel 41d is indexed, a rotational input of 45° will be delivered to the differential 49d but its output shaft 46d will rotate only one-half that or 22½°. Since the mechanical output at the shaft 46d is also delivered as a second input to the differential 49e, the 22½° rotation of the shaft 46d will deliver to the shaft 46e a rotational output of 11¼°, or one-fourth of the motion of the Geneva wheel 41d. Likewise, indexing the Geneva wheel 41c will result in a rotational displacement in the shaft 46e of 5¾° or one-eighth of the motion of the Geneva wheel 41c. Similarly, indexing the wheel 41b imparts to the shaft 46e a rotational displacement of one-sixteenth the motion of the wheel 41b.

The motion of the gear 47a and of the wheel 41a are delivered directly to the shaft 46a through a gear 48a. Since no differential action is involved, the gear ratio between the gears 47a and 48a is made two to one so that when the wheel 41a is indexed, it will impart to the shaft 46a a rotational displacement equal to one-thirty-second the rotational displacement of the wheel 41a.

The unit motions imparted to the shaft 46e by the several Geneva mechanisms when indexed are not the same but are in the ratios of 1, 2, 4, 8 and 16, respectively. Accordingly, any desired number of units of motion up to a maximum of 31 may be imparted to the shaft 46e, so that any desired character width from 0 up to 31 units can be represented by a corresponding total displacement imparted to the shaft 46e.

If the width of a character is denoted on the control tape 10 by a plurality of indicia equal in number to the number of units corresponding to the width of the character, a corresponding number of signals will be produced as the tape 10 is scanned by either the antecedent signal pick-up device 30 or the printing signal pick-up device 31. These signals are fed to conventional means such as binary counter apparatus 25 (Fig. 4), for example, where they are converted to binary signals which are fed to the appropriate shiftable Geneva mechanisms 38a, 38b, 38c, 38d or 38e to produce a total displacement of the shaft 46e proportional in magnitude to the number of units on the control tape 10 representing the width of the particular character.

As in the system illustrated in the aforementioned copending application Serial No. 41,318, the apparatus shown in Fig. 2 performs alternately a justifying function and a printing function. During the former, the counter apparatus 25 responds only to signals from the antecedent signal pick-up device 30 whereas, during the latter, the counter 25 responds only to signals from the printing signal pick-up device 31. The apparatus may be switched from one function to another by means similar to that shown in the above-mentioned copending application.

As also described in detail in the above-noted pending application Serial No. 41,318, signals representing characters, character spaces, and other functions of the composing machine are received during the rotation past a projection point of a blank sector 22 (Fig. 1), called the reset sector, on the character disc 16. The information represented by the signals received during the reset period is then acted upon during the period required for the remainder of the character disc to rotate past the projection point.

The gears 43a-43e, inclusive, rotate at the same rate as the character disc 16 and their rotation is phased with respect to the character disc 16 so that the indexing of the Geneva wheels 41a-41e, inclusive, occurs during the reset portion 22 of a revolution of the character disc 16. In this fashion, the movement of the mirror 37 (Fig. 3) occurs in the interval between the printing of two successive characters.

The movement of the mirror 37 to provide space for any character occurs during the reset period succeeding the printing of the preceding character and is related to the width occupied on a composed line by the preceding character. The sequence of operations of Geneva engaging solenoids 21a-21e, inclusive, is shown graphically on line H of Fig. 7. In the second reset period at the beginning of the second revolution of the character disc 16 in the justifying cycle, signals corresponding to a first character are taken from the tape 10 as well as signals representing the width of that character. The latter signals actuate the binary counter apparatus 25 to control the proper Geneva mechanisms, as will be described in greater detail below.

During the printing period of the second revolution of the character disc 16 in the justifying cycle, the desired character is selected and printed. Also, the solenoids of the proper ones of the Geneva mechanisms 38a-38e, inclusive, are energized and the corresponding ones of the driving gears 43a-43e, inclusive, move to the engagement position as indicated by the shaded area 23 (Fig. 7). The appropriate ones of the driving gears 43a-43e, inclusive, are in the fully engaged position at the beginning of and during the reset period of the third revolution of the character disc 16 (Fig. 1), as shown by the shaded area 23 of Fig. 7, and the selected Geneva wheels are indexed during this reset period. The mirror 37 is moved a corresponding amount if the mechanism is operating in a composing cycle, or the gear 94 is moved if in a justifying cycle. Thus, during the third reset period, the mirror 37 (in a composing cycle) is moved in an angular amount proportional to the width of the first character. This mirror motion represents an actual spacing motion for the second character (about to be printed) in that the position of mirror 37 at the end of its motion determines the position where the second character is printed on the receiving medium 18. The purpose of the presently-described mirror motion is, however, to assign the proper width on the medium for the first character.

The binary circuits in the binary counter apparatus 25 which control the selected Geneva mechanism solenoids are reset to normal at the beginning of the reset period of the third revolution of the character disc 16. However, these binary circuits actuate means such as slow release control relay mechanisms to be described below which cause such of the Geneva drive gears as are in engagement to remain in engagement and not to become disengaged until during the printing period of the third revolution, as shown by the shaded area 23 in Fig. 7. During the reset period of the third revolution, signals are taken from the control tape 10 (Fig. 1) which govern the selection and indicate the width of the second character. By virtue of the slow releasing relay mechanisms, and since the binary circuits in the counter apparatus 25 were cleared and reset to normal at the beginning of the reset period in the third revolution of

the disc 16 (Fig. 1), the character spacing circuits and apparatus are ready to receive information and be set up in accordance with the width of the second character. This is done during the third reset period, simultaneously with the actual spacing motion for the second character equal to the width of composed line necessary for the now printed first character. The activation of the Geneva mechanism solenoids, the indexing, and the resetting for the second character and succeeding characters is the same as for the first.

#### *The point size adjustment mechanism*

In order to accommodate different point sizes of characters, the displacement imparted to the shaft 46e in Fig. 2 representing the total widths of the characters in a line may need expansion or contraction, as required. This may be accomplished by the point size adjustment mechanism 50 shown in Fig. 3 of the drawings. It comprises essentially a gear train mechanism having a substantially infinitely adjustable ratio of output motion to input motion within certain limits. More specifically, it comprises two pairs of log tape wheels 51 and 52 designed to give ratios of input shaft to output shaft rotation according to the range of point sizes of characters to be composed. For example, if the normal rotation of the character space input shaft 46e (Fig. 2) is adjusted to compose in 12 point type and it is desired to have a point range of from 6 point to 24 point, then the pairs of log tape wheels 51 and 52 should be designed to give ratios of from 2:1 to 1:2. The normal rotation of the shaft 46e (Fig. 2) will then be reduced or increased to compose in the selected type size.

As shown in greater detail in Fig. 3, the pair of wheels 51 comprises the wheels 53 and 54 which are shaped generally as shown. The wheels 53 and 54 are connected by a tape 55 secured to the wheel 53 at 56 and to the wheel 54 at 57, and by a tape 55a secured to the wheels 53 and 54 at 56a and 57a, respectively. The design is such that the rotation of the shaft 58 on which the wheel 53 is mounted is equal to the logarithm of the rotation of the shaft 59 on which the wheel 54 is mounted. Similarly, the pair 52 comprises the wheels 60 and 61 mounted on shafts 62 and 63, respectively, and connected by a tape 64 secured at the point 65 on the wheel 60 and at the point 66 on the wheel 61, and by a tape 64a secured on the wheels 60 and 61 at the points 65a and 66a, respectively. The wheels 60 and 61 are also so shaped that the rotation of the shaft 62 is the logarithm of the rotation of the shaft 63.

The tape wheels 54 and 61 carry stop pins 126 and 127, respectively, which are adapted to cooperate with suitable stops 126a and 127a, respectively, to determine specified initial positions for the wheels 54 and 61. The wheels 54 and 61 are provided with return springs 128 and 129 which serve to bring the pins 126 and 127 to the initial positions determined by the stops 126a and 127a, respectively, when certain of the clutches 104, 100, 67 or the brake 120 are released, as will be described below. The stops 126a and 127a are made adjustable in any known manner to provide a suitable home or starting position for the two sets of log tape wheels. It will be understood that the settings of the stops 126a and 127a will determine the transmission ratio from the shaft 59 to the shaft 63 through and as a result of the operation of the two pairs of log tape wheels.

The shafts 58 and 62 upon which the log tape wheels 53 and 60, respectively, are mounted are adapted to be coupled and uncoupled by means of a clutch 67. Normally, the shafts 58 and 62 are coupled together. However, when it is desired to adjust the positions of the stops 126a and 127a for pins 126 and 127, respectively, as required to effect a change in the point size setting, the clutch 67 is released to enable this to be done.

The pairs of log tape wheels 51 and 52 (Fig. 3) enable an infinite number of ratios of motion between the shafts

59 and 63 to be obtained, as will appear from the following considerations:

Let A and B be the initial settings of the shafts 59 and 63, respectively, as they are adjusted for any desired point size or any desired ratio of motion, and let C and D be the corresponding positions of the shafts 58 and 62, respectively. Then, because of the mechanical construction of the tape wheels or by definition:

$$C = \log A \text{ and } D = \log B$$

For an incremental movement  $\Delta A$  of the shaft 59, the shafts 58, 62, and 63 will be moved incremental amounts  $\Delta C$ ,  $\Delta D$ , and  $\Delta B$ , respectively, since the shafts 58 and 62 are mechanically coupled through the clutch 67. The new positions of the shafts are now, mathematically:

$$C + \Delta C = \log (A + \Delta A) \text{ and } D + \Delta D = \log (B + \Delta B)$$

Solving for  $\Delta C$  and  $\Delta D$ :

$$\Delta C = \log (A + \Delta A) - C$$

and

$$\Delta D = \log (B + \Delta B) - D$$

It will be apparent that  $\Delta C = \Delta D$  because the two shafts 58 and 62 are mechanically coupled by clutch 67.

Equating the two equations for  $\Delta C$  and  $\Delta D$  gives:

$$\log (A + \Delta A) - C = \log (B + \Delta B) - D$$

Substituting  $\log A$  for C and  $\log B$  for D gives:

$$\log (A + \Delta A) - \log A = \log (B + \Delta B) - \log B$$

or:

$$\log \left( \frac{A + \Delta A}{A} \right) = \log \left( \frac{B + \Delta B}{B} \right)$$

Taking the antilog gives:

$$\frac{A + \Delta A}{A} = \frac{B + \Delta B}{B}$$

Or:

$$1 + \frac{\Delta A}{A} = 1 + \frac{\Delta B}{B}$$

Whence:

$$\frac{\Delta A}{A} = \frac{\Delta B}{B}$$

and:

$$\frac{\Delta A}{\Delta B} = \frac{A}{B}$$

From which:

$$\Delta B = \frac{B}{A} \Delta A$$

The last expression, interpreted, means that the incremental rotation of the shaft 63 is equal to the ratio of the initial relative settings of the shafts 63 and 59 times the incremental rotation of the shaft 59. It will be noted that the ratio is linear for any initial setting.

Since the shafts 59 and 63 may be set to represent an infinite number of ratios, it follows that the settings of the pairs of log tape wheels 51 and 52 may provide an infinite number of ratios of motion between them.

#### *The character positioning and justifying mechanism*

Fig. 3 also shows mechanism 29 for justifying a line of characters to be composed by a system utilizing a rotating mirror 37, as in the photocomposing system disclosed in the aforementioned copending application Serial No. 41,318. The justifying mechanism 29 comprises a first pair of log tape wheels 38 and 71 mounted on the shafts 72 and 73, respectively. The wheels 38 and 71 are connected by a tape 74 secured to the wheel 38 at 75 and to the wheel 71 at 76, and by a second tape 74a secured to the wheels 38 and 71 at the points 75a and 76a, respectively. A second pair of log tape wheels 77 and 78 are

mounted on shafts 79 and 80, respectively. The wheels 77 and 78 are connected by a tape 81 connected to the wheel 77 at 82 and to the wheel 78 at 83, and by a tape 81a connected to the wheels 77 and 78 at the points 82a and 83a, respectively. The pairs of tape wheels 38, 71, and 77, 78 are similar in construction to the pairs of tape wheels 51 and 52 in the point size mechanism 50 but differ in the range of driving ratios which they can accommodate. The operation of the two is identical.

The shafts 73 and 80 on which the wheels 71 and 78, respectively, are mounted are adapted to be coupled mechanically by suitable means such as a magnetic clutch 84 controlled in response to signals derived from the tape 10 by the antecedent signal pick-up device 30. During the justifying cycle of the apparatus shown in Fig. 3, the clutch 84 is deenergized and the shafts 73 and 80 are uncoupled so as to enable separate adjustments to be made of the tape wheels 38 and 71 on the one hand, and of the tape wheels 77 and 78 on the other. This adjustment during the justifying cycle establishes the transmission ratio through the two pairs of tape wheels. After adjustment and during the printing cycle, a signal from the printing signal pick-up device 31 (Fig. 1) causes the clutch 84 to be energized to couple the shafts 73 and 80 together as required in the printing operation to be described in greater detail below.

The shaft 79 on which the wheel 77 is mounted is coupled through a conventional electrically operated clutch 68 to a shaft 69 which carries a gear 85 engaging a pinion 86 on a conventional Geneva wheel 87. The Geneva wheel 87 is adapted to be indexed, as previously described, by the usual pin 88 on a driving gear 89 meshed with a gear 70 carried by a continuously rotating shaft 90 which may be driven in synchronism with the shaft 40 (Fig. 2). The driving gear 89 is axially slidable and it carries the usual hub 91 which is slotted half-way through at 92 as shown. Normally, suitable means such as a spring (not shown) maintains the driving gear 89 in such position that the pin 88 cannot engage the Geneva wheel 87 while the unslotted portion of the hub 91 engages one of the curved edges of the wheel 87 so that the latter is locked against movement.

The driving gear 89 is adapted to be shifted axially by suitable means such as a conventional solenoid 93, for example, to a position where the pin 88 will engage a slot in the Geneva wheel 87, the latter being at this time in alignment with the slotted portion 92 of the hub 91 so that the Geneva wheel 87 may be indexed once for each revolution of the driving gear 89. The solenoid 93 is normally deenergized, but it is adapted to be energized by solenoid control mechanism responsive to word space code elements on the tape 10, as described in greater detail below. During the justifying cycle the control mechanism for the solenoid 93 responds only to word space signals generated by the antecedent signal pick-up device 30, whereas during the printing cycle it responds only to word space signals generated by the printing signal pick-up device 31.

The shaft 72 on which the wheel 38 is mounted carries a gear 94 engaging one input element 95 of a conventional differential 96, the other input element of which is adapted to be driven by the shaft 63. The output element of the differential 96 drives a shaft 96a coupled by conventional electrically controlled clutch mechanism 100 to a shaft 100a carrying a worm 97 engaging a worm wheel 98 on which the shaft 99 supporting the reflector 37 is mounted. Conventional electrically controlled braking mechanism 120 is also provided for the shaft 96a. During the justifying cycle, the clutch mechanism 100 is deenergized while the brake mechanism 120 is energized so that the shafts 96a and 100a are uncoupled while the shaft 96a is braked. At the conclusion of the justifying cycle, the braking mechanism 120 is deenergized and a signal from the printing signal pick-up device 31 energizes the clutch mechanism 100 so that the shaft 96a is

released and coupled to the shaft 100a in which condition it remains until the conclusion of the printing cycle.

The gear 94 on the shaft 72 also carries a pin 101 which is adapted to engage an adjustable stop 102. Normally, the gear 94 is urged by suitable means such as a spring 121 in the direction to bring the pin 101 into engagement with the stop 102 and the position of the latter is so chosen that the angular displacement of the gear 94 from a reference position when the two are in engagement will be proportional to the total line length available for printing a line of characters.

The justifying mechanism 29 performs the mathematical operations of subtracting the space  $a$  occupied by the characters in a line from the total line length  $(a+b)$ , dividing the remainder  $(b)$  by the number of word spaces  $(r)$  in the line, and then delivering the quotient, or the individual word space  $(s)$ , as a metered amount of motion to the mirror 37 during the composition of the line at each point where a word space is called for.

At the beginning of a justifying cycle, and when appropriate ones of the clutches in the mechanism have been deenergized to this end, the spring 121 on the gear 94 urges the pin 101 into engagement with the stop 102, at which time the shaft 72 has taken an angular displacement proportional to the total line length  $a+b$ . Appropriate ones of the clutches are then energized to couple the several parts of the mechanism operatively, as will be described later herein. As character space data,  $a$  is entered by rotating the shaft 72 during the justifying cycle, the shaft 72 rotates towards the zero position, thus accomplishing the subtraction of character space from total line length. At the end of a justifying cycle, the shaft 72 will finally reach a position proportional to the total word space  $b$  in the line and the shaft 73 will have assumed a position proportional to the logarithm of the total word space  $b$ .

During the justifying cycle, the clutch 84 is open so that the shafts 73 and 80 are free to assume their respective positions according to the amount of character space and the number of word spaces in the line being justified. Each time a word space is scanned by the antecedent signal pick-up device 30, it supplies a signal to solenoid control mechanism to be described later, which energizes the solenoid 93, thereby releasing the Geneva wheel 87 and enabling it to be indexed once by the pin 88.

Accordingly, at the end of the justifying cycle, the shaft 79 will have been rotated an amount proportional to the total number of word spaces  $r$  in the line being justified. Also, the shaft 72 will have acquired an angular displacement from zero position proportional to the total word space  $b$  in the line. If, under these conditions, the clutch 84 is energized to couple the shafts 73 and 80, it can easily be shown that unit motion of the shaft 79 will deliver unit word space motion to the shaft 72.

At the end of the justifying cycle, the printing signal pick-up device 31 (Fig. 1) generates a signal which energizes the clutch 84, coupling the shafts 73 and 80 together. At this point, the mechanism 29 has been set up for a motion ratio from shaft 79 to shaft 72 of

$$\frac{b}{r}$$

$$r$$

Since

$$\frac{b}{r}$$

$$r$$

is the quantity representing one word space  $s$ , unit motion of the shaft 79 will deliver unit word space motion of the shaft 72. Further, since indexing the word space Geneva wheel 87 one slot will give the shaft 79 unit motion, unit justified word space will be delivered by the shaft 72 each time the word space Geneva 87 is indexed.

In a photocomposing system of the type disclosed in the above-mentioned copending application Serial No.

41,318, two justifying and character positioning mechanisms of the type shown in Figs. 2 and 3 herein would be employed for rotating the reflector 37, the second (not shown) being adapted to rotate a shaft 103 connected to the worm 97 (Fig. 3). This would enable one unit to perform a justifying function on the line next to be composed while the second unit is performing a composing function on the line being composed.

### The control system

A typical control system for use with the character positioning mechanism shown in Figs. 2 and 3 is illustrated in Figs. 4-6, inclusive, and a graph illustrating the sequence of operations of the several components is shown in Fig. 7. The antecedent and printing pick-up devices 30 and 31, respectively, may be of the type disclosed in the above-identified copending application Serial No. 41,318. Thus, the antecedent scanning device 30 (Fig. 4) comprises a photoelectric cell 201 responsive to character space indicia on the control tape 10 (Fig. 1), which furnishes an input to an amplifier 202, and a photoelectric cell 203 responsive to different code indicia on the tape 10 representing word space and justifying signals, respectively, which supply signals to an amplifier 204. As indicated in the aforementioned copending application Serial No. 41,318, the shapes of the word space and justifying indicia on the tape 10 are such that they produce signals having different time rates of change, respectively. A filter network 205 is provided which receives the output of the amplifier 204 and passes only word space signals to an amplifier 206 and only justifying signals to an amplifier 207.

The printing scanning device 31 (Fig. 4) comprises a first group of photoelectric cells 208, 209 and 210 which are responsive to indicia on the control tape 10 (Fig. 1) representing character space, word space and line signals, respectively, and a second group of photoelectric cells 211-214, inclusive, which are responsive to other indicia on the control tape 10 that determine the characters to be selected for printing in a line. Preferably, a plurality of amplifiers 215-221, inclusive, are provided for amplifying the signal outputs of the photoelectric cells 208-214, respectively. The outputs of the amplifiers 218-221, inclusive, are fed to suitable character selecting circuits designated by the reference character 222. These form no part of the invention and they may be substantially the same as those employed in the photocomposing system disclosed in the above-identified copending application Serial No. 41,318.

Each time a line signal is generated by the photoelectric cell 210, a pulse is produced which is fed from the amplifier 217 through a conductor 223 to a conventional flip-flop circuit 224, successive operations of which cause the justifying mechanism shown in Figs. 2 and 3 to effect justifying and printing operations alternately. The flip-flop circuit 224 may be of the usual type comprising a pair of electron tubes 225 and 226 (Fig. 6) connected, as shown, to a plurality of resistors 227, 228, 229, 230 and 231 and to a plurality of condensers 232, 233 and 234. Between the positive plate supply lead and the plate 233 of the tube 226 are interposed in series the windings 234 and 235 of a slow actuating and slow releasing relay 236 and a quick-acting relay 237, respectively. For details as to the operation of flip-flop circuits of this type, reference is made to the book "Wave Forms," by Chance, Hughes et al., page 612 et seq.

With the relay 236 in the position shown in Fig. 4, the portion of the control system shown is connected to perform a justifying cycle of operation. Thus, character space signals generated by the photoelectric cell 201 are fed from the output of the amplifier 202 through a circuit including the conductor 238, the movable contact 239 of the relay 236 engaging the fixed contact 240, and a conductor 241 to the several counter circuits 25a, 25b, 25c, 25d and 25e in the binary counter apparatus 25

which controls the operation of the character space mechanism shown in Fig. 2. The binary counter circuits 25a-25e, inclusive, are identical in construction and it will be necessary, therefore, to describe only one in detail.

As shown in Fig. 5, the binary counter circuit 25a includes a pair of electron tubes 242a and 243a, which may conveniently be contained in a single envelope, connected in a circuit including a plurality of resistors 244a, 245a, 246a, 247a, 248a, 249a and 250a, a plurality of condensers 251a, 252a and 253a and a pair of unilaterally conducting devices 254a and 255a, as indicated in the figure. In series with the plate lead of the tube 242a, which is normally nonconducting, is a slow releasing relay 256a. It will be recognized that the circuit 25a is a conventional bistable flip-flop circuit. The operation of circuits of this type is explained in detail on pages 164-166, inclusive, and in pages 604-612, inclusive, of the aforementioned textbook by Chance, Hughes et al.

The counter circuit 25a receives an input from the conductor 241 and provides a pulse output at the conductor 257a which constitutes the input to the next counter circuit 25b, the output of each counter circuit being fed as an input to the next. In operation, upon receipt of one signal pulse from the conductor 241, conduction is transferred from the tube 243a to the tube 242a, thus energizing the relay 256a. When the next signal is received over the conductor 241, the tube 242a becomes nonconducting again, while the tube 243a becomes conducting. This sends a negative output pulse over the conductor 257a to the input of the next counter circuit 25b so that the counter apparatus 25 counts in binary fashion with the relays 256a, 256b, 256c, 256d and 256e registering the activated count.

In operation of the character positioning systems described herein, it is necessary to reset each of the binary circuits 25a-25e, inclusive, to its zero condition just after the last characters on the character disk 16 (Fig. 1) have passed the projection position and before the indicia on the tape 10 are read during the reset sector 22 of the character disk 16. This may be accomplished by connecting the junction point between the resistors 245a and 246a (Fig. 5) to a brush 258 which engages the surface of a conventional rotating commutator 259 driven in synchronism with the character disk 16 and having a conducting surface 260 interrupted by a narrow insulating segment 261. It will be understood that each time the insulating segment 261 passes beneath the brush 258, a ground connection to the junction point between the resistors 245a and 256a will be disconnected, thereby resetting the binary circuit 25a to its zero condition in which the tube 242a is nonconducting, while the tube 243a is conducting. The commutator 259 is connected in a similar manner to each of the binary circuits 25b, 25c, 25d and 25e (Fig. 4) so that they are also reset at the same time.

The relay 256a (Figs. 4 and 5), when energized, is adapted to close its normally open contacts 262a thereby connecting one terminal of the solenoid 21a, which controls actuation of the Geneva wheel mechanism 38a (Fig. 2), to the positive terminal of a source of electrical energy (not shown). The other terminal of the solenoid 21a is grounded so that the latter is energized and causes the Geneva wheel mechanism 38a to be indexed once. Similar connections are provided between the relays 256b-256e, inclusive, and the Geneva wheel mechanism solenoids 21b-21e, respectively, and corresponding parts have been designated by like reference characters having appropriate letters.

Another flip-flop circuit 263 (Fig. 4), which may be identical with that shown in Fig. 5 except that a slow release relay 264 is substituted for the relay 256a, is adapted to act in response to line signals received over the conductors 223 and 265 to control the clutch 104 (Fig. 2) and to prepare circuits for controlling the brake mechanism 120, the clutch 100 and a relay 266 (Figs. 75

3 and 4) which determines whether or not a standard word space or justified word space is to be inserted in the line to be composed. Thus, one terminal of the clutch 104 is connected to ground and the other terminal is connected through the normally closed contacts 267 on the relay 264, a conductor 268, and the normally closed contacts 269 on an adjusting relay 270 to the positive terminal of a source of electrical energy (not shown) the negative terminal of which is grounded.

Similarly, one terminal of the brake mechanism 120 is grounded and the other terminal is connected by a conductor 270a through the normally closed contacts 271 on the relay 264, a conductor 272a, the contacts 272 and 273 on the relay 236, the conductor 268, and the closed contacts 269 on the adjusting relay 270 to the positive source of electrical energy.

In like manner, one terminal of the clutch 100 is grounded and its other terminal is connected by a conductor 274 through the normally closed contacts 275, a conductor 276, the contacts 277 and 272 on the relay 236 (which are open in the position shown), the conductor 268, and the closed relay contacts 269 on the adjusting relay 270 to the positive terminal of the source of electrical energy.

The relay 266 has one terminal connected to the plate 278 of a conventional grid controlled gas discharge tube 279 such as a thyratron, for example, the cathode 280 of which is connected to ground, as shown. The other terminal of the relay 266 is connected through the conductors 350 and 305 and the normally closed contacts 306 of the relay 264 to the positive terminal of the voltage supply (not shown). The grid 281 of the tube 279 receives justifying signals from the amplifier 207 through the movable contact 282 on the relay 236 engaging the fixed contact 283, a conductor 284 and a condenser 285, a resistor 286 being connected between the grid 281 and ground.

The solenoid 93 which controls the word space generating mechanism (Figs. 3 and 4) has one terminal connected to ground and another terminal connected by a conductor 287 through the normally open contacts 288 of a relay 289 to the positive terminal of the source of electrical energy (not shown), the negative terminal of which is grounded. The relay 289 is adapted to be energized by another flip-flop circuit 290 which may be identical in construction with the circuit 25a shown in Fig. 5, the relay 289 corresponding to the relay 256a in the latter.

During the justification cycle, the flip-flop circuit 290 is adapted to receive word space signals from the amplifier 206 through a conductor 291, the closed contacts 292 and 292a on the relay 236 and a conductor 293. When the system shown in Fig. 4 is connected to effect the composing operation, however, the flip-flop circuit 290 receives printing word space signals from the amplifier 216 through a conductor 294, the movable contact 295 on the relay 236 engaging the fixed contact 296, a conductor 297, the movable contact 298 on the relay 266, the fixed contact 299 and a conductor 300.

In some cases, as for a paragraph ending, for example, the line of characters does not need to be justified. Under such conditions, the relay 266 and its control thyratron 279 provide for the insertion of standard word spaces rather than justified word spaces between successive words. Thus, where justification is required, a justifying pulse from the amplifier 207 will be transmitted through the engaged contacts 282 and 283 on the relay 236 to the grid 281 of the thyratron 279, causing it to become conducting and energizing the relay 266. This will cause the movable relay contact 298 to engage the contact 299 so that on the composing cycle when the contacts 295 and 296 on the relay 236 are engaged, printing word space signals will be transmitted to the flip-flop circuit 290, which will control the solenoid 93 through

the relay 289 to insert justified word spaces in the composed line, as required.

On the other hand, if justification is not required, no justifying signal will be received so that the relay 266 will not be energized. Hence, word space signals generated during the composing cycle will be supplied from the amplifier 216 through the conductor 294, the engaged contacts 295 and 296 on the relay 236, the conductor 297, the engaged contacts 298 and 301 on the relay 266, and a conductor 302 to the input of the binary circuit 25e. This will operate the solenoid 21e through the relay 256e to cause the Geneva wheel mechanism 38e to insert a 16 unit space as a standard word space between words.

#### Operation

In operation, let it be assumed that the character positioning and justifying mechanism shown in Figs. 2 and 3 is to undergo successively justifying and composing cycles as required for the justification and composition of a line of type. During the reset period of the first revolution of the character disk 16 (Fig. 1) in the justifying cycle, a line signal will be generated by the photoelectric cell 210 in response to an appropriate code on the control tape 10 (Fig. 1) and the output signal from the amplifier 217 will be fed to the flip-flop circuit 224. The latter will act to operate the slow releasing relay 236 in accordance with the time sequence shown generally in line F of the graph illustrated in Fig. 7. Simultaneously, the relay 237, which is in series with the relay 236, opens, disengaging its contacts 303 and disconnecting the justifying log tape wheel coupling clutch 84 from the positive terminal of a source of electrical energy (not shown) thereby releasing the clutch 84.

At the same time, the closed contacts 304 on the relay 237 are opened so that one energizing circuit for the justifying reset clutch 68 is broken. However, the clutch 68 does not release because another energizing circuit through a conductor 305 and the closed contacts 306 on the relay 264 is still closed. The clutch 68 is not released until the relay contacts 306 are opened a short time later.

The line signal from the amplifier 217 is also transmitted through the conductors 223 and 265 to the flip-flop circuit 263 which causes the relay 264 to be energized, opening its normally closed contacts 267. This opens the energizing circuit for the clutch 104 so that the latter is released. At the same time, the contacts 271, 275 and 306 are opened so that the clutches 100 and 68 are released. With the release of the clutches 104, 100, 84 and 68, the point size adjusting and the justifying mechanisms are returned to their normal or starting positions through the action of the return springs 128, 129, 121 and 132. Also, the mirror 37 (Fig. 3) is returned to its line beginning position through the action of a return spring 131 mounted on the shaft 103.

The opening of the relay contacts 306 on the relay 264 extinguishes the thyatron 279 and deenergizes the relay 266. This causes the movable contact arm 298 of the latter to disengage the fixed contact 299 and to engage the fixed contact 301 which is the normal position of the justifying sensing circuit.

At the beginning of the reset period of the second revolution of the character disk 16 (Figs. 1 and 7), the reset commutator 259 resets the flip-flop circuits 263 and 290 to their normal conditions of operation, thereby deenergizing the relays 264 and 289. Deenergization of the relay 264 closes its contacts 267 and energizes the clutch 104.

The closing of the relay contacts 271 energizes the brake 120 and the closing of the contacts 306 energizes the clutch 68. At the same time, plate voltage is applied to the thyatron 270 through the relay 266. The closing of contacts 275 does not energize the clutch 100 since its source of current is interrupted by the operation of the relay 236.

If, during the justifying cycle, a justifying signal is generated by the photoelectric cell 203, a signal will be fed from the amplifier 207 to the grid 281 of the thyatron 279 causing the latter to become conducting and energizing the relay 266. This will disengage the movable contact 298 from the fixed contact 301 and cause it to engage the fixed contact 299, thus preparing a circuit for the insertion of justified word spaces between words.

As the antecedent signal pick-up device 30 (Figs. 1 and 4) scans the respective character width indicia on the control tape 10, the photocell 201 generates signals which are amplified by the amplifier 202 and fed through the conductor 233, the engaged contacts 239 and 240 on the relay 236 and the conductor 241 to the several binary circuits in the binary counting apparatus 25. This results in operation of appropriate ones of the relays 256a-256e, inclusive, causing appropriate ones of the Geneva mechanisms 38a-38e, inclusive, to produce a total displacement of the shaft 46e proportional to the total width of the characters. This displacement is either reduced or increased by the point size adjustment mechanism 50 (Figs. 3 and 4) as required for the particular point size that has been selected and the reduced or increased displacement appears at the shaft 63 which feeds it as one input to the differential 95.

Since the shaft 96a at this time is braked by the braking mechanism 129, the character width information represented by the total displacement imparted to the shaft 63 is fed to the gear 94 in the justifying and character positioning mechanism 29 (Figs. 3 and 4). This causes the gear 94 to move from its maximum line length position (in which the pin 101 is in engagement with the stop 102) towards the zero position. At this time, the clutch 84 is disengaged (Figs. 3 and 7) so that the log tape wheels 38 and 71 are free to assume positions commensurate with the movement of the gear 94.

In the meantime, whenever a word space code indicia on the control tape 10 (Fig. 1) is scanned by the photoelectric cell 203 in the antecedent signal pick-up device 30 (Fig. 4), a signal is generated which is amplified in the amplifier 204 and transmitted through the filter network 205 to the amplifier 206. From the amplifier 206, the word space signal is transmitted through the conductor 291, the closed contacts 292 and 292a of the relay 236 and the conductor 293 to the flip-flop circuit 290, causing the latter to operate and energize the relay 289. This closes the relay contacts 288 and completes the energizing circuit for the clutch 93, causing the pin 88 on the gear 89 to index the Geneva wheel 87 once and produce a corresponding movement of the shaft 79.

At the end of the justifying cycle, the gear 94 will be in a position of displacement representing the difference between the total line length and the total width of all the characters in the line and the log tape wheels 38 and 71 will have been brought to a corresponding position. At the same time, the Geneva wheel 87 will have been indexed a number of times equal to the number of word spaces in the line so that the log tape wheels 77 and 78 will have been brought to a corresponding position.

As stated, a line end code indicia is formed on the control tape 10 (Fig. 1) at the end of each line of characters. When a line end indicia is scanned by the photoelectric cell 210 in the printing signal pick-up device 31, a signal is generated which is amplified in the amplifier 217 and transmitted over the conductor 223 to the flip-flop circuit 224. Actuation of the flip-flop circuit 224 reverses the position of the slow acting relay 236, causing the movable relay contacts 239, 292, 282, 307, 205, 272a and 308 to disengage the fixed contacts 240, 292a, 283, 309, 310, 273 and 311, respectively, and to engage the fixed contacts 312, 313, 314, 315, 296, 297 and 317, respectively. This transfers the justifying and character positioning mechanism shown in Figs. 2, 3 and 4 from the justifying function to the composing function, while

the second justifying and character positioning mechanism (not shown) ceases the composing function and begins the justifying function on the next line of characters on the control tape 10.

Actuation of the flip-flop circuit 224 also energizes the quick acting relay 237 which is in series with the relay 236, thereby closing its normally open contacts 303 and 304. The closing of the contacts 303 energizes the clutch 84 and couples the shafts 73 and 80 (Fig. 3) together. The closing of the relay contacts 304 maintains the justifying reset clutch 68 energized and prevents it from resetting during the transfer to the composing cycle as it would when the relay 264 is deenergized, as described below.

The line signal is also applied over the conductors 223 and 265 to the flip-flop circuit 263 which energizes the relay 264. However, since the relay 264 is of the slow releasing type, it delays opening its contacts for a short period of time after the reset period of the first revolution of the disk 16 (Fig. 1) in the composing cycle. The opening of the contacts 267 and 271, respectively, releases the clutch 104 and the brake 120, enabling the point size mechanism 50 (Fig. 3) to return to its initial position under the influence of the return springs 128 and 129. Since the clutch 84 (Figs. 3 and 4) was engaged immediately upon receipt of the line signal to lock the gear 94 through the two pairs of log tape wheels 78 and 77, the engaged clutch 68, the gearing 85, 86 and the locked Geneva wheel 87, the gear 94 cannot move under the influence of its return spring 121, so that it maintains the previously made adjustment for proper justification of the line.

With the release of the clutch in the second unit (not shown) which corresponds to the clutch 100 on the shaft 103 (Fig. 4), the mirror 37 returns to its line beginning position under the influence of its return spring 131 (Fig. 3). As indicated, since the contacts 304 of the fast acting relay 237 were closed before the contacts 306 of the slow releasing relay 264 were opened, the justifier reset clutch 68 is maintained energized during the transfer function. Also, voltage is maintained on the plate of the thyatron 279 (Fig. 4) during the transfer function through this same circuit.

At the beginning of the reset period of the second revolution in the composing cycle (Fig. 7), the commutator 259 acts to reset the flip-flop circuit 263, thus deenergizing the relay 264 and permitting its contacts 267, 271, 275 and 306 to close. This results in energization of the clutches 104 and 100, the latter through the closed contacts 275 on the relay 264 and the closed contacts 272 and 277 on the relay 236. The mechanism is now ready for the composing cycle.

The indicia on the control tape 10 (Fig. 1) which were previously scanned by the antecedent pick-up device 30 are now scanned by the printing signal pick-up device 31. Character space indicia scanned by the photoelectric cell 208 generate electric signals which, after amplification in the amplifier 215 are transmitted through the engaged contacts 307 and 315 of the relay 236 and the conductor 241 to the binary circuits 25a-25e, inclusive, in the binary counting apparatus 25. This results in energization of one or more of the relays 256a-256e, inclusive which cause corresponding ones of the Geneva wheel solenoids 21a-21e, respectively, to be energized to actuate the corresponding ones of the Geneva mechanisms 38a-38e, respectively (Fig. 2). The operation of the Geneva mechanisms causes incremental displacements to be imparted to the shaft 46e in proportion, respectively, to the widths of the characters represented by the several code elements scanned. These displacements are either reduced or increased by the point size adjustment mechanism 50 (Fig. 3) following which they appear at the shaft 63.

So long as only character width indicia on the control tape 10 (Fig. 1) are being scanned, the gear 94 remains

stationary so that the output of the shaft 63 is transmitted to the shaft 96a (Figs. 3 and 4) and rotates the worm 97 to turn the reflector 37 as required to position the several characters of a word along a line on the photosensitive medium 18.

When a word space code indicia on the control tape 10 (Fig. 1) is scanned by the photoelectric cell 209 in the printing signal pick-up device 31 (Fig. 4), a signal is generated which is fed from the amplifier 216 through the conductor 294, the engaged contacts 295 and 296 on the relay 236, the conductor 297, the engaged contacts 298 and 299 on the energized relay 266 and the conductor 300 to the flipflop circuit 290. This actuates the flip-flop circuit 290 and operates the relay 289 causing its contacts 288 to become engaged to energize the solenoid 93. This causes the pin 88 on the gear 89 to index the Geneva wheel 87 once. Since the clutches 68 and 84 are now engaged, the gear 94 rotates an amount equal to the word space which should be inserted between successive words in order to insure composition of the characters in a properly justified line. The rotation of the shaft 94 is fed as a second input to the differential 955 and appears at the shaft 96a which drives the worm 97.

The apparatus continues to operate in this manner until the entire line of characters has been exposed on the photosensitive emulsion 18 (Fig. 3). When that occurs, the reflector 37 is returned to its initial position and the operation of the unit shown in Figs. 2 and 3 is switched from the composing function back to the justifying function, while the second unit (not shown) is switched from the justifying function to the composing function in the manner described hereinabove.

As previously stated, the stops 126a and 127a for the pins 126 and 127 of the point size adjusting mechanism 50 (Fig. 3) are adapted to be positioned according to the size desired for the composed type. Also, the stop 102 for the pin 101 of the justifying mechanism is adapted to be adjusted according to the length desired for the composed line. These adjustments may be made by closing an adjusting switch 315 (Fig. 4) to energize the relay 270 and open its normally closed contacts 269. This deenergizes the clutches 67, 100, 104 and 84 and releases the brake 120 so that the adjustments mentioned above may be effected by manual or other means. It will be understood that the two adjustments of point size and line length should be made prior to the justifying cycle of any particular line to be composed.

The invention thus provides novel and effective mechanical apparatus for positioning characters in correctly justified lines on a photosensitive medium. Further, it enables a wide range of character widths to be accommodated and also provides means for adjusting the point size of the characters in the printing line.

The mechanism for selecting the characters to be printed forms no part of the invention. Apparatus suitable for the purpose is disclosed in the aforementioned application Serial No. 41,318. That application also includes a detailed disclosure of a number of components and control circuits that have been referred to broadly above. In order to avoid duplication, such components and control circuits are described herein only to the extent necessary for an understanding of the invention.

The specific embodiment described herein and illustrated in the drawings is obviously susceptible of considerable modification within the spirit of the invention. It, therefore, is to be regarded merely as illustrative and as not limiting the scope of the following claims.

I claim:

1. In justifying apparatus, the combination of a first pair of log tape wheels carried, respectively, by one and another shafts and coupled together to provide a logarithmic motion transmission ratio from the former to the latter shaft, means normally maintaining said shafts in an initial position corresponding to the length of a line

of characters, a second pair of log tape wheels carried, respectively, by one and another shafts and coupled together to provide a logarithmic motion transmission ratio from the former to the latter shaft, means for coupling and uncoupling said other shaft of said first pair and said other shaft of said second pair of log tape wheels, means operable when said other shafts are uncoupled for moving said shafts of said first pair of log tape wheels from said initial position as a function of the widths of the characters to be printed in a line, and means operable when said other shafts are uncoupled for moving said shafts of said second pair of log tape wheels as a function of the number of word spaces in said line of characters said movements when completed and said other shafts thereafter coupled together providing therethrough and between said one shafts a motion transmission ratio representing the size of justified word spaces along said line.

2. In justifying apparatus, the combination of a first pair of log tape wheels carried, respectively, by one and another shafts and coupled together to provide a logarithmic motion transmission ratio from the former to the latter shaft, means normally maintaining said shafts in an initial position corresponding to the length of a line of characters, a second pair of log tape wheels carried, respectively, by one and another shafts and coupled together to provide a logarithmic motion transmission ratio from the former to the latter shaft, means for coupling and uncoupling said other shaft of said first pair and said other shaft of said second pair of log tape wheels, a record strip having first indicia representing character width information and second indicia representing word space information, means responsive to said first indicia for displacing when said other shafts are uncoupled said shafts of said first pair of log tape wheels as a function of the character widths represented by said first indicia, and means responsive to said second indicia for displacing said shafts of said second pair of log tape wheels as a function of the number of word spaces represented by said second indicia, said displacements when completed and said other shafts thereafter coupled together providing therethrough and between said one shafts a motion transmission ratio representing justified word spaces along said line.

3. In justifying apparatus, the combination of a first pair of log tape wheels mounted on, respectively, one and another shafts and coupled together to provide a logarithmic motion transmission ratio from the former to the latter shaft, a second pair of log tape wheels mounted on, respectively, one and another shafts and coupled together to provide a logarithmic motion transmission ratio from the former to the latter shaft, releasable means for coupling said other shaft in said first pair with said other shaft in said second pair of log tape wheels, means normally urging said one shaft of said first pair of log tape wheels to an initial position representing line length, stop means retaining said one shaft in said first pair shaft in said initial position, means operable when said other shafts are uncoupled for displacing said one shaft in said first pair shaft away from said initial position as a function of the widths of characters in a line, and means operable when said other shafts are uncoupled for displacing said one shaft of said second pair of log tape wheels as a function of the number of word spaces in a line.

4. In justifying apparatus, the combination of a first pair of log tape wheels each mounted on a shaft, a second pair of log tape wheels each mounted on a shaft, releasable means for coupling a shaft in said first pair with a shaft in said second pair of log tape wheels, means normally urging the other shaft of said first pair of log tape wheels to an initial position representing line length, stop means retaining said other shaft in said initial position, a record strip carrying first indicia representing character widths and second indicia representing word spaces, means responsive to said first indicia on the record strip for displacing said other shaft away from said initial posi-

tion as a function of the widths of characters in a line, and means responsive to said second indicia on the record strip for displacing the other shaft of said second pair of log tape wheels as a function of the number of word spaces in a line.

5. In justifying apparatus, the combination of a first pair of log tape wheels each mounted on a shaft, a second pair of log tape wheels each mounted on a shaft, releasable means for coupling a shaft in said first pair with a shaft in said second pair of log tape wheels, means normally urging the other shaft of said first pair of log tape wheels to an initial position representing line length, stop means retaining said other shaft in said initial position, a record strip carrying first indicia representing character widths and second indicia representing word spaces, a plurality of mechanisms responsive to said first indicia on the record strip for producing mechanical outputs of different unit magnitudes representing in sum the widths of characters, means for displacing said other shaft of the first pair of log tape wheels away from said initial position in accordance with the total output from said plurality of mechanisms, Geneva mechanism adapted when indexed to displace the other shaft of said second pair of log tape wheels, and means responsive to said second indicia on the record strip for indexing said Geneva mechanism.

6. In justifying apparatus, the combination of a first pair of log tape wheels each mounted on a shaft, a second pair of log tape wheels each mounted on a shaft, releasable means for coupling a shaft in said first pair with a shaft in said second pair of log tape wheels, means normally urging the other shaft of said first pair of log tape wheels to an initial position representing line length, stop means retaining said other shaft in said initial position, a record strip carrying first indicia representing character widths and second indicia representing word spaces, a plurality of Geneva mechanisms adapted when indexed to produce different unit mechanical outputs, means responsive to said first indicia on the record strip for indexing certain of said Geneva mechanisms to produce a total mechanical output therefrom representing character width, means for displacing said other shaft of the first pair of log tape wheels away from its initial position in accordance with the total output from said plurality of Geneva mechanisms, another Geneva mechanism adapted when indexed to displace the other shaft of said second pair of log tape wheels, and means responsive to said second indicia on the record strip for indexing said another Geneva mechanism.

7. In printing apparatus having a carrier medium and printing means adapted to assume with respect to said carrier medium successive printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, the combination of a movable member adapted upon displacement thereof to produce relative movement in terms of printing position between said carrier medium and said printing means, a record strip bearing first indicia in the form of binary digit groups of which the total value of the digits in each group represents a character width in terms of units of displacement in the direction of said relative movement and bearing second indicia representing word spaces, a plurality of mechanisms relatively corresponding to the binary digits in said groups thereof and adapted when actuated to provide respective, fixed value mechanical outputs whose magnitudes are graded in the proportional relation characterizing said binary digits, means responsive to the binary digits in each group thereof formed by first indicia on said record strip for actuating corresponding ones of said mechanisms to provide outputs therefrom which total to a magnitude commensurate with the character width represented by the binary digit group, mechanical means for imparting to said movable member a displacement in accordance with said total magnitude, and other mechanical means responsive to said

second indicia on the record strip for displacing said movable member to insert a word space between words during the printing of a line.

8. In justifying apparatus, the combination of a movable member for controlling the positioning of characters on a medium, a record strip carrying first indicia representing character widths as sums of units of displacement along a printed line and second indicia representing word spaces, a plurality of mechanisms including Geneva movements, said mechanisms being adapted when the Geneva movements thereof are indexed to provide different unit mechanical outputs, means responsive to each given first indicia on the record strip for indexing certain of said Geneva mechanisms to produce outputs therefrom representing in total output the sum denoted by said given indicia and thus the associated character width, means for displacing said movable member in accordance with the total output from said mechanisms to control the positioning of characters on said medium, and means responsive to said second indicia on the record strip for displacing said member to insert word space between words being positioned on said medium.

9. In justifying apparatus, the combination of a movable member for controlling the positioning of characters on a medium, a record strip carrying first indicia representing character widths and second indicia representing word spaces, first mechanical means responsive to said first indicia on the record strip for displacing said movable member to control the positions of characters on said medium, a first pair of log tape wheels having shafts therefor, a second pair of log tape wheels having shafts therefor, releasable means coupling one shaft of said first pair and one shaft of said second pair of log tape wheels, Geneva mechanism adapted when indexed to displace the other shaft of said second pair of log tape wheels, thereby displacing the other shaft of said first pair of log tape wheels, means responsive to said second indicia on the record strip for indexing said Geneva mechanism, and means for displacing said movable member in accordance with the displacement of said other shaft of the first pair of log tape wheels.

10. In justifying apparatus, the combination of a movable member for controlling the positioning of characters on a medium, a record strip carrying first indicia representing character widths and second indicia representing word spaces, a plurality of Geneva mechanisms adapted when indexed to provide different unit mechanical outputs, means responsive to said first indicia on the record strip for indexing certain of said Geneva mechanisms to produce outputs therefrom representing in sum character widths, means for displacing said movable member in accordance with the total output from said Geneva mechanisms to control the positioning of characters on said medium, adjustable mechanism interposed between said Geneva mechanisms and the movable member for modifying the total output from said Geneva mechanisms as required to accommodate different point sizes of characters, a first pair of log tape wheels having shafts therefor, a second pair of log tape wheels having shafts therefor, releasable means coupling one shaft of said first pair and one shaft of said second pair of log tape wheels, another Geneva mechanism adapted when indexed to displace the other shaft of said second pair of log tape wheels, thereby displacing the other shaft of said first pair of log tape wheels, means responsive to said second indicia on the record strip for indexing said another Geneva mechanism, and means for displacing said movable member in accordance with the displacement of said other shaft of the first pair of log tape wheels.

11. In printing apparatus having a carrier medium and printing means adapted to assume with respect to said carrier medium successive printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, the

combination of a movable member adapted upon displacement thereof to produce relative movement in terms of printing position between said carrier medium and said printing means, a record strip bearing first indicia representing character widths and second indicia representing word spaces, means for scanning a complete line of said first and second indicia a first time for justifying purposes and a second time for printing purposes, first mechanical means responsive for both scanings to said first indicia for producing mechanical displacements respectively commensurate with the character widths denoted thereby, second mechanical means responsive for both scanings to said second indicia for producing corresponding unit value mechanical displacements representing unjustified word spaces, mechanism for transmitting word space displacements during said second scanning from said second mechanical means to a movable element of said mechanism, said mechanism during said first scanning being adjustable responsive to character width and word space displacements supplied thereto over the whole scanned line from said first and second mechanical means to provide through said mechanism a motion transmitting ratio which, when said second scanning occurs, converts unjustified word space displacements from said second mechanical means into displacements of said movable element commensurate with the size of justified word spaces for the scanned line, and means responsive during said second scanning to the character width displacements of said first mechanical means and the justified word space displacements of said movable element for producing commensurate displacements of said movable member.

12. A combination as in claim 11 wherein the last-named means of said claim comprises a differential means having an input coupled with said first mechanical means to receive the character width displacements produced thereby, an output, and a differentially movable element coupled with said movable element of said adjustable mechanism, said combination further comprising means operable during said first scanning for holding said output to produce adjustment of the ratio of said mechanism by transmission of character width displacements thereto from said first mechanical means through the input and movable element of said differential means and to the movable element of said mechanism, and means operable during said second scanning for coupling said output to said movable member, said differential means producing displacements at its output in accordance with the displacements received at its input from said first mechanical means and at its movable element from said adjustable mechanism.

13. In printing apparatus having a carrier medium and printing means adapted to assume with respect to said carrier medium successive printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, the combination of a movable member adapted upon displacement thereof to produce relative movement in terms of printing position between said carrier medium and said printing means, a record strip bearing indicia in the form of binary digit groups of which the total value of the digits of each group represents a character width as sums of displacement units in the direction of said relative movement, means having a plurality of outputs respectively corresponding to the binary digits in said groups thereof, said means being responsive to the binary digits in each group thereof formed by said indicia for producing at corresponding ones of said plurality of separate outputs mechanical displacements of fixed value representing in accordance with the outputs at which they appear the value of the digits of the binary digit group, mechanical means responsive to the displacements appearing at said outputs for producing therefrom a total displacement which in amount is commensurate with the total value represented by said displacements at said outputs, and means for im-

parting to said movable member a displacement in accordance with said total displacement.

14. In printing apparatus having a carrier medium and printing means adapted to assume with respect to said carrier medium a succession of printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, the combination of a movable member effective upon motion thereof to produce relative movement in terms of printing position between said carrier medium and said printing means, a record strip bearing indicia in the form of binary digit groups of which the total value of the digits of each group represents the width of a character to be printed in terms of units of displacement in the direction of said relative movement, a shaft, motion transmitting means interposed between said shaft and said movable member, a plurality of mechanisms respectively corresponding to the binary digits in said groups thereof and adapted to be individually actuated to produce respective, fixed value, mechanical outputs whose magnitudes are graded in the proportional relation characterizing the values of said binary digits, means responsive to the binary digits in each group thereof formed by indicia on said record strip for actuating corresponding ones of said mechanisms to provide outputs therefrom which total to a magnitude commensurate with the character width represented by the binary digit group, means for adding the outputs of such of said mechanisms as have been actuated, and means for imparting to said shaft a displacement in accordance with said added outputs.

15. In printing apparatus having a carrier medium and printing means adapted to assume with respect to said carrier medium a succession of printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, the combination of a movable member effective upon motion thereof to produce relative movement in terms of printing position between said carrier medium and said printing means, a record strip bearing indicia in the form of binary digit groups of which the total value of the digits of each group represents the width of a character to be printed in terms of units of displacement in the direction of said relative movement, a shaft, motion transmitting means interposed between said shaft and said movable member, a plurality of mechanisms respectively corresponding to the binary digits in said groups thereof and respectively including Geneva movements, said mechanisms being adapted, when the Geneva movements thereof are indexed, to produce respective, fixed value, mechanical outputs whose magnitudes are graded in the proportional relation characterizing the values of said binary digits, means responsive to the binary digits in each group thereof formed by indicia on said record strip for indexing the Geneva movements of corresponding ones of said mechanisms to provide outputs therefrom which total to a magnitude commensurate with the character width represented by the binary digit group, means for adding the outputs of such of said mechanisms as have had their Geneva movements indexed, and means for imparting to said shaft a displacement in accordance with said added outputs.

16. In a printing apparatus adapted to be controlled by a record strip bearing first and second indicia respectively representing characters to be printed and preselected numerical values corresponding to and relatively relating the widths of said characters, said apparatus having a carrier medium and printing means responsive to said first indicia to assume with respect to said carrier medium successive printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, the combination of a movable member effective upon motion thereof to produce between each printing of an individual character a relative movement in terms of printing position between

said carrier medium and said printing means, mechanism responsive to said second indicia for moving said member respective amounts corresponding to and in proportion to said preselected values of character width represented by said second indicia, and adjustable means to vary the value of the proportion between said amounts of movement and said corresponding preselected values by expanding or contracting, by amounts determined by the adjustment of said last-named means and as required to accommodate different point sizes of characters, the movement imparted by said mechanism to said movable member.

17. In printing apparatus adapted to be controlled by a record strip bearing first and second indicia respectively representing characters to be printed and preselected numerical values corresponding to and relatively relating the width of said characters, said apparatus having a carrier medium and printing means responsive to said first indicia to assume with respect to said carrier medium successive printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, the combination of a movable member effective upon motion thereof to produce between each printing of an individual character a relative movement in terms of printing position between said carrier medium and said printing means, a shaft coupled to said movable member, mechanism responsive to said second indicia for imparting to said shaft incremental displacements corresponding to and in proportion to the preselected values represented by said second indicia, and adjustable motion transmitting mechanism providing in accordance with its adjustment a continuously adjustable ratio between its input and output motions, and having its input and output respectively coupled with said displacement imparting mechanism and with said shaft to vary the value of the proportion between said displacements and said preselected values by expanding or contracting the displacements imparted to said shaft as required to accommodate different point sizes of characters.

18. In printing apparatus adapted to be controlled by a record strip bearing first and second indicia respectively representing characters and preselected numerical values corresponding to and relatively relating the widths of said characters, said apparatus having a carrier medium and printing means responsive to said first indicia to assume with respect to said carrier medium successive printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, the combination of a movable member effective upon motion thereof to produce between each printing of an individual character a relative movement in terms of printing position between said carrier medium and said printing means, a shaft, motion transmitting mechanism coupling the shaft to said movable member, mechanism responsive to said second indicia for imparting to said shaft incremental displacements corresponding to and in proportion to the preselected values represented by said second indicia, and adjustable ratio gear train mechanism interposed between said displacement imparting mechanism and said shaft to vary the value of the proportion between said displacements and said preselected values by expanding or contracting the displacements imparted to said shaft as required to accommodate different point sizes of characters.

19. The combination defined in claim 18 in which the adjustable gear train mechanism comprises a first pair of log tape wheels mounted, respectively, on one and the other of a first pair of shafts and coupled together to provide a logarithmic transmission ratio from said one to said other shaft, a second pair of log tape wheels mounted on, respectively, one and the other of a second pair of shafts and coupled together to provide a logarithmic transmission ratio from said one to said other of said

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second pair of shafts, means to selectively couple and uncouple said other shaft of said first pair thereof to said other shaft of said second pair thereof, and means adapted when said other shafts of said two pairs thereof are uncoupled to establish selected relative angular displacements between said one shafts of said two pairs thereof to thereby change the effective gear ratio between said one shafts for motion transmitted therebetween through said other shafts when the latter shafts are thereafter coupled together.

20. A justifying assembly for a printing apparatus having a carrier medium and printing means adapted to assume with respect to said carrier medium successive printing positions for thereafter correspondingly printing successive individual characters on said medium in spaced apart relation in a line, comprising the combination of, a movable member effective upon being driven to produce between each printing of an individual character a relative movement in terms of printing position between said carrier medium and said printing means, adjustable ratio gear mechanism for supplying, during the printing of a line, a justifying word space output to drive said movable member, means for supplying unit input to said gear mechanism whenever a word space is to be inserted between words during the printing of said line, and means operative before the printing of said line for adjusting the ratio of said gear mechanism as a function of the length of said line, the sum of character widths therein and the number of word spaces therein.

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21. Adjustable ratio gear train mechanism comprising, a first pair of log tape wheels mounted, respectively, on one and the other of a first pair of shafts and coupled together to provide a logarithmic transmission ratio from said one to said other shaft, a second pair of log tape wheels mounted on, respectively, one and the other of a second pair of shafts and coupled together to provide a logarithmic transmission ratio from said one to said other of said second pair of shafts, and releasable means for selectively coupling and uncoupling said other shaft in said first pair thereof and said other shaft in said second pair thereof, said releasable means permitting relative change in angular position between said other shafts when the same are coupled to effect an adjustment in the motion transmission ratio provided, when said other shafts are thereafter coupled, between said one shaft of said first pair thereof and said one shaft of said second pair thereof.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |           |                |
|-----------|-----------|----------------|
| 1,428,927 | Vinik     | Sept. 12, 1922 |
| 1,803,465 | Dina      | May 5, 1931    |
| 2,229,689 | Westover  | Jan. 28, 1941  |
| 2,332,509 | De Vry    | Oct. 26, 1943  |
| 2,351,126 | Highton   | June 13, 1944  |
| 2,378,371 | Tholstrup | June 12, 1945  |
| 2,388,961 | Elliott   | Nov. 13, 1945  |