D. MURRAY.

CODE TRANSPOSING APPARATUS FOR TELEGRAPH SYSTEMS.

APPLICATION FILED JAN. 20, 1919.

1,394,439. Patented Oct. 18, 1921.

3 SHEETS—SHEET 1.

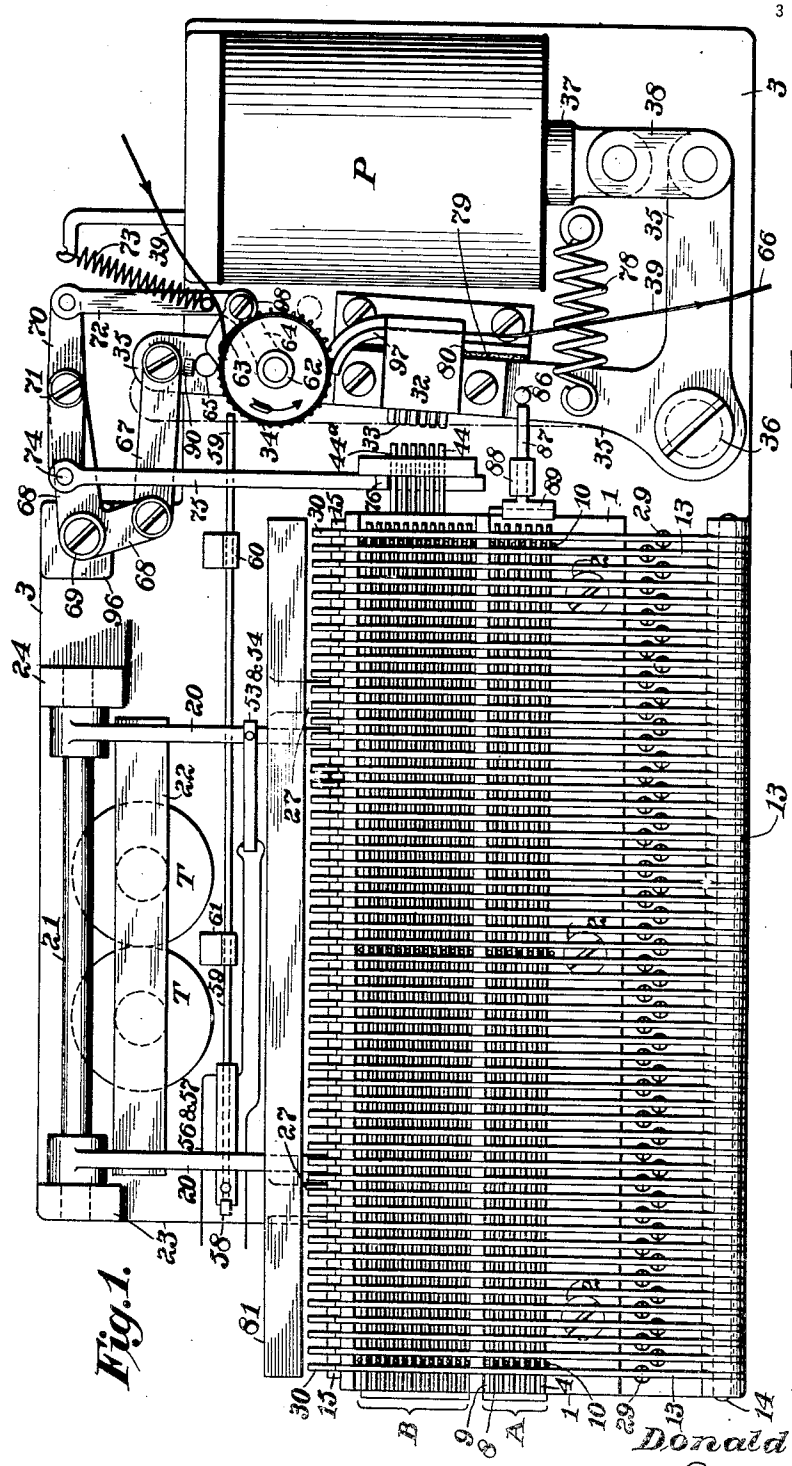


Fig. 1.

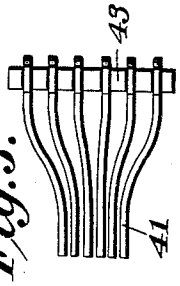


Fig. 5.

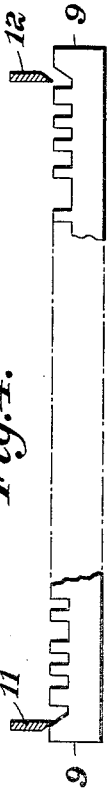


Fig. 4.

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3 SHEETS—SHEET 2.

Fig. 2.

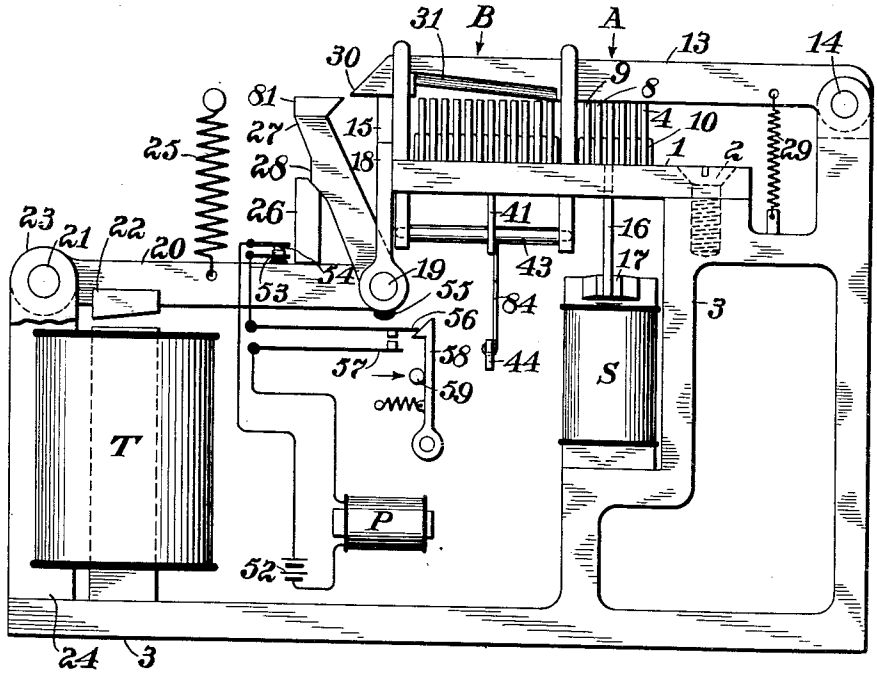


Fig. 3.

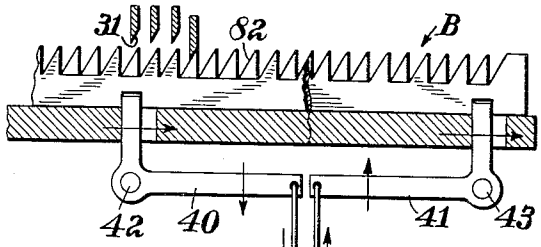


Fig. 6.

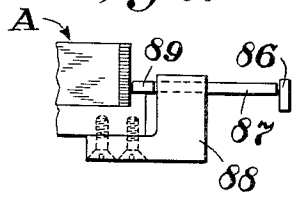


Fig. 7.

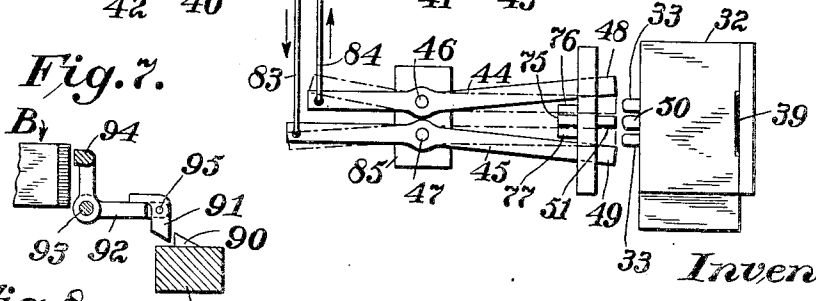
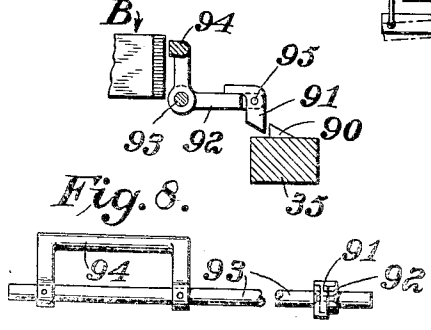


Fig. 8.



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3 SHEETS—SHEET 3

Fig. 9.

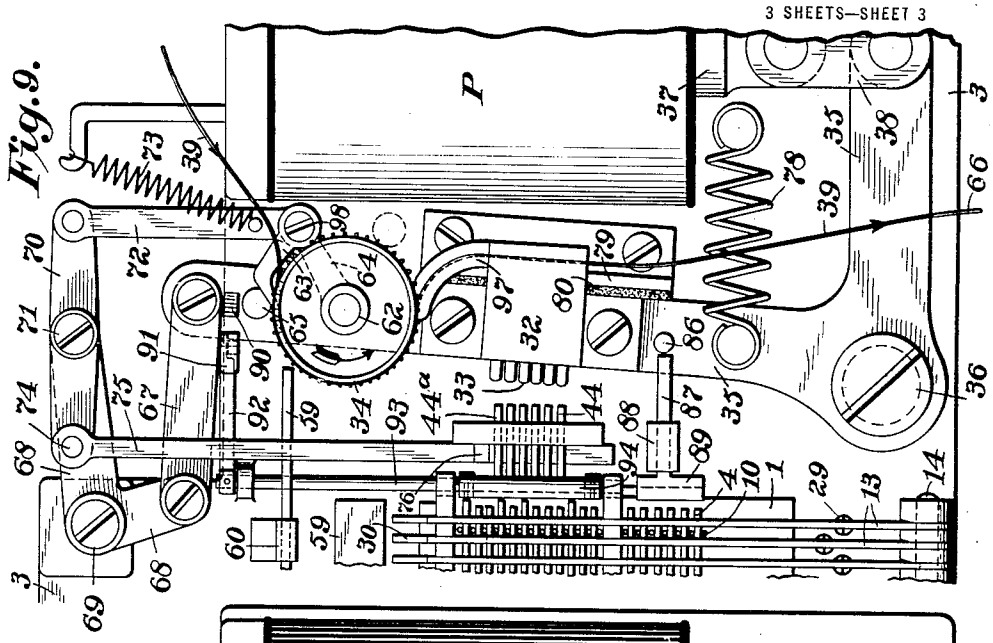
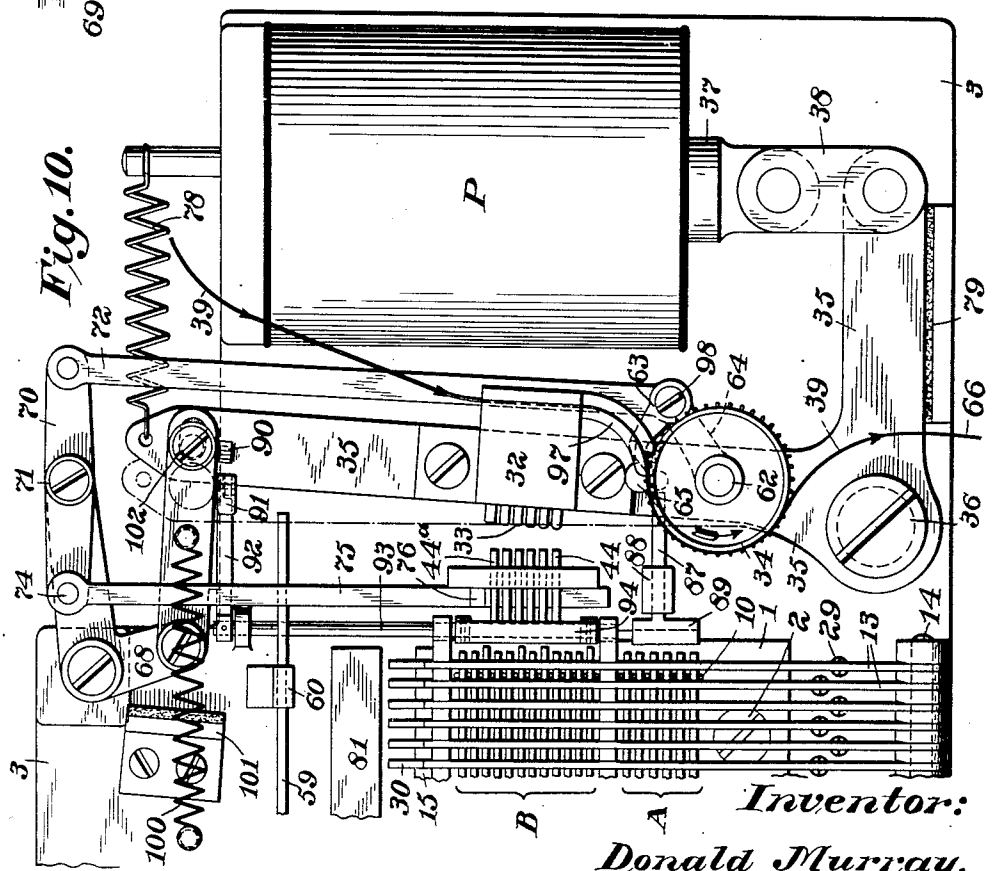


Fig. 10.



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UNITED STATES PATENT OFFICE.

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CODE-TRANSPOSING APPARATUS FOR TELEGRAPH SYSTEMS.

1,394,439. Specification of Letters Patent. Patented Oct. 18, 1921.

Application filed January 20, 1919. Serial No. 272,140.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

To all whom it may concern:

Be it known that I, DONALD MURRAY, a subject of the King of Great Britain, residing at London, England, have invented certain new and useful Improvements in Code-Transposing Apparatus for Telegraph Systems (for which I have filed application in England August 22, 1917, Patent No. 116,195), of which the following is a specification.

This invention relates to mechanism for automatically transposing signals or messages from one code into another and is primarily intended for use in connection with printing telegraph systems.

In the operation of machine telegraphy or printing telegraph systems on land lines, the well-known five-unit code has proved its superiority over other signal codes and is displacing the use of the Morse code; but in the operation of long ocean cables the Morse code has held its own, although there are indications that the three-unit cable code may be used on cables more largely in the future.

As in many instances long ocean cables are worked in conjunction with considerable lengths of land line, it is desirable to have machines at the cable stations for transposing messages automatically from one code into the other, particularly from the five-unit into the cable-Morse code or the three-unit code, and vice versa. There are also some other instances in which automatic transposition of one telegraph code into another is desirable, such for instance as the Baudot arrangement of the five-unit code into the Murray and Western Union arrangement of the five-unit code and vice versa.

The object of this invention is to supply such a machine in a simple and compact form. A telegraph printing machine, preferably of the typebar variety, adapted for printing messages in Roman type by means of the five-unit code may be arranged by replacing the typewriter or printing part by a keyboard perforator adapted to produce, say, cable-Morse tape, the levers or keys of the five-unit selector mechanism of the telegraph printer being then connected by wires or hooks to the keys of the keyboard perforator mechanism. With necessary modifications of detail, any telegraph printing mechanism employing any telegraph code can be used in this way to operate a keyboard perforator or other mechanism employing a different telegraph code. The conjunction of two machines in this way, however, is costly and cumbersome. The mechanism which I have invented condenses and combines the essential parts of the two machines into one compact mechanism. For the purpose of illustrating the invention, I have shown a machine arranged for the transposition of the five-unit into the cable-Morse code.

In the accompanying drawings, Figure 1 is a plan view of the machine;

Fig. 2 is an end elevation of the same;

Fig. 3 shows the intermediate link connections between the combs and the tape punching mechanism;

Fig. 4 is a detail of the letter and figure-shift comb;

Fig. 5 is a fragmentary detail of the link connections shown in Fig. 3;

Figs. 6, 7 and 8 show details of two devices for restoring the combs to zero position;

Fig. 9 is an enlarged detail plan view showing a portion of Fig. 1, embodying the comb restoring mechanism; and

Fig. 10 is a view of the same parts shown in Fig. 9 with a modified arrangement of the tape feeding device.

The selecting mechanism now generally adopted in telegraph printers consists of a group of permutation-bars or "combs," one comb being provided for each element or unit of a letter signal. Instead of permutation bars or combs, permutation disks are sometimes employed. The principle and action remain the same, and the only change is in the mechanical form necessitated by the circular instead of straight line arrangement. For purposes of illustration, I have shown the bar form, but it is to be understood that this invention applies equally to either the bar or the disk form. In the five-unit code five combs or five disks are needed, and in cable-Morse twelve combs or twelve disks are required, while in the three-unit cable code six combs or six disks are employed. By cable-Morse is meant the Morse code used on long ocean cables employing positive, negative and zero dots or units in place of the ordinary Morse dots and dashes.

I shall describe the invention as applied to the task of transposing five-unit signals into cable-Morse signals.

In this invention I employ two groups of combs A and B arranged side by side on a common bedplate 1, attached by screws 2 to the frame 3 of the machine. The group A comprises six combs numbered 4 to 9 which are provided with slots to represent the five-unit code, and are free to slide on the bedplate 1 lengthwise about $\frac{1}{16}$th inch between rows of guide-pins 10. Five of these combs represent the five-unit code, while the sixth comb 9 operates to produce the figure-shift.

The group B, located on the same bedplate parallel and closely adjacent to group A, consists of twelve combs provided with slots arranged for the Morse-cable alphabet, the maximum number of signal elements per character in this alphabet being six arranged in two positions. There are approximately fifty-two characters used in the Morse code, while in the five-unit code there are thirty-one, the additional characters required for commercial use being obtained by a figure-shift. Usually this change is obtained by shifting the typewriter carriage or the typebar basket or the typewheel, according to the style of printing mechanism. In the present invention I greatly simplify the machine by employing a sixth comb 9 for the figure-shift, this comb being operated by wedge levers controlled by the other five combs. These levers, indicated at 11 and 12, in Fig. 4 are provided with wedge-shaped ends adapted to engage the inclined sides of the outer slots in the bar 9 when selected by the mechanism hereinafter described. Assuming that wedge 11 is selected, the mechanism causes it to press down on the inclined side of the left outer slot of the comb 9, causing it to move about $\frac{1}{16}$th of an inch to the left. In the same manner the wedge lever 12, when operated by the mechanism, causes the comb 9 to move about $\frac{1}{16}$th of an inch to the right. The combs are really a group of permutation locks, and this shifting of the sixth comb to the right or to the left alters the selection so that permutations of signals representing figures in the signal code will be recorded if the comb 9 moves in one direction and letters if it moves in the other direction. In this way an adequate number of signals are obtained from the five-unit code to operate the fifty-two or more Morse signal permutations in the twelve combs of group B.

Resting just above and at right angles to the two sets of combs A and B, there are a series of crossbars 13 on the rod 14 and held up at the other end by a supporting bar 15 just clear of the combs. As the five-unit combs are the controlling combs in the present case of transportation from the five-unit code to the Morse-cable, they are made with vertical teeth or slots suitably spaced as shown in Fig. 4, and the five combs 4 to 8 are free to move to the right about $\frac{1}{16}$th of an inch under the action of springs (not shown) as soon as released by a tripping pawl 16, Fig. 2, controlled by the armature 17 of a small setting magnet S. There are five of these trip pawls 16 and five of these setting magnets S, arranged in a row beneath the combs in group A, only one being visible in Fig. 2. The pawls 16 may operate directly to thrust the combs to the right. Mechanism of this kind is well-known in connection with printing telegraphs and it is therefore not necessary to describe it more in detail. The pawl 16 engages in a slot on the under side of its comb, and when the pawl is pulled down by its magnet S the comb is released and moves to the right under the action of its spring. The five-unit code signals are distributed by well-known means to one or more of these five magnets. The combs are thus set into a certain permutation corresponding to the character signal transmitted, a particular group of slots in the combs being in this way alined so as to permit one of the crossbars 13 to fall into the alined group of slots as soon as the supporting bar 15 drops down. At the right moment the distributing mechanism (well-known and not forming part of this invention and therefore not described) after operating on one or more of the five setting magnets S, sends an impulse into the transposing magnet T, which controls the supporting bar 15. This transposing magnet T corresponds to the printing magnet in a printing telegraph, but instead of operating to record the character on paper it records it as a transposed permutation in the Morse combs, group B in the following manner:

The supporting bar 15 is provided with two downwardly projecting pillars or arms 18, Fig. 2, which are pivoted on the rod 19, secured to the outer ends of two armature levers 20, Figs. 1 and 2. The levers 20 are fastened to a shaft 21, and carry the armature bar 22. The whole forms an armature frame pivoted in the bearings 23, 24, and normally held in its upper retracted position against the back-stop 26 by a spring 25.

A universal bar 81, extends parallel to the bar 15 and is carried by two arms 27 also pivoted on the rod 19. The arms 27 are provided with cam projections 28 which normally bear upon the upper inclined end of the back-stop 26.

The operation of this mechanism is as follows: When the armature 22 is attracted by the magnet T the supporting bar 15 is drawn downwardly away from the crossbars 31, and the latter are then pulled down upon the top of the combs by their springs 29. One cross-bar will drop slightly into

the alined slots in the comb group A, which were brought into alinement by the code signal transmitted to the magnets S, so that the tip of the beveled or wedge-shaped end of that particular bar 30 will project slightly below the other bars. As the depression of the armature progresses, drawing the arms 27 downwardly, the cam projections 28 bearing against the inclined face of the back-stop 26, cause the arms 27 to carry the universal bar 81 forwardly toward the ends of the bars 30. The bar 81 is arranged to pass below the tips 30 of the cross-bars which are in their normal position but will engage any bar which has been depressed into a group of alined slots. The forward edge of the bar 81 is cut wedge shape as shown and its sharp edge engages the beveled tip of the depressed selected cross-bar and forces it to descend with the armature frame. Each of the cross-bars 13 is provided with a sloping beveled portion 31, Figs. 2 and 3, extending over the comb group B and as the selected bar is pulled downwardly by the universal bar 81, the beveled portion 31 engages the wedge-shaped teeth 82 of certain bars and moves them laterally to form the desired combination of the Morse character. The teeth of certain of the twelve group B combs are cut away in the manner indicated in Fig. 3 to form the required Morse character permutation, so that only the bar or bars whose movement will form the Morse character corresponding to the transmitted five-unit character will have teeth in the path of the depressed bar.

In this way the five-unit code signal is transposed into the corresponding cable-Morse signal representing the same character. It remains now to record the Morse signal in such a form that it may be either read or transmitted over another telegraph line or into an ocean cable. This may be effected by direct-transmitting mechanism, or by a metal pin or plate storage transmitter or by perforated paper tape. In ordinary commercial practise perforated tape is preferred for Morse-cable transmission, and that form of registering mechanism is therefore described in connection with this invention. The perforating mechanism may be any well-known form of Morse keyboard perforator, but I prefer to simplify the arrangement by making the punch-block movable and the hammer fixed. That is to say, I attach the punch-block 32, Fig. 1, with its group of punches 33 and the star-wheel 34 for feeding the paper tape 39, to a long bellcrank lever 35, pivoted at 36, Fig. 1, and operated by a punching magnet P, which may be conveniently of the solenoid type, the plunger 37 being connected by the link 38 to the short arm of the bellcrank lever 35. I can use the ends of the selected Morse-cable combs, group B, as the fixed hammer for forcing the required punches 33 through the paper tape 39 in the punch block 32, but the accepted dimensions of Morse-cable tape make the action rather cramped, and I therefore prefer to insert some intermediate levers and links, which can be cranked to the required dimensions to come opposite the punches. In this way more space is provided for the combs and they can be made thicker (about $\frac{1}{16}$th of an inch) and therefore more durable.

A system of intermediate levers and links for this purpose is shown in Figs. 1, 2, 3, and 5. I do not confine myself to this particular arrangement, as many modifications may be introduced to secure the same effect. Referring to Fig. 3, two groups each of six bellcrank levers 40, 41, are pivoted on rods 42, 43. One of these rods 43 is shown in its bearings in Fig. 2. The short vertical arms of the levers 40, 41, engage in slots in the under edge of the Morse combs, and at the ends of the long arms of the levers 40, 41, are wire links 83, 84, connecting them to two other groups each of six levers 44, 45, pivoted at 46 and 47 to a fixed block 85. The cranking of these levers 40, 41, to bring them into line with the punches is shown in Fig. 5. It will be seen by inspection of the arrows in Fig. 3 that slight movement of one or more of the Morse combs to the right will throw one or more of the ends 48 49 of the twelve levers 44, 45 (six above and six below) into the path of the message-hole punches 33 arranged in two rows in the punch-block 32. Consequently when the punch-block, carried on the oscillating lever 35, is moved inward, the punches 33 are forced against the ends of such of the levers 44, 45, as have been moved by the Morse combs (group B) into the path of the punches. In this way the punches are forced through the paper tape 39, perforating in the tape the required permutation of message holes. The punch-block and its punches and punch retracting springs may be of any well-known form, and they are consequently not described or shown here in detail.

It is obvious that the punching operation must not take place until the required Morse permutation has been set up in group B. Also as there is very little time intervening between the reception of one group of signals and the next, it is desirable that the punching shall take place immediately after the completion of the setting of the permutation in group B. The electrical and mechanical arrangements for this purpose are shown in Fig. 1, and diagrammatically in Fig. 2. Referring to the diagram in Fig. 2, P is the punching magnet, in circuit with a battery 52. The pair of contacts 53, 54 tend

to spring open, but they are arranged immediately above one of the armature frame levers 20, Figs. 1 and 2, which holds the contacts closed. As soon as the armature frame begins to descend under the attraction of magnet T, the contacts 53, 54 spring open, and prevent the operation of the punching magnet. Further depression of the armature frame causes the insulated stud 55 to press down the contact spring 56, closing the contact with the spring 57. At the same time the pawl 58 catches the end of the spring 56 and maintains the contacts closed. When the magnet T is deënergized and the armature frame is retracted, thereby closing the contacts 53, 54, the punching magnet P is immediately energized and punches the tape. When the punching magnet has nearly completed its stroke and the lever 35, Fig. 1, has nearly reached its innermost position, the lever 35 strikes one end of rod 59, carried in bearings 60, 61, causing its opposite end to strike against the pawl 58 and throw it out of engagement with the contact spring 56, thereby opening the punching magnet circuit and deënergizing the magnet P. The contacts 53, 54 are not absolutely necessary, but they prevent any risk of the five-unit comb restoring mechanism, presently to be described, starting to operate before the selected crossbar 13 is clear of the slots in the combs.

In addition to being perforated, the paper tape must be fed forward differentially, that is to say, it must move forward different distances corresponding to the different lengths of the Morse-cable letters, varying from one to six units or feed-holes. This is effected by a system of links and compound levers shown in Fig. 1. The toothed wheel 34, which may conveniently have thirty-six teeth as shown, is carried on a vertical spindle 62, and below the toothed wheel on the same spindle is a ratchet wheel (not shown) also provided with thirty-six teeth. A feed pawl 63 pivoted at 98 on the end of the oscillating arm 64 engages with the ratchet wheel and rests normally against the stop-pin 65, which limits the motion and prevents overfeed of the toothed wheel. The paper tape 39 is shown passing around the toothed wheel 34, through the tape guide 97, and the punch-block 32 and out of the machine at 66. Assuming that there is only one unit in the Morse signal, for instance the letter E or T, then only one or other of the first pair of levers 44, 45 will be moved into the path of the punches. This first pair of levers is indicated in Fig. 1 by 44, and the sixth by 44^a. When the lever 35 moves inward under the action of the magnet P, it forces to the left the link 67 connecting the end of the lever 35 and the short arm of the bellcrank lever 68, the latter being pivoted at 69 on the post 96 of the frame 3. The link 67 forces the long arm of the lever 68 inward, the latter carrying the lever 70 which is centrally pivoted at 71 and connected at one end by the link 72 to the end of the arm 64 carrying the pawl 63. This link and the pawl 63 and the arm 64 are retracted to their position of rest by the spring 73. Pivoted at 74 on the other end of the lever 70 is a differential rod 75 carried in guides (not shown) and sliding between the two sets of levers 44, 45. This rod 75 shown in end view in Fig. 3, carries a tooth or projecting block 76 above and a corresponding block 77 below. One or other of these two blocks 76, 77, engages with the side of any one of the pairs of levers 44, 45, which may have been thrown by the Morse combs into the path of the punches. If there is only one unit in the character, such as E or T, then only one or other of the first pair of levers 44, Fig. 1, will be in the path of the punches and also in the path of the differential rod 75. If the Morse signal represents a long character of six units, then all six of the pairs of levers 44, 45 will be brought into the path of the punches and of the rod 75. In that case the rod 75 by means of its projecting blocks 76, 77, will be stopped by one or the other of the pair 44^a, Fig. 1, and so also with characters of intermediate length. The rod 75 will therefore stop in six different positions in accordance with the length of the characters and will have a maximum motion for a short character like E or T and a minimum motion for a long character, such for instance as the hyphen. Inspection of Fig. 1 will show that this results in a minimum motion for the pawl 63 for a short character of one unit, and a maximum motion of the pawl 63 for a long character of six units. The stroke of the pawl is also arranged to feed one more unit or tooth of the ratchet wheel than the number of units in the character in order to provide for the space between characters. The action is as follows: On the inward stroke of the lever 35, the link 67 causes the bellcrank lever 68 to move its long arm inward, carrying the lever 70 inward. The spring 73 maintains the link 72 and the pawl 63 in their position of rest until the differential rod 75 is stopped by one of the six pairs of levers 44 to 44^a. When this occurs the further movement of the link 72 extends the spring 73 and carries the pawl 63 rearwardly over the corresponding number of teeth of the ratchet wheel. The tape having been punched, and the circuit of magnet broken at contacts 56, 57, the lever 35 is retracted by the large spring 78 to its position of rest against the leather buffer 80 on the backstop plate 79 and at the same time spring 73 pulls up the pawl 63 to its position of rest against the stop 65, thereby rotating

the toothed wheel around and feeding the tape along for a distance corresponding to the character perforated.

In order to prevent the feeding of the tape before the punches have been withdrawn, a certain amount of lost motion must be provided in the link mechanism, as for instance, at the pivot 98 in the link 72. Morse tape perforators are well-known, however, and details are therefore omitted. The punches 33 are provided with retractile springs to hold them normally out of the paper slot as usual. If the tape passes around the toothed-wheel before entering the punch-block as shown in Fig. 1, it must be perforated beforehand with a central row of feed-holes; but if it is preferred to use plain unprepared tape, the toothed-wheel should then be placed on the other side of the punch-block so as to pull the tape through the punch-block as illustrated in Fig. 10. The link 72 is then made longer, but the action remains the same. Also a central row of feed-hole punches has to be provided in the punch-block as shown at 50 in Fig. 3. These punches are forced through the paper by the permanently fixed hammer 51. Provision must also be made for a certain amount of lost motion to prevent the tape feed wheel 34 from starting before the punches are withdrawn from the paper. This may be accomplished by elongating the slot at the pivot 102, Fig. 10, to allow about one-sixteenth of an inch of lost motion and providing a spring 100 to hold the bell-crank arm 68 against the back-stop 101 until the lever 35 has been moved on the back stroke by the spring 78, the slight distance equal to said lost motion, thereby permitting the punches 33 to be retracted. It is immaterial, therefore, as far as this invention is concerned, whether prepared or unprepared tape is employed.

In order to restore the two groups of combs A and B to zero position ready for the next character to be transposed, the devices shown in Figs. 6, 7, 8 and 9 are employed, the mechanism for restoring the Morse combs B being omitted from Fig. 1 for the sake of clearness. The device for restoring the combs in group A is shown in Fig. 1 as well as in Figs. 6, 9 and 10.

The combs in group A have to be reset as soon as possible to permit the setting up of the next character while the last character is being perforated, and must therefore, be restored to zero position first. For this purpose a stud 86 on the lever 35 on the forward stroke strikes the rod 87 which passes through the guide-block 88 and carries at its inner end a flat plate 89. This strikes and throws back the five combs 4 to 8 of group A, but it does not touch the sixth comb 9, as this figure-shift comb is controlled exclusively by the figure and letter shift levers 11 and 12 operated by the group of five combs 4 to 8.

Such of the cable-Morse combs, group B, as have been shifted are restored to zero position on the back-stroke of the lever 35 moving to its position of rest. On the forward motion of lever 35 a wedge-shaped tooth 90 strikes a small oscillating member 91, Figs. 7, 8, 9 and 10, pivoted at 95 on the end of the lever arm 92, which tilts and allows tooth 90 to pass. The lever 92 carrying the tilting member 91 is secured to a rock-shaft 93 which carries a push-arm 94 of sufficient breadth to extend across the ends of all the Morse combs. On the rearward movement of lever 35, to its position of rest, the tooth 90 engages with the member 91, which in this case can not tilt, and the cam action of the inclined tooth 90, lifts the member 91 and the lever 92, thereby rocking shaft 93 and causing the arm 94 to push such of the combs of group B as were previously moved to the right, back to their zero position on the left. This results in the Morse combs in group B being restored to zero position after their work has been done and after the restoration to zero of the combs in group A.

In the case of printing telegraphs such as the Murray multiplex, employing the five-unit code (or other code in which the letter signals are of equal duration), correcting mechanism is provided for invisible correction of errors by punching five holes in the tape in place of each erroneous character. The five hole group in the tape leaves the printing mechanism idle. Hence there is no visible indication of the correction in the printed message, not even a space. This is a valuable feature, but it results in loss of time in proportion to the number of corrections made. This is of no importance on land lines where the possible speed is far above requirements, but it is desirable on ocean cables to avoid any loss of line time. I arrange for this by providing that on the arrival of a five-hole signal (five marking units) the crossbar selected in the transposer by this signal, upon being depressed shall meet no teeth in the cable-Morse combs. Hence the cable-Morse combs are not moved and the punching and tape feeding action does not take place. Accordingly, perfectly "clean" cable-Morse tape is prepared automatically by the transposing machine even though the arriving message in the five-unit alphabet may contain many corrections. In the same way, in the case of transposition from five-unit to cable-Morse there is no need for figure and letter shift signals and no need for "new line" signals. They are accordingly omitted by cutting out the teeth that would represent them in the cable-Morse combs.

Instead of perforating a tape, the trans-

posing machine may record the transposed signals in any other convenient way, such for instance as opening or closing electrical contacts by the motion of the combs. This is particularly applicable in the case of two different arrangements of the five-unit code. For instance, in the case of the Baudot printing telegraph the characters are differently allocated to the five-unit permutations compared with the allocations of the characters of the permutations in the Murray multiplex and the Western Union multiplex. For example the Murray and Western Union five-unit permutation for E is the same as that for the Baudot A. This involves a breach of continuity in cases where these two different arrangements of the five-unit code come into connection with each other. The present invention overcomes this difficulty. For this purpose, assuming that the Murray or Western Union arrangement has to be transposed into the Baudot arrangement of the five-unit code, so that there are two groups of five 5-unit combs, one in group A being slotted in accordance with the Murray and Western Union arrangement and the other in group B being slotted in accordance with the Baudot arrangement, the slots in group B being wedge-shaped, as already described. In this case five combs are sufficient and there is no need for the sixth figure-shift comb mechanism shown in Fig. 6, nor for the paper perforating mechanism, or the intermediate link mechanism shown in Fig. 3. Likewise only thirty-one crossbars 13 are required instead of about fifty-two. The combs in group B that have been moved by a transposition, close or open one or more of a corresponding group of five electrical contacts, and this group of signals recorded in the group of electrical contacts is swept by the distributer in the normal way either into the telegraph line for retransmission or into a Baudot printer. Transmitting-groups of five electrical contacts are well-known devices in five-unit multiplex apparatus, and it is therefore not necessary to describe them. The transposer in this case is of a very compact and simple character, the only substantial difference being in the mechanism for recording or retransmitting the transposed signals. The recording mechanism, as I have already pointed out, may be of any form convenient for the purpose for which the invention is required. It is to be noted that in a case of this kind where the number of crossbars is comparatively small, the combs in group B may be set by the action of the crossbar springs 29, these springs being strengthened sufficiently to perform the work. The universal bar 81 can then be dispensed with and the magnet T simply lowers and raises the supporting bar 15. It is possible also as will be evident to lower and raise the supporting bar 15 by toggle-joint supports operated by the magnet T, the crossbar springs 29 then being strengthened and performing the transposing work even in the case of a considerable number of crossbars. I have illustrated and described the preferred method of operating the cross bars in cases in which a considerable number of crossbars have to be operated, but I do not confine myself to that particular mechanical device.

In the case of a transposer operating from Morse into five-unit code, the five-unit combs and the sixth or figure comb change places with the Morse combs, becoming group B, while the Morse combs become group A. The five-unit combs then become saw-toothed and the Morse combs have vertical teeth.

Having now fully disclosed my invention and in what manner it may be carried out, I declare that what I claim is:—

1. Apparatus for transposing signals from one telegraph code into another, comprising a group of selecting devices representing one telegraph code, a second group of juxtaposed selecting devices representing another telegraph code, and means for operating upon the second group under the mechanical control of the first group, so as to transpose a signal from the first group into the second group.

2. Apparatus for transposing signals as set forth in claim 1, in combination with means for recording the result of the transposition.

3. Apparatus for transposing signals from one telegraph code into another, comprising a group of combs representing one telegraph code, a second group of combs representing another telegraph code, said groups being located side by side with the combs in parallel arrangement, a set of cross-bars common to said two groups and selectable under the control of the first group, and means for operating the cross-bar selected by any given signal to thereby transpose the signal from the first group into the second group.

4. An apparatus as set forth in claim 3, in combination with means for recording the result of the transposition.

5. An apparatus as set forth in claim 3, and a power-driven universal bar adapted to forcibly depress the selected cross-bar and cause the latter to set the combs in the second group into the desired transposed signal permutation.

6. An apparatus as set forth in claim 3, in which the cross-bars are provided with wedge-shaped engaging faces, in combination with an electro-magnetically actuated universal bar adapted to forcibly depress the selected cross-bar and cause the latter to

set by wedge action the combs in the second group into the desired transposed signal permutation.

7. An apparatus as set forth in claim 3, and a power actuated universal bar adapted to forcibly depress the selected cross-bar and cause the latter to set the combs in the second group into the desired transposed signal permutation, in combination with a telegraph tape perforating mechanism for recording the result of the transposition in the form of holes in the tape.

8. Apparatus for transposing signals from one telegraph code into another, comprising a group of combs having teeth arranged to represent one telegraph code, a second group of combs having teeth arranged to represent another telegraph code, the groups being juxtaposed in parallel arrangement, a set of cross-bars common to the two groups and selectable under the control of the first group, a power-driven universal bar adapted to forcibly depress the selected cross-bar and cause it to set the combs in the second group into the desired transposed signal permutation, a tape perforating mechanism for recording the result of said transposition, a punch block having punches for perforating the tape, a movable support carrying said punch-block and adapted to force the punches against projecting elements corresponding to said second set of combs.

9. Apparatus for transposing signals from a telegraph code with signals of equal length into a telegraph code having signals of varying length, comprising a group of combs representing the code with signals of equal length, a second group of combs representing a code with signals of varying length, a set of cross-bars common to the two groups and selectable under the control of the first group of combs, a universal bar operable to forcibly depress the selected cross-bar to thereby set the combs in the second group into the desired transposed signal permutation, a tape perforating mechanism for recording the result of said transposition in the form of perforations representing signals of varying length, and differential mechanism for feeding the tape forward varying lengths corresponding with the varying lengths of the signals.

10. Apparatus for transposing signals from one telegraph code into another, comprising a group of cross-bars, a group of combs adapted to select any one of said group of cross-bars, a second group of combs having wedge-shaped teeth adapted to cooperate with the selected cross-bar when the latter is operated to force the combs engaged thereby into the desired signal permutation.

11. Apparatus for transposing signals as set forth in claim 1, in combination with means for preventing the actuation of devices in the second group upon the formation of a certain signal in the first group to thereby eliminate corrections or unnecessary signals existing in the original series of signals.

12. Apparatus for the transposition of signals from one telegraph code into another, comprising groups of combs representing respectively different telegraph codes, and a figure-shift comb in one group adapted to be operated under the control of the other combs of the same group.

In testimony whereof I affix my signature.

DONALD MURRAY.