

Oct. 13, 1931.

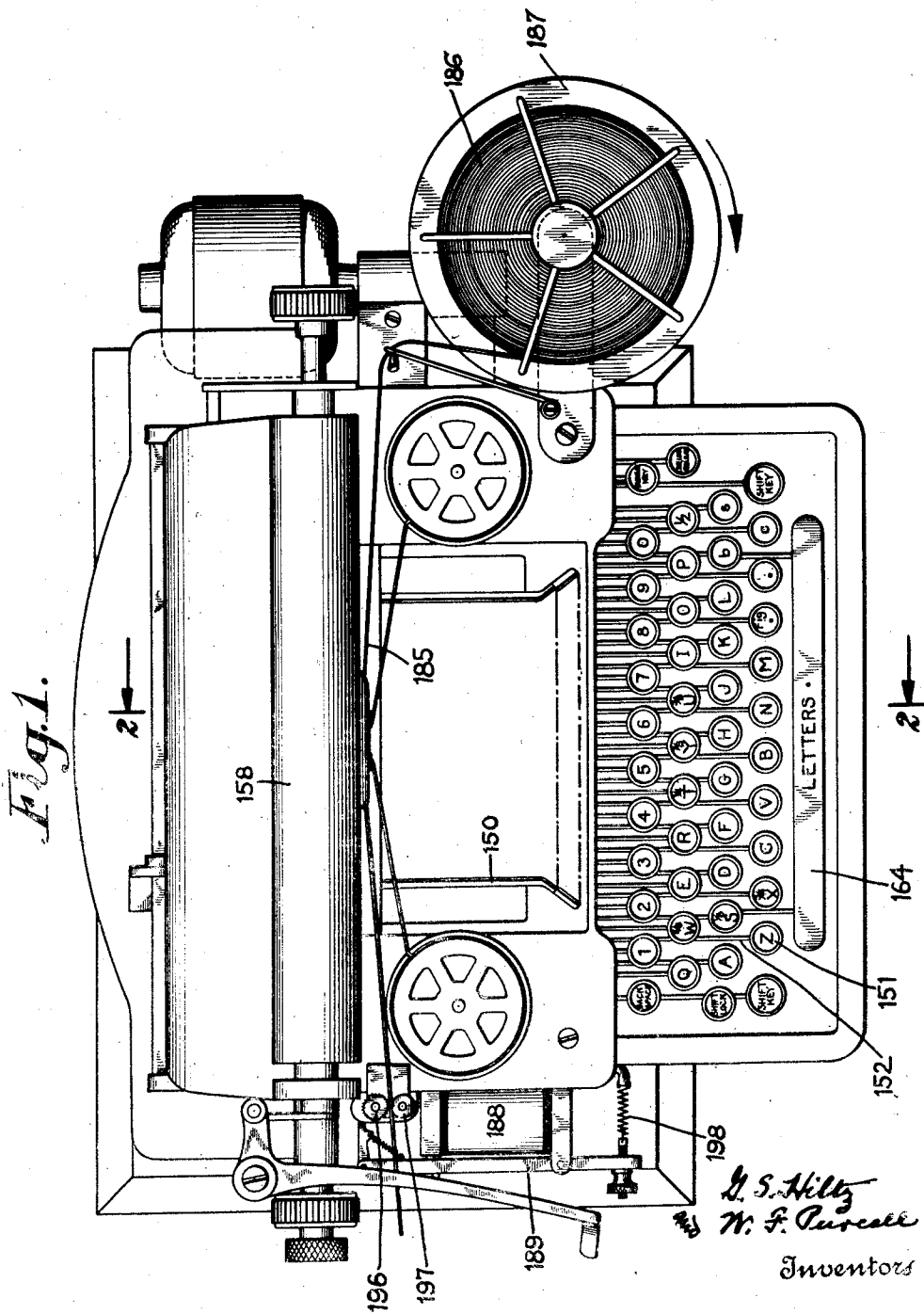
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1,827,362

PRINTING TELEGRAPH SYSTEM

Filed March 21, 1928

11 Sheets-Sheet 1



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Cooper, Kier & Dunham*

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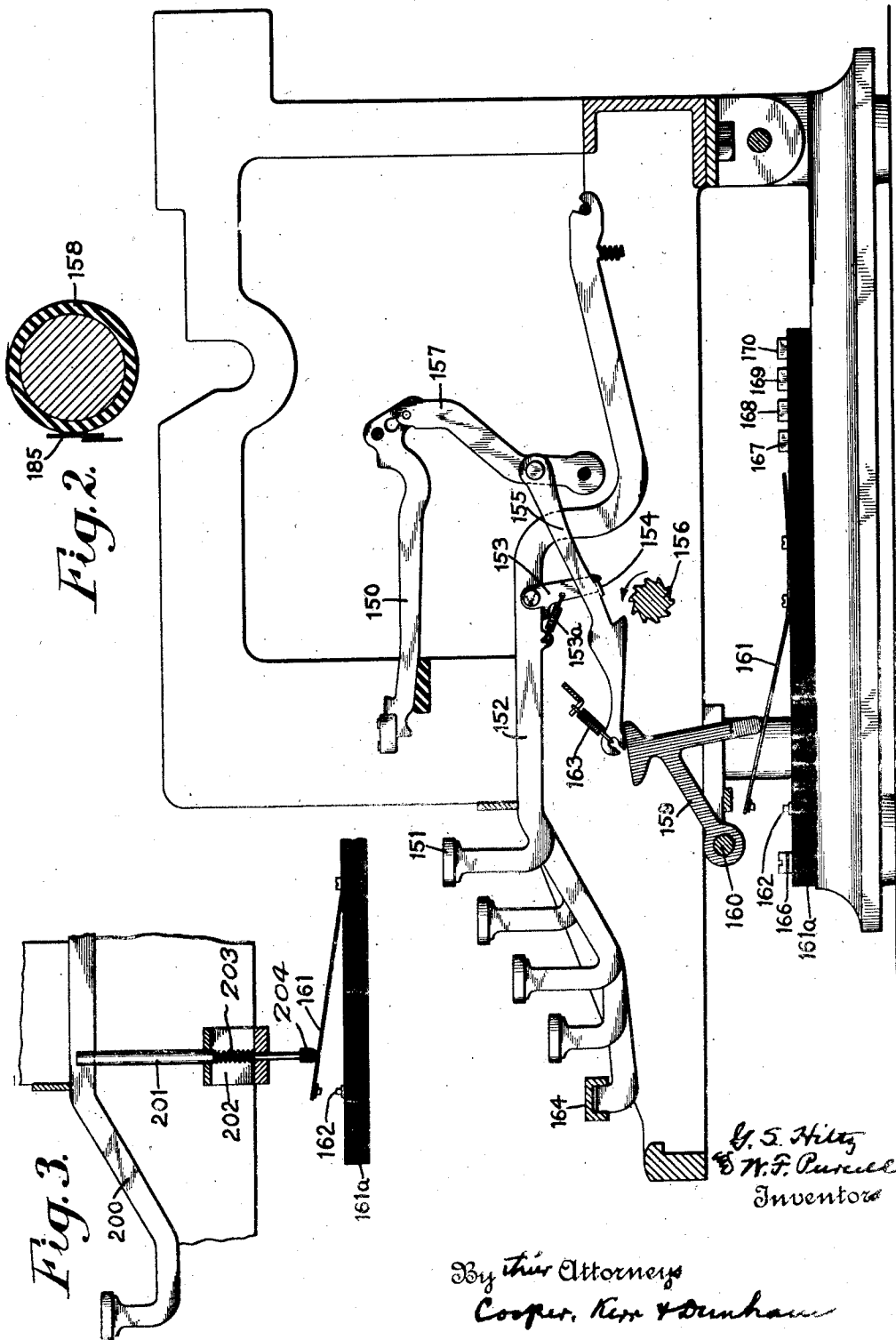
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PRINTING TELEGRAPH SYSTEM

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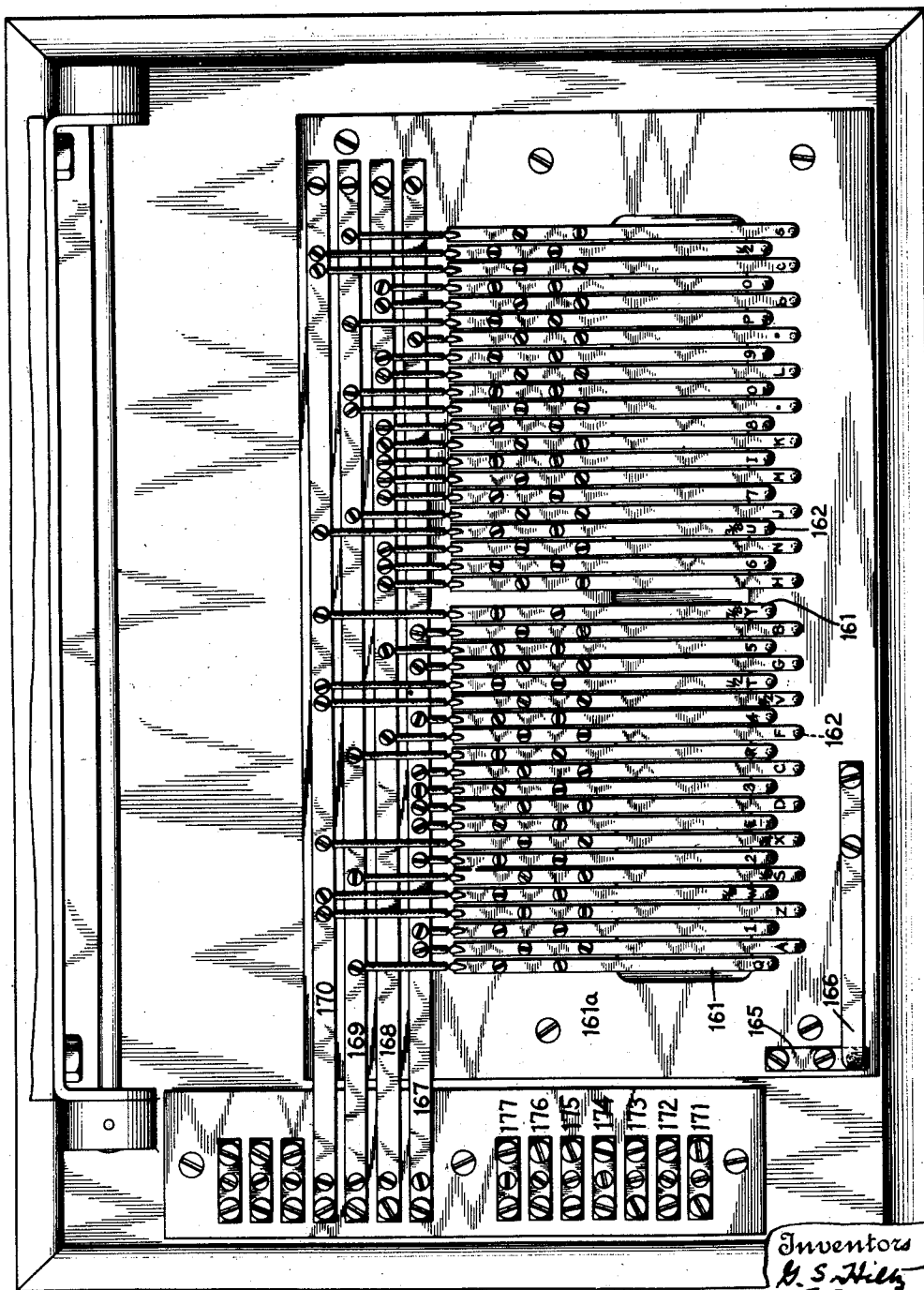
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Fig. 4

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Fig. 8.

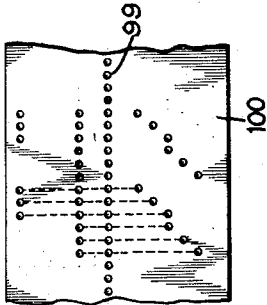


Fig. 7.



Fig. 9.

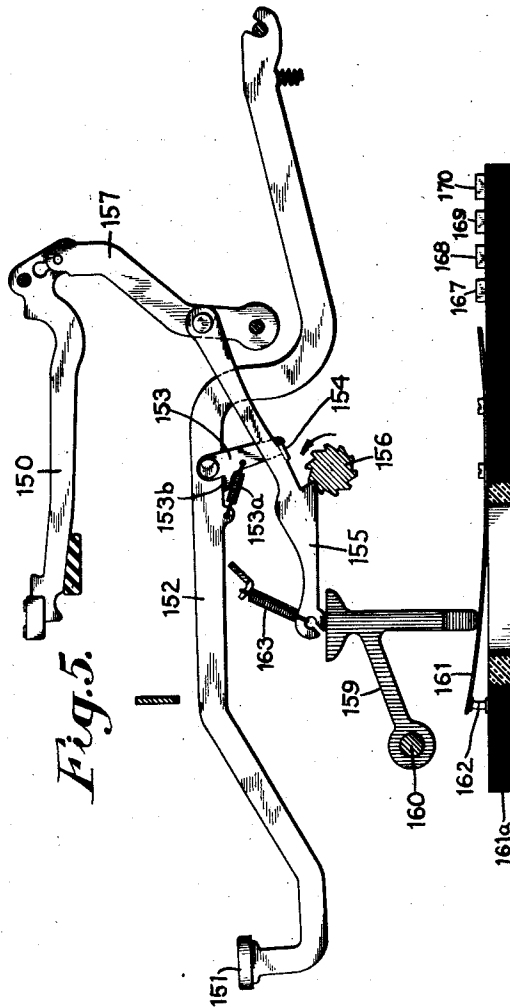
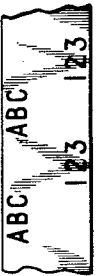
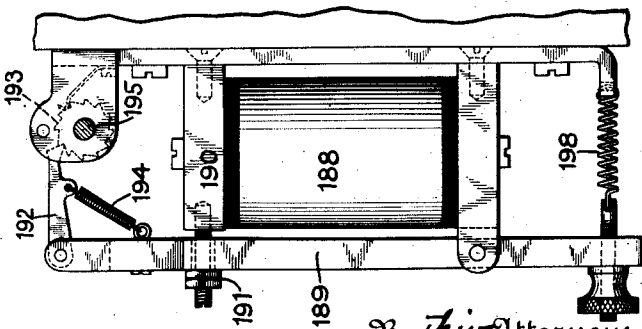


Fig. 6.



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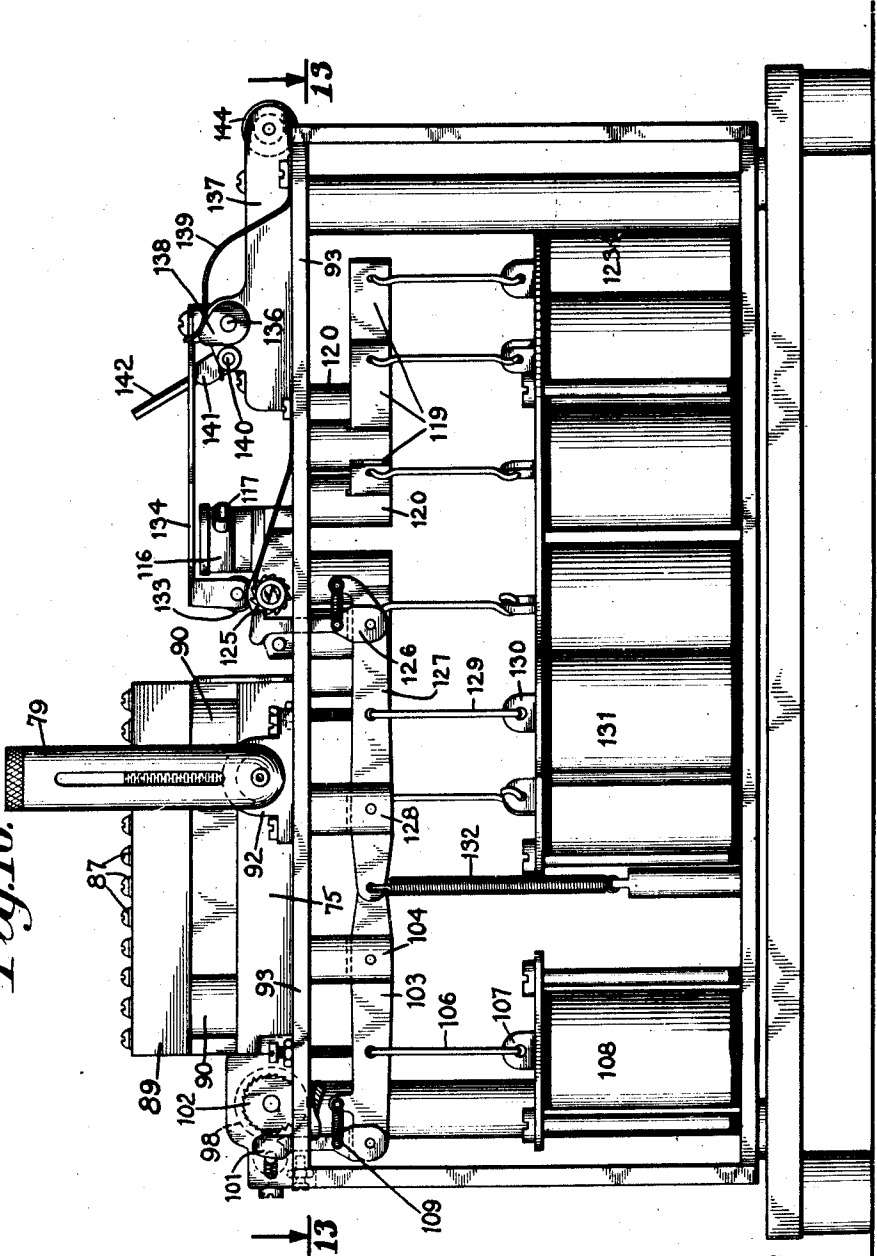
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Fig. 10.



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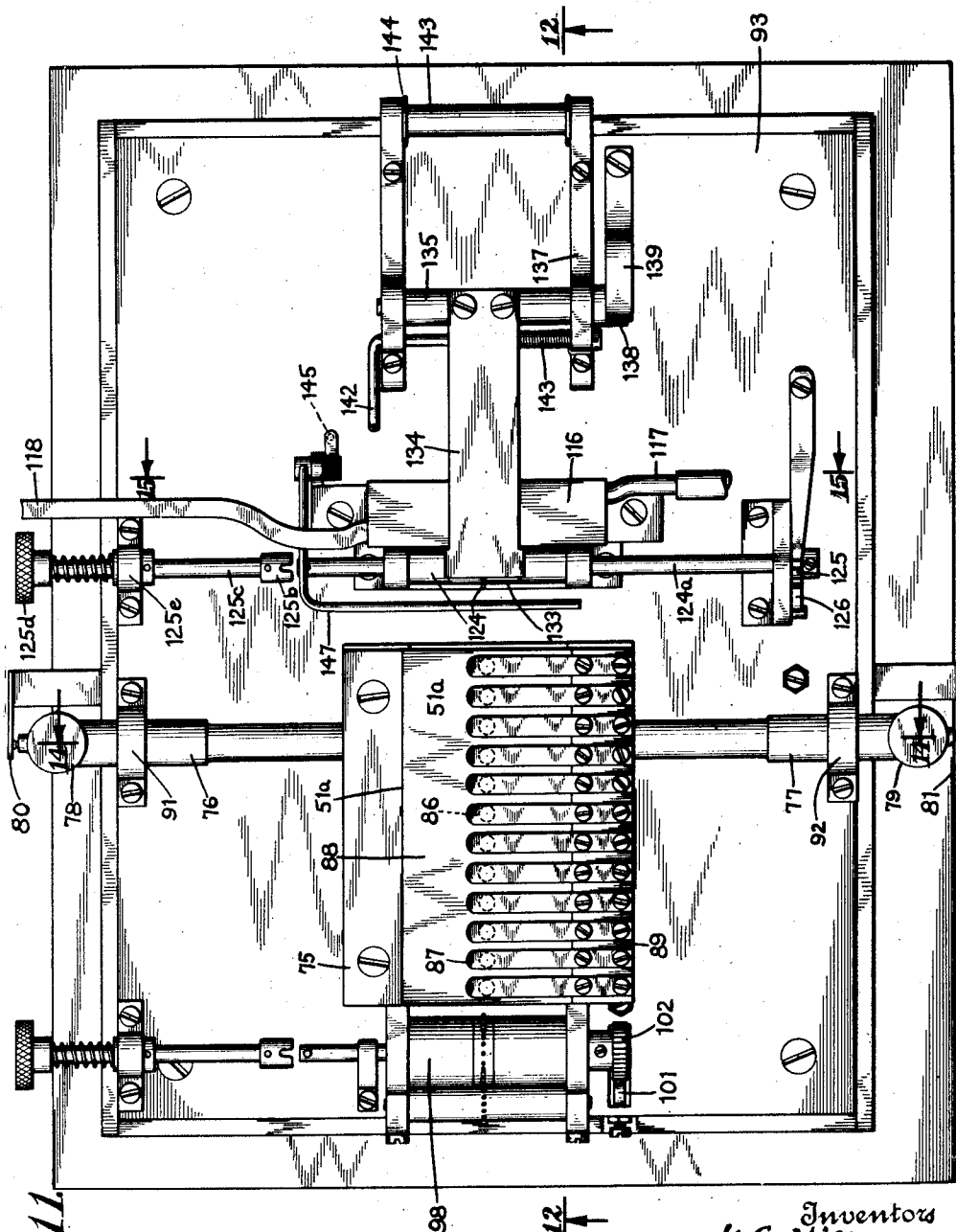


Fig. 11

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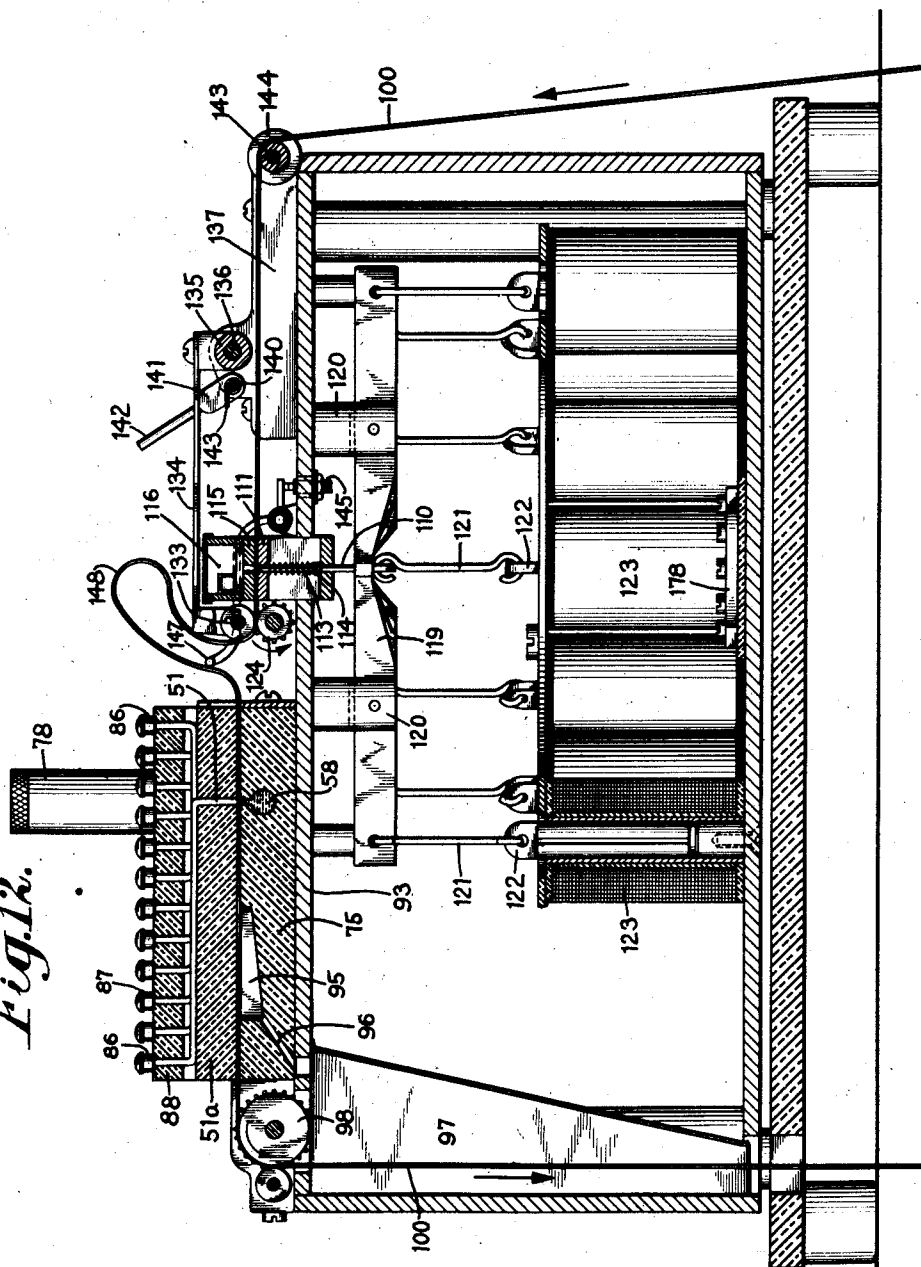
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Fig. 12.



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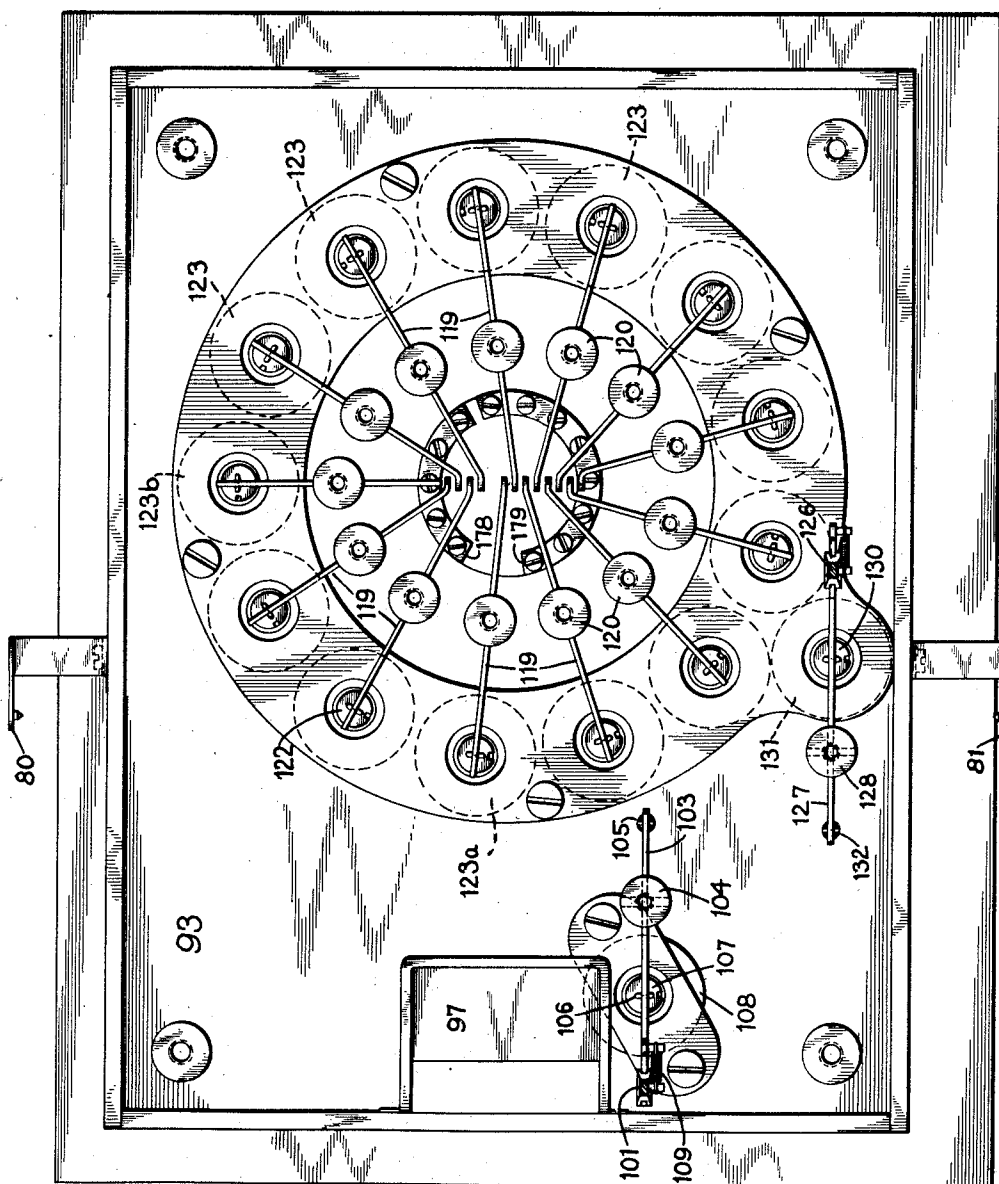


Fig. 13.

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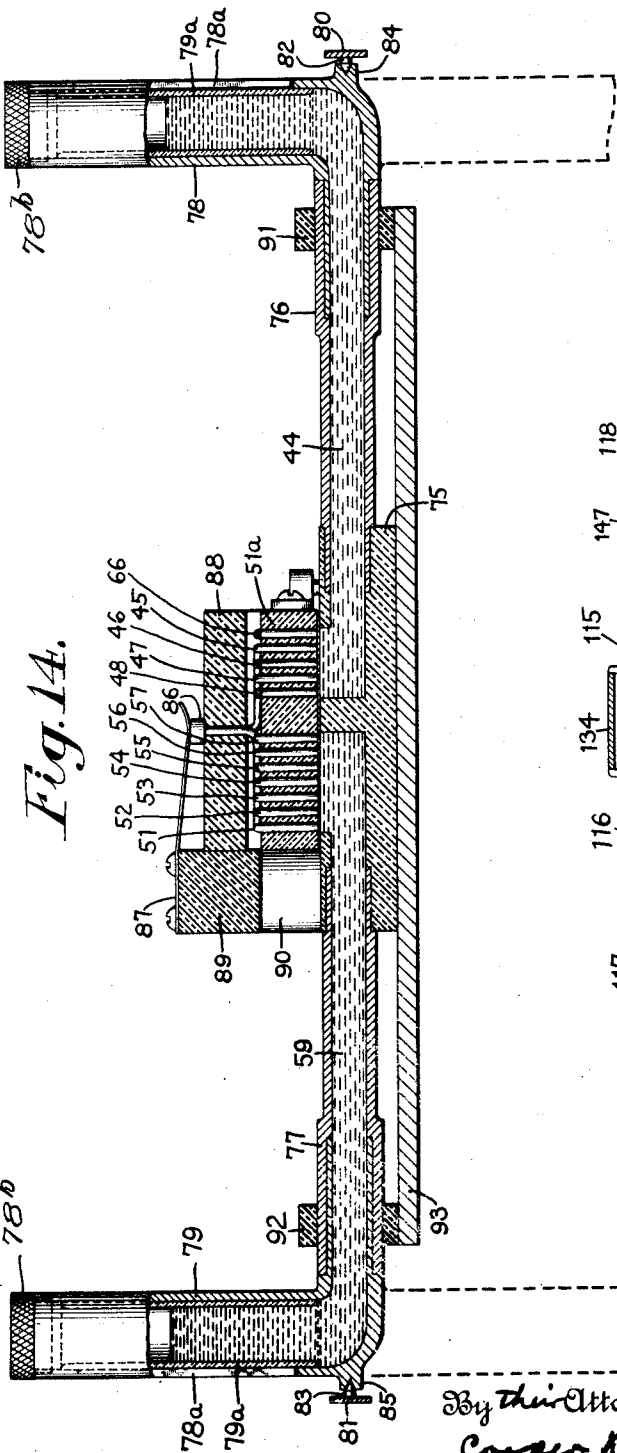


Fig. 14.

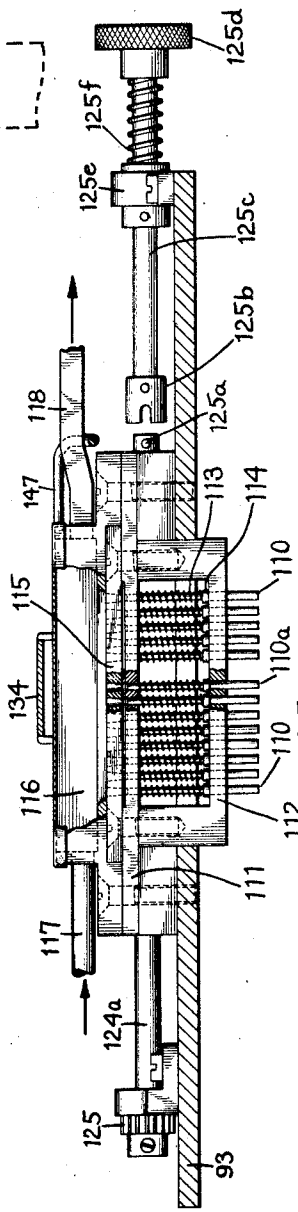


Fig. 15.

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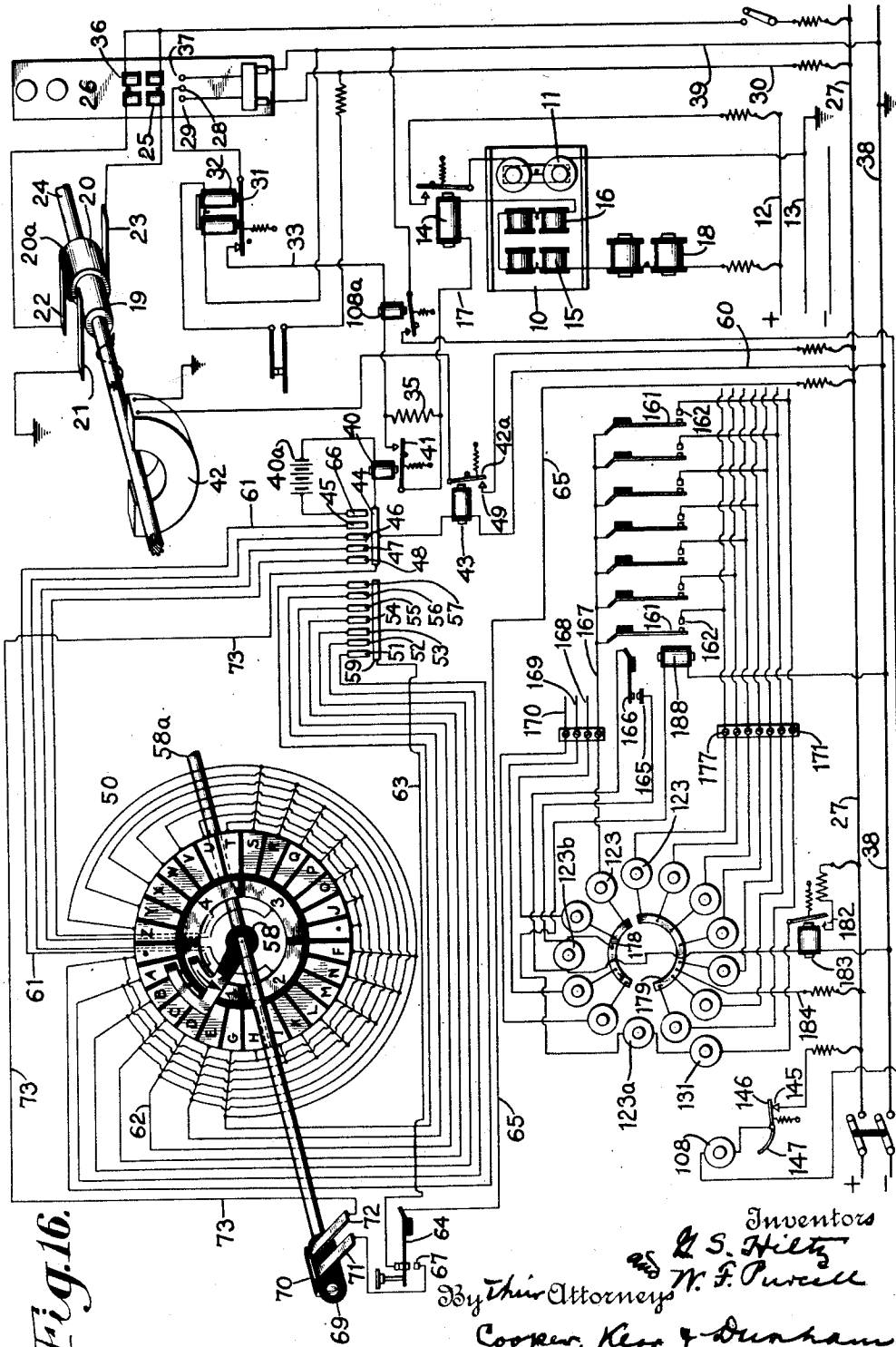


Fig. 16.

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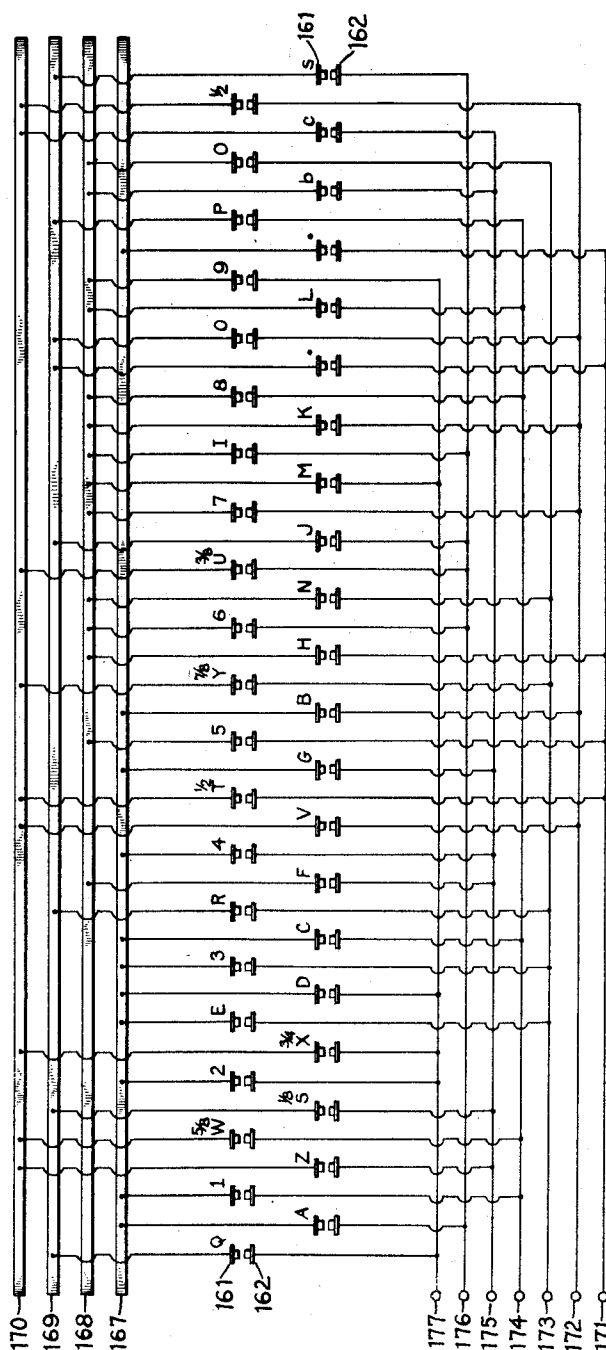
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Fig. 17.



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UNITED STATES PATENT OFFICE

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PRINTING TELEGRAPH SYSTEM

Application filed March 21, 1928. Serial No. 263,362.

This invention relates to printing telegraph systems of the class in which the operation of the distant receiver or receivers is controlled by current impulses sent over a transmission circuit under the control of a plurality of local controlling circuits at the transmitter. More particularly the invention relates to systems in which the local controlling circuits are themselves controlled by a perforated tape or strip of paper or other insulating material which passes between co-operating contacts in said controlling circuits. Since the tape is non-conducting no current flows from one contact to another except when a perforation is in registry with the two. The latter can then close, permitting current to flow in the circuit with which the particular contacts are associated. More especially our present invention pertains to the mechanism or apparatus for punching the tape in accordance with a suitable code in which the relative positions of two or more perforations (located in transverse alignment in the tape) determines what letter or other character the receiver will print when the group of transversely-aligned perforations reaches the control contacts. The chief object of the invention is to provide power-actuated punching mechanism which can be manually controlled, so that all the punching operator has to do is to manipulate finger keys in the same or much the same way as he would the keys of an ordinary typewriter but without the fatiguing exertion that would be required if the apparatus were driven or actuated entirely by manual effort. A further object is to provide electromagnetic means for actuating the tape-punching mechanism, so that the latter may be electrically controlled by finger-actuated contacts of simple character. Another object is to provide apparatus which not only punches the transmitter-control tape but also prints on a suitable tape the letters and other characters corresponding to those "punched" in the control tape, so that by watching the printed tape the operator can detect any error as soon as it is made. Also, if the operation is suspended the printed tape instantly shows what has been recorded on the control tape and hence the exact point at which the work is to be resumed. A further object is to provide simple and durable apparatus, positive in operation and capable of use for long periods without the necessity of frequent repair of critical adjustment. To these and other ends the invention comprises the novel features of construction and combinations of elements hereinafter described.

The invention can be embodied in a considerable variety of constructions, and of these we have selected for specific description and illustration herein the one which at the present time is believed to exhibit the invention in its most convenient and effective form. The construction referred to is designed particularly for use in the printing telegraph system described in U. S. Patent No. 1,711,497, in which the receiver is of the so-called "ticker" type, printing on a paper tape under the control of current impulses of alternating polarity the number of which in each group or train is controlled at the transmitter by a sunflower comprising an annular series of insulated contacts and a revolving wiper which passes over the contacts in succession and is synchronized with a pole-changing switch in such manner that as the wiper passes off one contact and onto the next the current in the transmission circuit is reversed in polarity. The system thus briefly outlined may also include the so-called "magnetic shift" mechanism described in U. S. Patent No. 1,700,225 and the preferred form of our present invention is adapted to the use of the mechanism mentioned, as will be explained more fully hereinafter.

Referring now to the accompanying drawings, Fig. 1 is a plan view of the manually actuated mechanism which controls the electrically actuated punching mechanism and which also prints on a tape the characters recorded on the transmission control tape by the punching mechanism.

Fig. 2 is a simplified cross section, taken about on a plane indicated by the line 2—2 of Fig. 1.

Fig. 3 is a detail cross section illustrating a modification of the punching-control mechanism.

Fig. 4 is a plan view of the contact system of the apparatus shown in Fig. 1, the pivoted frame carrying the keyboard and printing devices being swung back to expose the aforesaid contact system or assembly.

Fig. 5 is a detail side view of one of the keys shown in Fig. 2, with its associated type hammer and contact actuator in the positions occupied just after the associated contacts have been closed and just before the printing hammer or type bar is actuated.

Fig. 6 is a detail plan view of the electromagnetic feed mechanism for feeding the printing tape step by step past the printing position, to receive the imprints from the printing hammers (through the usual inked ribbon) just after the punching mechanism has operated to punch in the transmission control tape the transversely spaced perforations which represent the character to be transmitted.

Fig. 7 illustrates a piece of the tape printed by the punch-control mechanism.

Fig. 8 illustrates a piece of the transmission tape, showing the groups of transversely aligned perforations corresponding to the characters (letters and numerals) shown on the printed tape in Fig. 7.

Fig. 9 illustrates a piece of the "ticker" tape printed by the receiver, showing the characters transmitted by the successive groups of perforations in Fig. 8.

Fig. 10 is a side view of the electrically actuated punching apparatus and the associated contact mechanism to which the perforated tape passes from the punching devices.

Fig. 11 is a plan view of the punching and contact mechanisms shown in elevation in Fig. 10.

Fig. 12 is a longitudinal section on the line 12—12 of Fig. 11.

Fig. 13 is a sectional plan view on the line 13—13 of Fig. 10, showing the electromagnets or solenoids which actuate the punches.

Fig. 14 is a detail cross section, on the line 14—14 of Fig. 11, showing the contacts which engage each other through the perforations in the insulating tape. Two of these contacts are composed of bodies of mercury under sufficient head to force the mercury through the perforations into contact with the rigid pin-contacts immediately above.

Fig. 15 is a detail cross section on the line 15—15 of Fig. 11, showing the transversely aligned vertically movable punches and the cooperating dies, for perforating the tape.

Fig. 16 is a wiring diagram showing the electrical connections between the punching mechanism and the manual control mechanism, and so much of the wiring of the transmission system as seems useful in understanding the function of the perforated tape

in controlling the transmitter and the distant receiver.

Fig. 17 is a detailed diagram showing the wiring of the contacts (at the keyboard) shown in Fig. 4.

Referring first to Fig. 16, 10 represents a receiver or "ticker" which may be of well known type described in the patent of George S. Hiltz, No. 1,085,124, issued January 27, 1914, having a printing or "press" magnet 11 in a local circuit, supplied with current from the main 12, and the third wire or grounded return 13, under the control of a relay 14. The escapement magnets 15, 16 are in series with the transmission line 17, as is also the "shift" magnet 18 which determines which of the two receiver type wheels (not shown) will make the imprint, as explained in U. S. Patent No. 1,700,225 above referred to. The transmitter has a pole-changing switch comprising a pair of slip rings 19, 20 and brushes 21, 22, 23 on a shaft 24 driven by a constantly running motor, not shown, through a slipping clutch, not shown, which permits the shaft to be arrested without stopping the motor. Slip ring 20 has an insulating segment 20a which, as the shaft revolves, lifts brushes 22, 23 out of contact alternately. In the position shown, current flows from grounded brush 21, slip ring 20, brush 23 through magnet 25 of the pole-changing relay 26 to the current-supply main 27. The armature of the relay, represented by contact 28, is thus attracted by magnet 25 and engages contact 29, and positive current then flows from main 27 through wire 30, contacts 29, 28, armature 31 of the "repeat" magnet 32, wire 33, magnet 108a (which controls the feed of the perforated tape through the transmission-controlling contact mechanism), resistance 35 and line wire 17 to the ticker press relay 14. When the rotation of shaft 24 carries insulating segment 20a into cooperation with brush 23, brush 22 is then in engagement with ring 20 and current flows through magnet 36 of the pole-changing relay 26. Armature 28 is swung over to contact 37, whereupon negative current flows from main 38 through wire 39, contacts 37 and 28, and thence through the path traced above, to the receiver. In this way current impulses of rapidly alternating polarity are sent over the transmission line as long as shaft 24 revolves. These impulses through the escapement magnets 15, 16 control in the usual way the rotation of the receiver type wheels (not shown) to bring the desired character to the printing position, whereupon the shaft 24 is arrested. The impulse last sent (of whatever polarity it may be) is thus prolonged, thereby energizing the slow-acting relay 14 which then draws its armature over and closes the local circuit of the press magnet 11. The latter then actuates the receiver platen, not shown. As long as the shift relay magnet 40 is deenergized

resistance 35 remains in the transmission circuit; the current through shift magnet 18 is therefore too weak to energize the latter magnet, and hence all the imprints at the receiver are made from the same type wheel. When, however, the circuit of magnet 40 is closed (as hereinafter described) the armature 41 is raised, thereby laying a shunt or short circuit across the resistance, thus strengthening the line current a value sufficient to energize the shift magnet which then causes the next imprint to be made from the other type wheel.

Still referring to Fig. 16, the shaft 24 is arrested at the proper instant (when a sufficient number of current impulses have been sent to bring the desired character on the receiver type wheel to the printing position) by an electromagnetic clutch 42, which may be of a well known type, connected to ground and to the armature 42a of a relay 43. The latter is connected to main 38 through lower mercury contact 44 and upper pin contacts 45, 46, 47, 48. Whenever current flows through contact 44 and any one of the four upper contacts the relay is energized and swings its armature over against contact 49, whereupon current flows in the clutch local circuit. Being thus energized, the clutch arrests the shaft 24 and the current then flowing continues to flow, with the results described above.

The transmitter is also provided with a "sunflower" 50, Fig. 16, comprising an annular series of twenty-eight insulated contacts, twenty-six of which are shown marked with the letters of the alphabet and two, diametrically opposite each other, are shown marked with dots, representing periods. The upper of these two is termed herein the "letters period" contact and the lower as the "figures period" contact. The sunflower contacts are connected to form seven sets of four each, one contact of each set being connected to one of every other group. Thus, upon tracing the connections it will be seen that contact "letters period" is connected to contacts H, "figures period" and T, these four constituting a "set". Similarly, contacts G, F, S, Z are connected together and so form another set. Each set is also connected to one of seven pin contacts 51, 52, 53, 54, 55, 56, 57, above the mercury contact 59. Thus the set composed of contacts G, F, S, Z is connected to pin contact 57 and that composed of "letters period" H, "figures period" and T is connected to pin contact 51. Inside of the outer series of sunflower contacts is an annular series of four insulated contacts 1, 2, 3, 4, each spanning seven contacts of the outer series and connected to the pin contacts 45, 46, 47, 48 respectively. The sunflower also has a wiper 58, fixed on a shaft 58a which is connected with the motor-driven shaft 24 by reducing gearing (not shown) of such ratio that the wiper makes one revolution for each four-

teen revolutions of the shaft 24. Since two current impulses are transmitted in each revolution of the latter shaft, it will be seen that twenty-eight impulses are sent in each revolution of the wiper 58. The latter has two electrically connected fingers bearing one on the outer contacts and the other on the inner, so that as the wiper revolves from the position shown in Fig. 16 it connects inner contact 1 to outer contacts A, B, C, D, E, G, in succession, then contact 2 to contacts H, I, K, L, M, N, F, and so on.

Suppose now that the letter A having been printed at the receiver it is desired to print D. Tracing the connections it will be seen that outer contact D is connected to pin contact 55 and inner contact 1 to pin contact 45. Hence connection is made (as described hereinafter) between mercury contact 59 and pin 55 only, and between mercury contact 44 and pin 45 only. If, as in the present embodiment, the letters are on the typewheel which prints only when strong current is transmitted, that is, when the resistance 35 is shunted out by energization of relay 40, connection must also be made between contacts 44 and 66, in series with the relay and battery 40a. Now as the wiper moves counterclockwise the pole-changing switch or commutator sends alternating impulses to the receiver, whose type wheels follow in unison with the wiper until contact D is reached and type D at the receiver is at the printing position. Current now flows from main 38 through wire 60, relay magnet 43, contacts 44 and 45, wire 61 to inner sunflower contact 1, across the wiper to outer contact D, thence through wire 62, pin contact 55, mercury contact 59, wire 63, unison key 64 and wire 65 to main 27. Relay 43, thus energized, closes the local circuit of the clutch 42, and the latter arrests shafts 24 and 58a. Letter D having been printed, suppose that the next letter is O. The circuit being broken at contacts 59—55 and 44—45 the clutch is deenergized, shaft 24 rotates and the wiper 58 moves over the sunflower contacts. Arriving at contact O the wiper finds the circuit of clutch relay 43 established through contacts 59—53 and 47—44, whereupon the clutch is energized as described and (contacts 44 and 66 being also closed) D is printed. In this way the receiver type wheels can be rotated step by step to bring to the printing position any one of the characters corresponding to the respective outer contacts on the sunflower.

As previously stated the receiver has two type wheels. These are mounted on the same shaft, with the characters on one in axial alignment with those on the other. Since (in the present instance) each wheel has twenty-eight character spaces each outer sunflower contact corresponds to two characters or character spaces, one on each wheel. In general one wheel

has letters of the alphabet and the other carries numerals, fractions, and any special characters or symbols that may be desired. When (in the present system) it is desired to print from the second wheel, say a number or a fraction, or a special character, contacts 44 and 66 are not closed at the same time as the desired character-selecting contacts are closed, and hence resistance 35 is not shunted out and weak current is therefore sent over the line as explained above.

It will be readily seen that accuracy of printing depends upon keeping the receiver type wheels in step or in "unison" with the sunflower wiper. If the wheel gets out of unison, as sometimes happens, the operator can bring it back into unison by depressing the unison key 64 to its neutral or mis-position. This opens the circuit through the clutch relay 49, so that the clutch cannot be energized even though the other contacts in the circuit be closed. Hence the sunflower wiper will revolve as long as the key is held in the neutral position, and the receiver type-wheels will also revolve until by means (not shown) provided for the purpose at the receiver they are brought to rest automatically with "letters period" at the printing position. The operator has before him a receiver (not shown herein) in circuit with the distant receiver, and when he observes the type wheels of his own receiver come to rest he depresses key 64 further, bringing it into engagement with contact 67. On shaft 58a is a cylinder 69 of insulating material carrying a conducting bar 70 axially aligned with the tips of the fingers on the wiper 58 and adapted to bridge the two brushes 71, 72 when the wiper is on the "letters period" contact. Brush 72 being connected with mercury contact 44 and brush 71 with the lower contact 67, it will be seen that current can flow through the clutch relay 43 when, and only when, the wiper is on the "letters period" contact (which is the upper of the two contacts marked with a dot in Fig. 16). Hence when the wiper comes to the contact mentioned, current flows from main 38 through contact 44, wire 73, brush 72, contact bar 70, brush 71, contact 67, key 64 and wire 65 to main 27. The clutch relay 43, being thus energized, closes the clutch local circuit and shafts 24 and 58a are then arrested with the wipers on the "letters period" contact. This method of coming to unison forms the subject of our copending application filed May 21, 1928, Serial No. 263,364.

Referring now to Fig. 14, the bodies of mercury 44, 59 are the similarly numbered contacts in Fig. 16, and the pins 45, 46, 47, 48, 66, 51, 52, 53, 54, 55, 56, 57 are the contacts having the same numbers in the figure last mentioned. The two mercury contacts are contained in narrow transversely elongated chambers in an insulating block 75 into which

the horizontal metal tubes 76, 77 are snugly fitted. At their ends the tubes are bent to form standpipes 78, 79, in which the mercury rises, as shown. When the standpipes are upright the mercury in the block 75 can rise into contact with the pins, but when the standpipes are turned down, as indicated in dotted lines, the mercury runs down into them and out of contact with the pins. The mercury bodies are connected in circuit by means of springs 80, 81, Fig. 11, having points 82, 83, Fig. 14, pressing firmly into recesses in the bosses 84, 85. The perforated tape 100, Fig. 12, passes between the pins and the underlying bodies of mercury, and it will be seen that when a perforation comes under a pin the mercury rises through the hole into contact with the pin thus exposed. Hence the transverse spacing of the perforations in the tape determines the character printed at the receiver. Thus (referring to Figs. 14 and 16) with only two perforations (spaced to expose pins 52 and 48) to the underlying mercury, the letter U will be printed. With a third perforation, to expose pin 66 also, the receiver platen will be shifted to the other type wheel and some other character will be printed, for example the fraction $\frac{3}{8}$.

The tubular mercury containers 76, 77, Fig. 14, may be made in two parts, as shown, the standpipe portions 78, 79 being fitted into the ends of the horizontal portions. The former are slotted along one side, forming windows or sight-openings 78a closed by inner glass tubes 79a suitably sealed in place at top and bottom to prevent leakage of mercury. Screw-closures or caps 79b are provided in the ends of the standpipes for easy supply or withdrawal of mercury.

The contact pins 45, 46, 47, 48, 66, 51, 52, 53, 54, 55, 56, 57, Figs. 14 and 16, are composed of heavy wires, for example copper or brass, and are mounted in a two-piece insulating body 51a and are bent to bring them up through suitable openings in the upper part of the supporting body into connection individually with a longitudinal row of terminal buttons 86 engaged by spring terminals 87 (shown best in Figs. 11 and 12) for connection with the corresponding sets of outer contacts and the four inner contacts on the sunflower. The block or body 51a, carrying the contact pins, is held in place by the spring terminals and may be slipped out from under the same for easy insertion of the tape. The spring terminals are mounted on an insulating block 89 supported by pillars 90 on block 75, which, along with the tube bearings 91, 92, is carried by the top plate or table 93 (see also Fig. 10) of the housing 94 in which the actuating solenoids of the punching mechanism are located.

As the tape passes between the upper and lower contacts to present successive groups of perforations thereto there is a tendency

for the tape to carry minute globules of mercury away with it. In order to save any mercury thus carried away the block 75, Fig. 12, is provided with a recess or receiving chamber 95 over which the tape passes and into which the mercury drops and passes thence through an outlet or escape passage 96 to a funnel 97, open at the bottom. From the latter the mercury drops into a small receptacle not shown.

The control tape is fed through the contact mechanism step by step by a sprocket wheel or roller 98, Figs. 10, 11, 12, cooperating with a central longitudinal row of holes (shown at 99 in Fig. 8). This roller, located at the outlet or discharge end of the contact mechanism, is rotated by a pawl 101 engaging a ratchet 102. The pawl is pivoted on the rear end of an actuating lever 103 fulcrumed in a block 104 depending from the underside of the top plate 93. At the other end the lever is connected to a coil spring 105 (Fig. 13) by which it is urged clockwise to raise the pawl, and between the fulcrum and the pawl the lever is connected by a link 106 to the core 107 of an actuating solenoid 108. The pawl is held in engagement with the ratchet by a small coil spring 109, Fig. 10, between the pawl and its actuating lever.

The solenoid magnet 108, which draws the perforated tape step by step through the contact mechanism, as above described, is controlled by the relay 108a, in the transmission circuit connecting the transmitter and the distant receiver or receivers, as indicated in Fig. 16. The relay 108a is not energized by the rapidly alternating character-selecting impulses sufficiently to actuate its armature but when the final impulse is prolonged (by arrest of the shaft 24 as explained above) to print the character at the receiver the relay is fully energized and closes the local circuit of feed magnet 108. It will therefore be seen that each time the receiver prints a character the feed solenoid is energized and the pawl 101 is drawn down, thereby feeding the tape forward one step and bringing the next group of control perforations to the contacts. When the transmission circuit is broken (as a result of the movement of the tape) the pawl is raised by the spring 105 into position for the next feeding operation. Preferably the feed of the tape takes place just after the printing and hence the relay 108a is made slightly slower in action than the relay 14 which controls the press magnet 11.

The tape perforating mechanism comprises a transverse series of twelve punches 110, Fig. 15, having exactly the same spacing as the pin contacts 45, 46, etc., Fig. 14. There is also a centrally located punch 110a, for cutting the feed perforations as described below. The punches move vertically in upper and lower guide plates 111, 112 and are urged downwardly by encircling coil springs 113.

The collars 114 limit the downward movement of the punches and maintain them with their lower ends in the same horizontal plane. Above the guide plate 111 is a die plate 115. The tape is fed step by step between the two plates, and it will be seen that when a punch is pushed upwardly into its die opening a hole is cut in the tape. The punchings are lifted into a chamber 116 above the die plate and are carried away by a draft of air entering the chamber through pipe 117 and passing out through pipe 118. The draft may be produced by any convenient means, not shown, as for example a blower connected to pipe 117 or a suction fan or pump connected to pipe 118.

The twelve punches 110 and the feed punch 110a, Fig. 15, are actuated by an annular group of thirteen hammer levers 119, Figs. 10, 12 and 13, fulcrumed in blocks 120 depending from the top plate 93 and connected at their outer ends by links 121 to the cores 122 of an annular group of actuating solenoids 123, individual to the several punching devices. The inner ends of the levers bear upwardly against the lower ends of the punches as clearly indicated in Fig. 12, and are held down, with the solenoid cores raised, by the coil springs 113, encircling the punches above the collars 114, so that when a solenoid is energized the resulting actuation of its core will throw the associated punch upwardly. As will appear later, these solenoids are connected in parallel banks, that is, some of them are connected in parallel with each other to a common terminal and others are similarly connected to another terminal.

The control tape 100, Fig. 12, is fed between the punches and the die plate 115 by a sprocket roller 124, Figs. 12 and 15, fixed on a shaft 124a and cooperating with the central row of perforations 99, Fig. 8. The feed roller is rotated step by step by a ratchet 125 and pawl 126, Fig. 10. The latter is pivoted on the inner end of a lever 127, fulcrumed in the block 128 on the under side of top plate 93 and connected by a link 129 to the core 130 of an actuating solenoid 131. See also Fig. 13. When the solenoid is energized the resulting downward movement of the pawl draws the tape forward one step, and when the solenoid circuit is broken the coil spring 132, Fig. 10, connected to the outer or rear end of the lever, raises the pawl to a new position of engagement with the ratchet. The tape is held in engagement with the feed roller by a cramp roller 133, Figs. 10 and 12, carried by one end of the blade spring 134 fastened at its other end on a sleeve 135 fixed on a transverse rock shaft 136 carried by a pair of side members 137 mounted on the top plate 93. On the end of shaft 136 is a cam arm 138, Fig. 10, engaged by a stiff blade spring 139, serving to hold the cramp roller in operative position but per-

mitting the roller to be swung up for access to the sprocket in fitting the tape feed perforations thereto. When the roller is swung back to operative position the spring 139 tends to throw it down violently against the sprocket. To obviate this danger a transverse rock shaft 140 is arranged under the spring 134 close to the rock shaft 136 and is provided with a transversely elongated cam arm or rib 141 bearing on the under side of the spring. The shaft is provided with a handle 142 and is urged clockwise (Fig. 12) by a spring 143. Now when the handle is rocked backward the rib swings the spring 134 up and toward the rear, the rib passing beyond the vertical until arrested by the sleeve 135, Fig. 12, where it holds the spring up, against the force exerted on the cam 138 by spring 139. A firm grasp on the handle in rocking it counter-clockwise to restore the cramp roller to its operative position of engagement with the sprocket makes it easy to lower the roller gently and without slamming. At the rear of the side members 137 is a guide roller 143 over which the tape passes in its travel to the punches. End flanges 144 on the roller prevent lateral displacement of the tape. Shaft 124a, at the end opposite the ratchet 125, has a pin 125a, Fig. 15, adapted to be engaged by a slotted socket 125b on the inner end of an aligned shaft 125c equipped at its outer end with a knob 125d. The shaft can slide in its bearing 125e but is normally held in outer position, disengaged from shaft 124a by a coil spring 125f. By pushing shaft 125c inwardly to bring its socket into engagement with the pin on shaft 124a the latter can be turned by hand to advance the tape independently of the magnetic feed. If pawl 126, Fig. 10, is disengaged from the ratchet the shaft can also be turned backward.

As indicated in Fig. 12, the tape passes directly from the punching mechanism to the adjacent mercury contact mechanism, but separate and independent feed mechanisms are provided. If, however, the operator should not punch the tape fast enough to keep up with the contact feed, the tape would inevitably be torn. To eliminate this possibility the contact feed is put under the control of the tape itself. For such purpose the transmission circuit, in which the contact feed solenoid 108, Fig. 16, is connected, is provided with separable contacts 145, 146 (see also Fig. 12), so that when the contacts, normally held closed by a suitable spring, not shown, are opened no current flows through the solenoid and hence the tape is not advanced. Contact 146 is pivoted and has an actuating arm 147 extending forwardly and laterally under a loop 148 formed in the tape between the contact mechanism and the punching mechanism. Then if the operator does not perforate the tape fast enough to

keep pace with the contact feed the slack in the loop is taken up and the resulting pressure of the tape on arm 147 lifts contact 146 and so breaks the circuit of the contact feed magnet. Thereafter the tape is not fed through the contact mechanism until enough tape is fed out of the punching mechanism to relieve the pressure on the contact arm 147.

Referring to Figs. 13 and 16, magnet 123a actuates the punch which cuts the feed perforations 99, Fig. 8. Magnet 123b actuates the punch which makes the "shift" perforation for controlling contact 66, Fig. 14, magnet 108 actuates the ratchet by which the tape is fed through the contact mechanism, and magnet 131 actuates the sprocket by which the tape is fed through the punching mechanism. The other magnets shown in Figs. 13 and 16 (eleven in number) actuate the punching hammers corresponding to contacts 45, 46, 47, 48, 51, 52, 53, 54, 55, 56, 57, and are energized in pairs under the control of contacts actuated by the keys of a keyboard, which may be in all respects similar to a typewriter keyboard, with its keys in the common "universal" arrangement. Suitable control mechanism, having a keyboard of the kind referred to, is shown in Figs. 1 to 6 inclusive. In the present instance an electrically actuated typewriter of well known type is employed, having type bars 150 and finger keys 151 mounted on levers 152 as in Fig. 2. When a key is depressed, the dog 153, bearing against a laterally extending finger 154 on the pawl 155, swings the pawl down into engagement with the constantly rotating motor driven ratchet shaft 156, which instantly advances the pawl which in turn rocks lever 157 toward the operator. This movement of the lever throws the associated type bar 150 upwardly against the platen 158. Under the front end of the pawl is a contact-actuator 159 pivotally mounted on a transverse shaft 160 and bearing on a spring contact 161, so that when the pawl is depressed by the lever 152 the spring contact is brought down upon a fixed contact 162, as indicated in Fig. 5, just before the pawl is caught by the ratchet shaft 156. As the latter continues its rotation it advances the pawl, and as the pawl nears the end of its movement its finger 154 escapes from under the dog 153, the leftward movement of which, under the influence of its spring 153a, is limited by the stop 153b extending laterally under the key bar 152. The engaging tooth of the ratchet shaft then disengages itself from the pawl, whereupon the spring 163 restores the pawl to normal position, shown in Fig. 2, and permits the spring contact 161 to rise out of engagement with contact 162 and lift the actuator 159. Assuming that the key bar has been held down during the operation described, release of the bar permits the bar to be raised by spring 152a, and as the bar nears its normal or

upper position the dog 153 is raised above the finger 154, whereupon it is drawn leftwardly into normal position above the finger by spring 153a. The parts are then in the positions shown in Fig. 2.

The typewriter shown has the usual bank of forty-two keys and type bars for letters, figures, punctuation marks, etc., and for the present purpose certain punctuation type are replaced by fractions and the lower case type are omitted entirely except such as may be needed in the particular field in which the system is employed. Thus if the system is to be used for reporting transactions on a stock exchange the lower case letters *a*, *b* and *c* may be retained. For each of these forty-two keys we provide a pair of contacts 161, 162, and an actuator 159, which is depressed by the pawl 155 as described above. We also connect the space bar 164 to the "key, Fig. 1, so that depression of either the space bar or the regular period key will provide for the "letters period". Fig. 4 shows two contacts, 165, 166, which, as explained hereinafter, control the solenoid which punches the "shift" hole in the tape. The figure just mentioned also shows the bank of forty-two spring contacts 162, and below these the fixed contacts 161 are shown in dotted lines, mounted on the insulating base 161a. Each pair of contacts controls a pair of punching solenoids, and for this purpose each spring contact is connected to one or another of four busbars 167, 168, 169, 170, corresponding to the four contacts 45, 46, 47, 48. Similarly, each fixed contact is connected (by wires not shown in Fig. 4) to one or another of the seven terminals 171, 172, 173, 174, 175, 176, 177, corresponding to the seven contacts 51, 52, 53, 54, 55, 56, 57.

Referring to Figs. 13 and 16, the bank of four solenoids which punch the holes for contacts 45, 46, 47, 48 are connected on one side to an arc-shaped busbar 178 which is itself connected to main 38, through solenoid 123b and solenoid 183, and the seven solenoids which punch the holes for the contacts 51, 52, 53, 54, 55, 56, 57, are connected on one side to a similar busbar 179, itself connected to main 27. Also, each of the four solenoids 123 in the first bank is connected on the other side to one or another of the four busbars 167, 168, 169, 170, Fig. 4, and each of the seven solenoids in the second bank is connected on the other side to one or another of the seven terminals 171, 172, 173, 174, 175, 176, 177. Then by singly combining each of the four busbars and the connected solenoids with the seven terminals and their connected solenoids any one of the four solenoids connected to the busbar 178 can be connected in series with any one of the bank of seven solenoids connected to busbar 179, the two solenoids forming a group, thus providing for actuation of the puncher in groups of two solenoids

for each closing of any pair of contacts 161, 162, with the result that twenty-eight pairs of perforations can be made in the tape, each pair differing from every other pair in transverse spacing. It will also be seen that by utilizing the "shift" at the receiver so as to print from the other type wheel, each of the twenty-eight combinations can be used twice, thus providing for fifty-six characters in all if so many are desired. In Fig. 16 seven of the spring contacts 161 and fixed contacts 162 are shown. The former are by way of example connected to the busbar 167, and the fixed contacts are connected individually to the seven terminals 171, 172, 173, 174, 175, 176, 177. Fig. 17 shows one method of making the complete connections, in which it will be observed that the six pairs of contacts marked A, E, C, G, B, and "." (period) are all connected to busbar 167 but are connected separately to terminals 176, 173, 174, 175, 172 and 171 respectively. So also the contacts marked 1, 2, 3, 4 are all connected to busbar 167, and since the type for printing these numerals are not shown on the same type wheel with the letters A, E, C, G, B, and . (period), they may be connected to the terminals to which these latter are connected. Thus, if type 1 and C are aligned axially on the two type wheels, the contacts marked 1 and C may be connected to the same terminal, 174, as well as to the same busbar 167, but when the numeral is to be printed the operator must not only depress the key marked "1" but must also see that the key marked "Shift" is not down, so that the shift perforation will be punched. Fig. 8 shows the twelve groups of perforations needed to print, for example ABC—123—ABC—123 shown in Fig. 9. The third group of two perforations (counting from the left) is spaced exactly like the fourth pair and hence in each case the same character (the letter C) is brought to the printing position at the receiver. But to the fourth pair a third or "shift" perforation is added, in position to connect mercury contact 44, Fig. 16, and pin contact 66, and accordingly 1 is printed instead of C. The solenoid 123b, which cuts the shift perforation, is in series with each of the four solenoids 123 connected to busbar 178, so that whenever a pair of character-selecting perforations are punched (to control contacts 45, 46, 47, 48, 51, 52, 53, 54, 55, 56, 57) a shift perforation is also punched, unless the solenoid 123b is shunted out of the circuit. This is done by means of the contacts 165, 166, Figs. 4 and 16, connected across solenoid 123b. Then when the contacts are closed, by depressing the shift key, a shunt is laid across the solenoid 123b and consequently the latter does not actuate the punch which cuts the shift perforation. The shift key locks down automatically and is released to open the

shunt when the operator desires to punch a shift perforation.

As indicated in Fig. 16, magnet 123a which cuts the feed perforations (99, Fig. 8), magnet 131 which feeds the tape through the punching mechanism, and magnet 188 which feeds the typewriter tape across the platen, are in series with each other and are connected to the supply mains through the armature 182 of a relay 183 between the arc-shaped busbar 178 and main 38, so that every time one of the spring contacts 162 is depressed the relay 183 and the three magnets controlled thereby are energized. Thus, suppose the contact 162 at the left of the row in Fig. 16 is depressed upon the cooperating contact 161. Current then flows from main 38 through relay 183, magnet 123b (or through the shunt which includes contacts 165, 166), busbar 178, the upper of the two magnets marked 123, busbar 167, contacts 162, 161, terminal 177, lower magnet marked 123, busbar 179, and wire 184 to main 27; whereupon the relay controlled circuit is closed and current flows from main 38 through magnets 188, 123a, 131, and relay armature 182 to main 27.

The tape 185, on which the type bars 150, Fig. 1, print as the keys are manipulated, is fed across the printing field from the roll 186 carried by a reel 187 suitably mounted at the right of the machine. The feeding of the tape is effected step by step by a magnet 188, Figs. 1, 6 and 16, having a pivoted armature 189 playing between the magnet pole piece 190 and a stop nut 191 on a screw set in the pole piece. At its free or rear end the armature carries a pawl 192, held in engagement with a ratchet 193 by a coil spring 194. The ratchet is fixed on the shaft 195, and on the latter is a feed roller 196, Fig. 1, cooperating with an idler cramp roller 197 which holds the interposed tape in contact with the feed roller. Whenever the feed magnet 188 is energized the rightward swing of its armature advances the pawl and so rotates the ratchet and feed roller one step. When the magnet is deenergized the spring 198 swings the armature leftwardly and retracts the feed pawl to a new position of engagement with the ratchet. Since the typewriter carriage feed mechanism is not needed it is removed or disabled, but the connection between the carriage and the shift key is retained so that the platen is raised as usual when the shift key is depressed.

It will be seen in Fig. 2 that the contact actuator 159 engages the spring contact between its ends so that the angular swing of the contact is nearly twice as great as the movement of the actuator. Also, the actuator is itself depressed by the end of the lever 155 and therefore the former has the maximum movement that the lever can impart. The net result is that the contacts 161, 162 are

brought together before the type on the printing hammer or type bar 150 strikes the tape, and hence the circuits of the punching magnets controlled by the contacts are closed before the tape 185 is printed, and accordingly if the key is depressed far enough to print the corresponding contacts are inevitably closed. Hence all the operator has to do is to print the message on the tape. If he does that, he knows that the corresponding perforations are made in the transmission control tape 100.

Fig. 3 illustrates a simplified construction in which the connection between the key and the punch-control contact is more direct. In this construction the key lever 200 fits loosely in a recess in the top of a light plunger 201 movable vertically in a guide bar 202. A spring 203 urges the plunger and key lever upwardly to normal or home position. The lower insulated end 204 of the plunger engages the spring contact 161, so that when the key is depressed the contact is brought down upon the lower contact 162. This construction is more especially useful with other typewriters of electrical or non-electrical type.

Since the movement of the tape 185 through the printing field and the movement of tape 100 through the punching field (see Figs. 1 and 12) are step by step, the magnets 188 and 131 which effect these movements must be energized and deenergized in harmony with the printing operation of the typewriter and the punching operation of the perforating mechanism. This harmony of operation is easily obtained by suitable timing of the magnets, as will be readily understood and the same is so in the case of other magnets which should perform their several functions in proper timed relation.

It is to be understood that the invention is not limited to the specific construction herein described but can be embodied in other forms without departure from its spirit.

We claim—

1. In tape-punching mechanism for tape-controlled printing telegraph systems, the combination with a typewriter having type bars, a rotating ratchet, pawls connected with the type bars to actuate the same, and finger keys connected with the pawls to engage the pawls singly with said ratchet, of a plurality of punch-controlling circuits, contacts associated with the controlling circuits to open and close the latter and connected with the type bar actuating pawls for actuation thereby.

2. In electromagnetic tape-punching mechanism for tape-controlled printing telegraph systems, the combination with a typewriter having finger keys and printing devices associated therewith to print corresponding characters when the keys are depressed, of two sets of bus bars, a solenoid connected with

each bus bar, a plurality of punch controlling means comprising pairs of contacts adapted to be closed by said keys, each pair of contacts having one contact connected to a bus bar of one of said two sets of bus bars and the other contact connected to a bus bar of the other of said two sets of bus bars, with at least two of said pairs of contacts being connected in parallel, another solenoid adapted to be placed in and out of circuit with one of said last-named two pairs of contacts, and contacts for controlling the circuit or shunt condition of said last named solenoid.

3. In electromagnetic tape-punching mechanism for tape-controlled printing telegraph systems, the combination with a typewriter having finger keys and printing devices associated therewith to print corresponding characters when the keys are depressed, of two sets of bus bars, a solenoid connected with each bus bar, a plurality of punch controlling means comprising pairs of contacts, each pair of contacts being individual to a single key and having one contact movable by a key and connected to a bus bar of one of said two sets of bus bars and the other contact connected to a bus bar of the other of said two sets of bus bars, with at least two of said pairs of contacts being connected in parallel, another solenoid in circuit with said bus bars, and a shunt circuit for shunting said last named solenoid.

4. In electromagnetic tape-punching mechanism for tape-controlled printing telegraph systems, in combination, a plurality of finger keys arranged side by side, stationary contacts arranged side by side, below the keys and connected together in a plurality of sets, an electromagnet for each of said sets, spring raised contacts between the stationary contacts and the keys and connected together in a plurality of sets, an electromagnet for each of said last named sets, and means individual to finger keys for depressing the spring raised contacts into engagement with the stationary contacts when the keys are actuated to selectively connect any set of the first named sets of contacts with any set of the second named sets of contacts whereby any electromagnet of one set may be connected in series with any electromagnet of the other set.

5. In electromagnetic tape-punching mechanism for tape-controlled printing telegraph systems, in combination, stationary contacts connected together in a plurality of sets, an electromagnet for each of said sets, movable contacts connected together in a plurality of sets, an electromagnet for each of said last named sets, and means including finger keys for closing pairs of said contacts individually to selectively contact any set of the first named sets of contacts with any set of the second named sets of contacts, each pair of contacts including one stationary contact and

one movable contact, whereby any electromagnet of one set may be connected with any electromagnet of the other set.

6. In electromagnetic tape-punching mechanism for tape-controlled printing telegraph systems, in combination, a plurality of character designating keys, a plurality of pairs of contacts adapted to be closed by said keys, a plurality of punching devices, electromagnets associated with the same, a plurality of controlling circuits for the electromagnets, each of which include a group of two or said electromagnets and at least one of said controlling circuits including two of said pairs of contacts connected in parallel whereby actuation of either of two keys causes closing of a single controlling circuit, a shift key, contacts controlled thereby, a punch corresponding to the shift key, an electromagnet for controlling said last named punch, and a circuit including said last named electromagnet and contacts controlled by said shift key.

7. In electromagnetic tape-punching mechanism for tape-controlled printing telegraph systems, in combination, three punch controlling electromagnets connected in series, a controlling circuit for the same including two pairs of contacts connected in parallel, and means comprising a shift key and contacts for controlling the energization of one of said electromagnets independently of said controlling circuit whereby owing to the energization or lack of energization of said last named electromagnet an indication is given as to whether or not the shift-key was operated.

8. In electromagnetic tape-punching mechanism for tape-controlled printing telegraph systems, in combination with a typewriter having type bars, actuating pawls therefor, a rotating ratchet to actuate the pawls, and finger keys connected with the pawls singly to shift the same into engagement with the ratchet and thereby cause actuation of the type bars when the keys are depressed, of a plurality of punch-controlling circuits, contacts associated with the controlling circuits to open and close the latter, and an actuator for each pair of contacts, each actuator being operable to close its associated pair of contacts by a type bar actuating pawl.

9. In electromagnetic tape-punching mechanism for tape-controlled printing telegraph systems, in combination with a typewriter having type bars, actuating pawls therefor, a rotating ratchet to actuate the pawls, and finger keys connected with the pawls singly to shift the same into engagement with the ratchet and thereby cause actuation of the type bars when the keys are depressed, of a plurality of punch-controlling circuits, contacts associated with the controlling circuits to open and close the latter, said contacts being in pairs and including spring contacts normally open, and a pivotal actuator bear-

ing upon each spring contact and being operable by its associated type bar actuating pawl to close the contact against the spring action of the actuator-bearing contact.

5 In testimony whereof we hereto affix our signatures.

GEORGE S. HILTZ.
WILLIAM F. PURCELL.

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