D. MURRAY.

TAPE TRANSMITTER.

APPLICATION FILED AUG. 14, 1914.

1,401,917.

Patented Dec. 27, 1921.

2 SHEETS—SHEET 1.

Fig. 1.

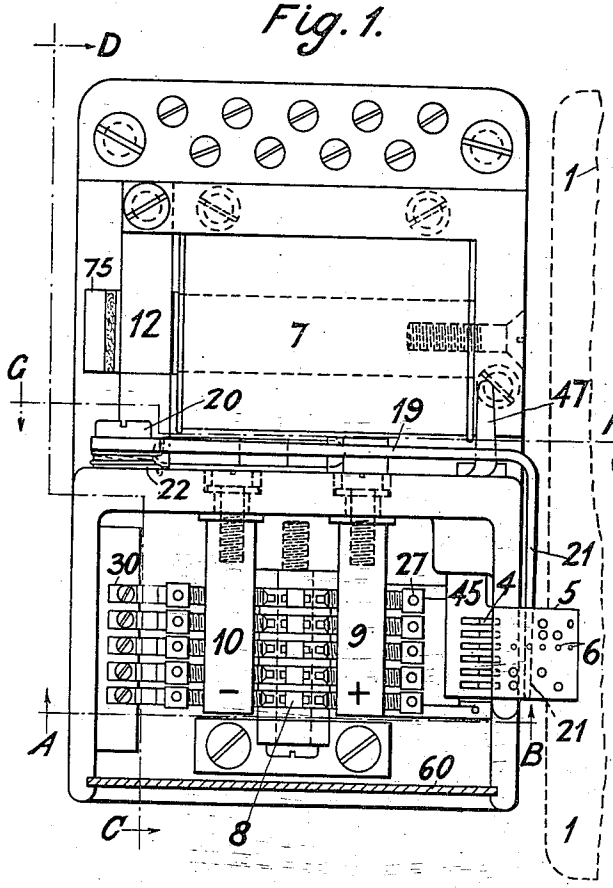


Fig. 3.

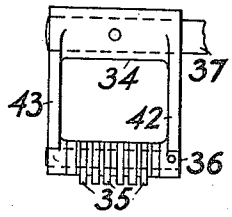


Fig. 4.

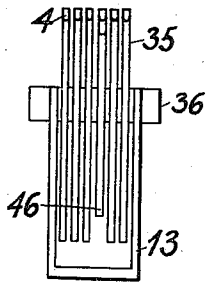


Fig. 13.

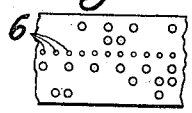
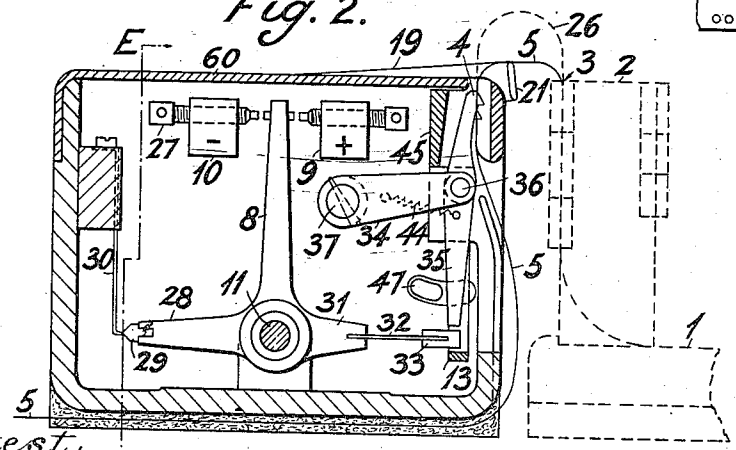


Fig. 2.



Attest:
Edw. L. Tolson.
B. D. Bishop.

Inventor,
Donald Murray,
by Pfeiffer Middleton Donaldson & Pfeiffer
Atty's.

D. MURRAY.

TAPE TRANSMITTER.

APPLICATION FILED AUG. 14, 1914.

1,401,917.

Patented Dec. 27, 1921.

2 SHEETS—SHEET 2.

Fig. 5.

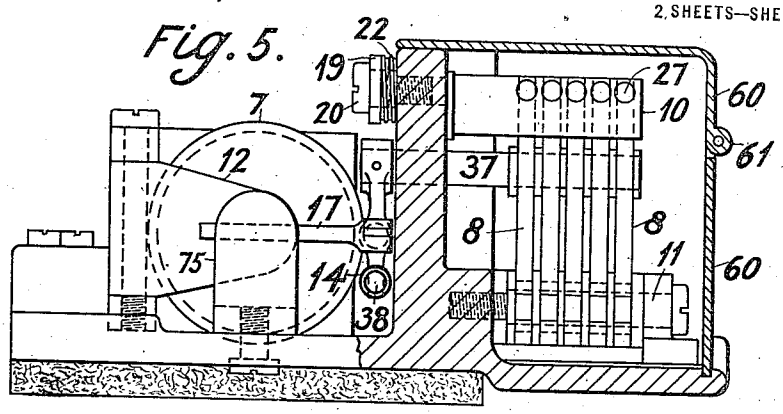


Fig. 6.

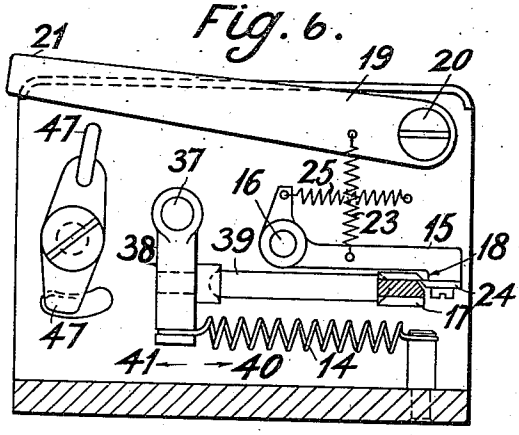


Fig. 7.

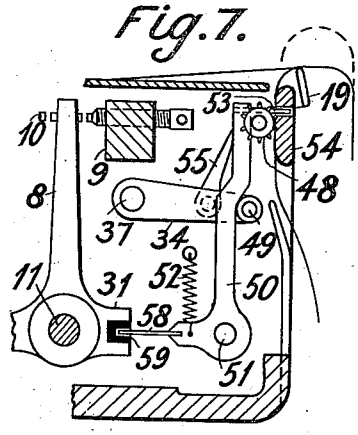


Fig. 8.

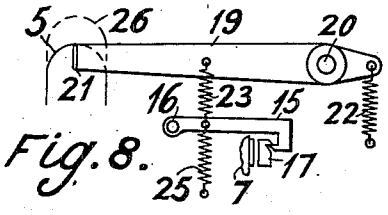


Fig. 9.

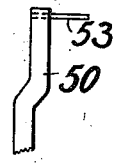


Fig. 10.

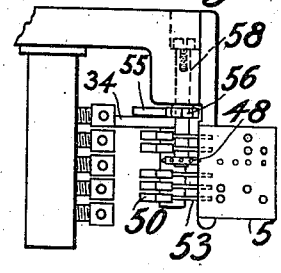


Fig. 12.

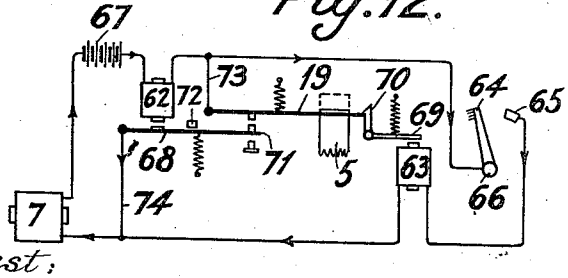
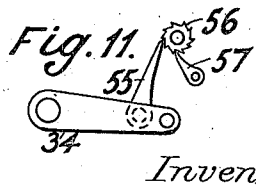


Fig. 11.



Attest:

Edwd L. Tolson.

B. L. Bishop

Inventor:

Donald Murray,

by Fisher Middleton Donaldson & Fisher Attys.

UNITED STATES PATENT OFFICE.

DONALD MURRAY, OF LONDON, ENGLAND, ASSIGNOR TO THE WESTERN UNION TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TAPE-TRANSMITTER.

1,401,917. Specification of Letters Patent. Patented Dec. 27, 1921.

Application filed August 14, 1914. Serial No. 856,845.

To all whom it may concern:

Be it known that I, DONALD MURRAY, a subject of the King of Great Britain and Ireland, and residing at 19 Victoria Mansions, Queen's Club Gardens, London, W., England, have invented certain new and useful Improvements in and Relating to Tape-Transmitters, of which the following is a specification.

This invention relates to an improved perforated paper tape automatic transmitter for use with a keyboard tape perforator in a multiplex printing telegraph system. The chief objects of the invention are to reduce as much as possible the delay between the perforation and the transmission of the messages and to provide for automatic starting and stopping of the transmitter under the control of the tension of the perforated paper tape.

In the accompanying drawings:—

Figure 1 is a plan view of the transmitter.

Fig. 2 is a sectional elevation along the lines A B in Fig. 1.

Figs. 3 and 4 are details.

Fig. 5 is a side elevation partly in section along the lines C D, Fig. 1, and E F, Fig. 2.

Fig. 6 is a sectional elevation along the line G H, Fig. 1.

Fig. 7 is a modification of part of Fig. 2.

Fig. 8 is a diagrammatic sketch of the automatic starting and stopping mechanism of the transmitter.

Fig. 9 is a detail of Fig. 7.

Fig. 10 is a plan view of the modification shown in Fig. 7.

Fig. 11 is a detail of part of Fig. 7.

Fig. 12 is an alternative arrangement of the automatic starting and stopping mechanism.

Fig. 13 shows a piece of the perforated paper tape.

In connection with the multiplex printing telegraph system for which the transmitter described in this application is specially adapted, I have also designed a key-board tape perforator for preparing telegraph messages in the form of perforated paper tape, one of the chief objects of that machine being to have the least possible delay between perforation of the tape and transmission of the signals by means of the perforated tape. For this purpose the work of perforation takes place at the extreme left-hand side of the key-board perforator. The extreme left-hand end of this key-board perforator is shown in dotted outline at 1, Figs. 1 and 2. The punch block of the perforator is shown in dotted outline at 2, in Fig. 2, and the tape is perforated by a group of five punches slightly below the point 3, Fig. 2. The telegraph tape transmitter, which is the subject of the present patent application, is designed to work in conjunction with the key-board perforator, and it is arranged with the same object, namely, to reduce to the minimum possible amount the delay between the preparation and the transmission of telegraph messages. The mechanism of transmission in the transmitter is therefore arranged to work at the extreme right-hand side of the instrument. Transmission takes place at the point where the hooks 4, Fig. 2, engage with the holes in the paper tape 5. The transmitter is so designed that it will work conveniently at a distance of about one inch and it may even be worked at a distance of half an inch from the left-hand side of the key-board perforator. The tape produced by the key-board perforator has the letter groups of perforations arranged across the tape, as shown in Fig. 13, and the letter perforations are $\frac{1}{10}$ inch (2.54 m/m.) apart on the tape lengthwise, each letter corresponding to one of the row of feed holes 6, Fig. 13. By having the perforator punching the message holes in the tape at the extreme left-hand side of the machine, and the transmitter transmitting on its extreme right-hand side with so little space between the two machines, the number of letters on the tape 5, Figs. 1 and 2, between the point of perforation and the point of transmission can be reduced if desired to as little as 12. As the speed of transmission on the Murray multiplex printing telegraph, for which this transmitter is specially suited, is about 40 words per minute on each "arm" or "channel" of the circuit, the delay between perforation and transmission is in this way reduced to about three seconds. In other words, transmission can take place up to within 12 letters or three seconds of the last letter punched on the key-board perforator. This is a much greater reduction of delay than has ever before been achieved in the transmission of telegrams by perforated paper tape.

An essential condition for transmission so close up to perforation of the tape is a

mechanism that will automatically stop transmission when the transmitter has caught up to within, say, 12 letters of the perforator. The transmitter is arranged to run at a uniform speed of about 40 words per minute (four letters per second), and if the transmitter followed close up to the perforating machine, the key-board operator would be under anxiety lest the transmitter should overtake the key-board perforator and break the tape. He would have to be always watching the transmitter and this watching would distract his attention from his proper work of perforating the messages. It is still more convenient for the operator if the transmitter is not only self-stopping but also self-starting. As far as I am aware, no mechanism of this kind has been devised before I devised it for a multiplex printing telegraph perforated tape transmitter. The conditions to be satisfied are rather complicated. In a multiplex printing telegraph, transmission on each arm or channel of the circuit takes place at fixed intervals, in the Murray multiplex about every quarter of a second. An electric impulse from the distributer, known as the "cadence," operates successively the transmitter on each channel. In the Murray multiplex tape transmitter, which forms the subject of the present application, the cadence impulse from the distributer energizes the magnet 7, Figs. 1 and 5, which feeds the paper tape forward one letter space and sets a row of five contact levers 8, Figs. 1, 2 and 5, into a particular group of positive and negative contacts representing a letter signal, the contact levers 8, pivoted at 11, Fig. 2, being pushed over against the positive contacts in the bar 9, or against the negative contacts in the bar 10. Immediately afterward the rotation of the contact brushes of the distributer sweeps this group of signals into the telegraph line, the two operations of setting the contact levers and sending the signal into the line being repeated regularly every quarter second. It is obvious that the starting or stopping of the transmitter must take place between the transmission of the signals. If the transmitter was stopped in the middle of the transmission of a signal into the telegraph line, one of two things would happen. Either (*a*) the group of positive and negative contacts in the transmitter representing a letter would remain undisturbed, or (*b*) the group would be broken up and the contact levers thrown back on to the negative contact bar 10, or on to the positive contact bar 9. In the former case the same letter would be sent repeatedly, once every quarter second, into the telegraph line, thereby causing an error in the printed message at the distant station through the continued repetition of the same letter. In the latter case, the contact levers all being thrown over to the negative or the positive contact bar in the midst of the transmission of the signal group into the line, the signal would necessarily be mutilated and a wrong letter would be printed at the distant station. It is therefore necessary that the starting and stopping mechanism shall operate between the transmission of signals. Another condition is that when the machine stops, the contact levers must be thrown over on to the negative contact bar 10, so that only negative current flows to line. If positive current went to the line from the transmitter while the transmitter was stopped it would cause the printer to keep on operating. Another condition that is desirable, though not absolutely necessary, to fill, if the transmitter is to be self-starting as well as self-stopping, is that the transmitter must not be continually starting and stopping. This would cause needless wear on the starting and stopping mechanism with risk of error through the continual chatter of starting and stopping. It is desirable to have a period of several letters intervening between stopping and starting, about six to twelve letters (three seconds) forming a convenient interval. These conditions are fulfilled in the following way:

Transmission does not begin in the transmitter until after the armature 12, Figs. 1 and 5, of the transmitter magnet 7 has been attracted and released. 75 is the back-stop for the armature. The transmitter can therefore be stopped or started safely at the instant when the magnet 7 has attracted its armature 12. At this point the attraction of the armature, by mechanism to be described presently, causes the paper feeding and contact selecting mechanism to rise to the point for starting work, and at the same time the rising of a small loop or stirrup 13, Figs. 2 and 4, throws over the contact levers 8 from their last letter permutation on to the negative contact bar 10 ready to be set into the next permutation as soon as the magnet 7 releases its armature 12, the tape feeding and the contact setting being performed by the armature spring 14, Figs. 5 and 6, on the back stroke of the armature. Consequently if the armature 12 is caught by suitable mechanism when attracted by the magnet 7 and retained in that position the contact levers 8 will go over and remain on the negative contact bar 10. Negative current only will go into the telegraph line, and negative current produces no effect on the printer at the distant station. When it is desired to stop the transmitter, a pawl 15, Fig. 6, pivoted at 16, is allowed to fall and catch a steel bar prolongation 17 of the armature so as to hold the armature close to the magnet. This pawl 16 can only drop down and catch the armature bar 17, Fig. 6, at the moment when the armature is attracted to

the magnet. This provides for stopping the transmitter at the right moment. Starting at the right moment is quite as important and for the same reason as stopping at the right moment. In order to prevent starting at the wrong moment, with resulting false signals, it must not be possible to raise the pawl 15 that locks the armature except when the magnet is energized. The pawl is therefore arranged so as to permit the armature to have a slight amount of play, but not sufficient to operate the instrument, and the pawl 15 has its hook slightly undercut 18, Fig. 6, so as to engage with a similar undercut portion of the steel bar 17, forming a prolongation of the armature. This undercut portion prevents the pawl being raised except when the armature is attracted by current in the magnet. The slight amount of motion permitted to the armature is just sufficient to free the pawl and allow it to be raised. The armature stopping pawl can therefore only be raised or lowered when the armature is attracted by the magnet. As the transmitter is stopped when the armature is held close to the magnet, the starting and stopping of the transmitter at the right moment is provided for by this special form of pawl and armature. An L shaped lever 19, pivoted at 20, hereinafter described as the tape lever, is arranged with the end 21 free to rise or fall in the space where the paper tape passes from the perforator to the transmitter. (See Figs. 1 and 2.) The tape forms a loop 5 at this point, rising up out of the perforator and passing down into the transmitter. The tape lever, pressed up by a coiled spring 22, Figs. 1 and 5, rises inside of this paper loop. As the tape gradually passes into the transmitter, if perforating stops, the loop becomes smaller and the tape lever is gradually depressed. The armature stopping pawl 15 is pivoted at 16 on the frame of the transmitter below the tape lever, and the two are connected together by a small spiral wire spring 23, Figs. 6 and 8. In order that this spring may not have to be strong with consequent heavy action, it is desirable to make the armature stopping pawl 15 of brass or other non-magnetic metal, the holding tip being reinforced with a small piece of clockspring steel 24, Fig. 6. A steel pawl is liable to be attracted and held down on the magnet armature. As the tape lever 19 rises the stopping pawl 15 tends to rise, and as the tape lever falls the stopping pawl also falls, being assisted in this respect by a separate spring of its own, 25, tending to press it down in antagonism to the spring connecting it to the tape lever. The pawl is therefore balanced between two opposing springs and when free rises or falls with the rise or fall of the tape lever. When the tape lever is depressed by the paper tape until all the loose tape in the loop has passed into the transmitter, as at 5, Fig. 2, the armature stopping pawl 15 has been allowed to fall until its hook rests on the edge of the prolongation of the armature 17. The moment the armature is attracted the pawl drops over the edge and the armature is caught and the pawl is locked by hooking into the undercut portion of the extension bar of the armature (see 18, Fig. 6). If six or eight letters are now perforated on the key-board perforator so as to give a little slack tape, as shown by the dotted outline 26, Fig. 2, the tape lever 19 rises and puts lifting tension on the armature stopping pawl 15 by means of the spiral spring 23 connecting the two. As soon as the cadence impulse attracts the armature, that is to say, at the right moment for starting the pawl is freed and jumps up under the tension of the spring. The transmitter then starts working until the loose tape is again used up. For reasons already explained it is not desirable to have this starting and stopping action repeated every one or two letters. This can be avoided by having the spring 23 connecting the tape lever and the stopping pawl of suitable strength and extensibility. A short stiff spring will start and stop on one or two letters. The lighter and more extensible the spring within reason the greater the number of letters that will intervene between starting and stopping.

Fig. 8 shows the automatic starting and stopping mechanism in diagrammatic form. The reference numbers enable the action to be easily followed from the description already given. 7 is a small portion of the transmitter magnet attracting the armature (or steel bar extension) so as to release or catch the pawl at the right moment.

When it is desired to stop the transmitter by hand and prevent it starting again, the operator depresses the tape lever 19 by hand and locks it down with a small lever latch (not shown). To start the transmitter it is only necessary to throw off the latch so as to free the tape lever. It will be seen that the essence of the automatic starting and stopping of the transmitter just described is catching and retaining the armature of the magnet in the attracted position. Obviously, in place of the mechanical arrangement just described, it is possible to arrive at the same result by keeping the circuit of the magnet 7 closed. This can be done electrically by a separate instrument in several ways. One of these arrangements is shown in Fig. 12. 5 is the loop of paper tape and 19 is the tape lever rising and falling under the varying length of the loop of paper tape. In this separate instrument there are two small relay magnets, 62 and 63, in series with the transmitter magnet 7. The three magnets are operated by the bat-

tery 67. 66 is the spindle of the multiplex distributer and 64 is the revolving contact brush which, at regular intervals, closes the circuit by making contact with the segment 65. While the transmitter is running, magnets 62 and 63 attract 68 and 69 at regular intervals, but no result is produced because the loop of tape lets the tape lever 19 rise clear of the pawl 70 and the contact 71, the stop 72 preventing the contact lever 68 from making contact with the tape lever 19. When the tape loop 5 diminishes, it pulls down 19, so that at the right moment when the transmitter magnet 7 is energized, the magnet 62 is also energized and attracts 68, so that the short circuit is closed from the battery 67, through the magnet 62, wire 73, lever 19, contact 71, lever 68, wire 74, transmitter magnet 7 and back to the battery 67. This holds the transmitter magnet 7 closed at the right moment. At the same time the tape loop has pulled lever 19 down so that it is caught by the pawl 70. The transmitter, therefore, cannot start again until the right moment, that is, when the tape loop is again increased in size so as to leave the tape lever 19 free to rise. This happens at the right moment because the pawl 70 has not been retracted to release 19 until the magnet 63 is energized at the same time as the transmitter magnet.

The transmitter itself is composed of a series of five vertical contact levers 8 arranged side by side in a row between two contact bars 9 and 10, one connected to positive and the other to negative battery. The contact bars carry adjustable contact screws 27 of the usual type. Projecting horizontally to the left from each of the vertical contact levers from their bearing point there is an arm 28, Fig. 2, carrying a glass-hard steel wedge 29, on its end. A series of five flat steel springs 30 with sharp ends bent to the right press against the steel wedges, thereby causing the contact levers to press firmly against the positive or the negative contacts. There is a corresponding arm 31, Fig. 2, projecting from each of the five contact levers to the right. To each of these right-hand arms there is attached a spring 32 carrying a small block of fiber or other suitable insulating material 33. Raising or lowering these little insulation blocks about $\frac{1}{16}$th inch (about 1.5 mm.) will throw the contact levers on to the negative or the positive contacts. On the right of the vertical contact levers and above the right-hand projecting arms, there is an oscillating frame 34, Figs. 2, 3 and 4, carrying a group of six small levers 35, pivoted at their centers 36 on the free end of the oscillating frame. The oscillating frame 34 and the hook levers 35 are shown in detail in Figs. 3 and 4. The frame 34 is pinned to the shaft 37, Fig. 5, and passes through the frame of the machine which also serves as a bearing for it. On the outer end of the shaft 37 there is pinned a downward projecting lever 38, Figs. 5 and 6. The lever 38 is connected to the steel bar extension 17 of the armature of the magnet 7 by the steel rod 39 with rounded ends, one of which fits into a socket in the lever 38 and the other end into a socket in the bar 17. The spring 14 pulls the lever 38 in the direction of the arrow 40. The armature, through its bar 17, when the magnet is energized, pushes the lever 38 in the direction of the arrow 41. In this way the shaft 37 is oscillated back and forward. The shaft 37 therefore rocks the frame 34, Fig. 2, so that the hook levers 35 pivoted at 36 rise and fall about $\frac{1}{8}$th inch (about 3.2 mm.). In Fig. 3, a plan view, the frame 34 is pinned to the shaft 37 and has two arms, 42 and 43. At the free end there is a small spindle 36 upon which the hook levers 35 are hung. In Fig. 4 a front elevation, it will be seen that in addition to the hook levers there is a loop or stirrup 13. It is this stirrup 13 that lifts the small blocks 33, Fig. 2, thereby throwing the contact levers on to the negative contacts when the magnet is energized so as to attract its armature and causing the frame 34 to rise and with it the hook levers 35 and the stirrup 13.

The upper end of each of the levers 35 carries a hook or claw 4 adapted to engage in the perforations in the paper tape. The lower ends of these levers project downward just clear of the insulation blocks of the contact levers. If there is a perforation in the paper tape the corresponding claw falls into it and the lower end of the lever carrying the claw moves inward under the tension of its spring 44 so as to be immediately over the insulation block 33 of the corresponding contact lever. The oscillating frame rises and falls regularly about $\frac{1}{8}$th inch (3.2 mm.) as the result of the operation of the transmitter magnet working from the cadence contact of the distributer. When the frame falls the claws engaged in the perforations in the paper tape drag the tape down $\frac{1}{10}$th inch (2.5 mm.) and at the same time the lower ends of the claw levers whose claws have entered perforations in the tape strike the insulation blocks and throw the corresponding contact levers over on to the positive contacts. The other hook levers, meeting no hole in the tape, are held out so that they do not strike the blocks 33. In this way a particular letter permutation of five positive and negative contacts is set up and the distributer of the multiplex system sweeps the signal into the telegraph line. The next moment the transmitter magnet is energized and it raises the free end of the oscillating frame about $\frac{1}{8}$th inch

(3.2 mm.). The claws slip out of the holes in the paper and rise a little over $\frac{1}{10}$th inch (2.54 mm.) so as to engage positively in the next letter group of perforations across the tape. A small friction block 45 prevents the paper tape from rising as the claws rise. It also serves as a guide for the hook levers. The result is that the claws keep clawing the tape down letter by letter and at the same time setting the contact levers in various positive and negative permutations in accordance with the perforations in the paper tape. It has been mentioned that there are six claws or hooks. Five operate on message holes, and the sixth engages in the row of feed holes. The sixth claw lever 46, Fig. 4, is cut short below so as not to affect any contact lever. The object of the sixth claw lever is to feed the tape through the transmitter at points where there are only central feed holes, and also to relieve the paper of the strain of being fed forward by one claw only. This would tend to tear the perforations. The sixth lever is made with a double claw, so that there are never less than two holes in the tape engaged by claws and usually three or four. A lever 47 is arranged at the back of the transmitter to throw the claws out from engagement with the paper tape when it is desired to remove the tape from the transmitter.

An alternative method of feeding the tape and setting the contact lever combinations is shown in Figs. 7, 9, 10 and 11. In this case the Wheatstone method of feeding the tape forward by a star-wheel 48 is employed. The oscillating frame in this case consists of a single arm 34 pinned to the oscillating shaft 37. At the free end the arm 34 carries a small spindle and friction roller 49. This extends in front of the five levers 50. These levers are pivoted at 51 and are pressed against 49 by the five springs 52. At their upper end the five levers 50 carry five needles 53, which pass through holes in the paper tape and enter the holes in the steel plate 54. These needles correspond to the needles of the Wheatstone transmitter. When the lever 34 rises, the spindle and roller 49 press up against the inclined or bent portion of the levers 50, thereby throwing them back so that the needles are withdrawn from the paper tape. As the lever 34 continues to rise the pawl 55, attached to the lever 34, rises and moves the ratchet wheel 56, Fig. 11, around one tooth and it is caught by the retaining pawl 57. The ratchet 56 is on the same small spindle 58, Fig. 10, as the star-wheel 48. The paper tape is in this way fed forward one letter space. The levers 50, when thrown back by the lever 34 rising throw the contact levers 8 over on to the contact bar 9 by means of five flat springs 58 engaging in slots in insulation blocks 59 fastened in the arms 31 of the the contact levers 8. In this case the contact block 9 is negative and 10 is positive. When the lever 34 falls, the levers 50, acting under the control of their springs 52, press their needles 53 against the paper tape. If there are message holes in the tape, the corresponding needles enter the holes and their levers 50 move forward and thereby throw their contact levers 8 over on to the positive contact bar 10. In positions where there are no holes in the tape the corresponding needles cannot enter and the corresponding levers 8 remain on the negative contact 9. Suitable arrangements are made for releasing the tape either by moving out the steel plate 54, Fig. 7, or by carrying the star-wheel and ratchet-wheel on an oscillating frame that can be moved back so as to liberate the paper tape. Fig. 9 shows the upper part of one of the levers 50 and its needle 53. The automatic starting and stopping action already described is exactly the same in the case of this arrangement as in the case of the hook or claw lever arrangement. It will be seen that in this case also the point of transmission is at the extreme right-hand corner of the machine so as to have minimum distance between the points of perforation and transmission.

In the alternative arrangement shown in Fig. 7, the contact levers 8 depend for their positions against either the positive or the negative contacts on the jockey-springs 30 and wedges 29, Fig. 2. Instead of this jockey spring arrangement, the levers 8, Fig. 7, may each be balanced between two spiral springs, one of these spiral springs connecting each lever 8 to each of the levers 50. In this case 58 and 59 are omitted. If any lever 50 moves to the right as its pin 53 enters a hole in the tape, the spring connecting it to lever 8 pulls lever 8 over on to contact 9 against the tension of the opposing spring, spring 52 of the corresponding lever 50 being sufficiently strong for this purpose. This balanced spring arrangement is the same in principle as that shown in Fig. 8, though used for an entirely different purpose. In this case the pawl 15 (Fig. 8) represents the contact lever 8, Fig. 7, balanced between two springs 23 and 25, Figs. 8, 19, Fig. 8, corresponds to the levers 50, (Fig. 7), and spring 22, Fig. 8, corresponds to spring 52, Fig. 7. The automatic starting and stopping mechanism can be used equally well with this or any other modified form of the automatic tape transmitter.

The tape feeds into the transmitter vertically downward in the arrangement shown in the drawings, and may pass to the floor through a hole in the table or along under the transmiter to the left. The tape when freed from the claws or the pins and

star-wheel, can be removed from the transmitter instantly by withdrawing it sidewise. The machine is provided with a cover 60, Fig. 5, which may be lifted off when required.

It will be understood that, in the foregoing description, where I have spoken of positive currents and negative currents, and have spoken of negative currents as producing no effect on the printer at the distant station, these terms positive and negative are purely relative. The reverse arrangement is equally practical. Ordinarily, the printer at the distant end is so arranged that a signal consisting of negative impulses only produces no effect on that printer. But, of course, it is possible to arrange the printer so that signals consisting of negative impulses only do produce an effect on that printer, while signals consisting of positive impulses only produce no effect on the printer. In such case, usually, the contact member 10 of the transmitter will be connected to a source of supply of positive current, and the contact member 9 will be connected to a source of supply of negative current. In the specification, the terms positive and negative have been used merely for contradistinction and for clearness and simplicity of language.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In an automatic tape transmitter of the step by step type, means operated by the tape for stopping the transmitter automatically, means for sending combinations of differential impulses such as positive and negative or make and break impulses together with means for sending a predetermined combination of impulses continuously to line when the transmitter is stopped automatically by the tape, substantially as described.

2. In an automatic tape transmitter of the step by step type, means operated by the tape for automatically stopping the transmitter between signals, together with means for sending a predetermined combination of impulses when the transmitter is stopped, substantially as described.

3. In an automatic tape transmitter, means for sending signals, means operated by the tape for starting the transmission of signals, together with means for sending currents of one direction only to line when the transmitter is stopped, substantially as described.

4. In an automatic tape transmitter, means for sending signals, means operated by the tension of the tape for starting the transmitter automatically, together with means for sending a predetermined combination of impulses to the line when the transmitter is stopped, substantially as described.

5. In an automatic tape transmitter, means for sending signals, means operated by the tape for starting and stopping the transmitter automatically, together with means for sending a predetermined combination of impulses to the line when the transmitter is stopped, substantially as described.

6. In an automatic tape transmitter, means for sending signals, means operated by the tension of the tape for starting and stopping the transmitter automatically, together with means for sending a predetermined combination of impulses to the line when the transmitter is stopped, substantially as described.

7. In an automatic tape transmitter, means for perforating said tape, means for transmitting signals corresponding to the perforations on said tape, a lever actuated by the length of the tape between the perforator and transmitter, an electromagnet adapted to be intermittently energized in the transmission of signals, an armature co-acting with said electromagnet, together with means co-acting with said lever and co-acting mechanically with said armature for retaining or releasing said armature to stop and start the transmission of signals automatically, substantially as described.

8. In an automatic tape transmitter, means for perforating said tape, means for transmitting signals corresponding to the perforations on said tape, a lever actuated by the length of tape between the perforator and transmitter, an electromagnet adapted to be intermittently energized in the transmission of signals, an armature co-acting with said electromagnet, a locking pawl adapted to engage the said armature in the energized position of said magnet, together with a resilient connection between said locking pawl and said lever, substantially as described.

9. In an automatic tape transmitter, means for perforating said tape, an electromagnet, means for energizing said electromagnet, a frame, a plurality of hook members in said frame, means co-acting with said electromagnet for reciprocating said frame, and causing said hook members to engage with the perforations in said tape, a plurality of contact members, means co-acting with the hook members which engage with the perforations to operate the corresponding contact members on one stroke of said frame, means for returning said contact members to their initial position on the other stroke of said frame, together with means controlled by a length of tape for stopping or starting the reciprocations of said frame, substantially as described.

10. In an automatic tape transmitter, means for perforating tape, an electromagnet, means for intermittently energizing said electromagnet, a frame, a plurality of hook members in said frame, means co-acting with said electromagnet for reciprocat-

ing said frame and causing certain of said hook members to engage with the perforations in said tape a plurality of contact members, means co-acting with the hook members which engage with the perforations to operate corresponding contact members on one stroke of said frame, means for returning said contact members to their initial position on the other stroke of said frame, means controlled by a length of tape for stopping or starting the reciprocations of said frame automatically together with means co-acting with said frame for intermittently feeding said tape, substantially as described.

11. In an impulse transmitter, the combination with opposed contact members, and a pivoted contact arm arranged to move from one to the other, of perforated-tape controlled means comprising a finger and a pivoted support therefor, and elastic pressure means tending to cause such finger to engage perforations of the tape when such perforations are opposite said finger, and means for moving said finger back and forth, said movable contact arm having a spring portion which is in the path of movement of the finger when the latter is in engagement with a perforation of the tape, and which is out of the path of movement of such finger when the latter is not in engagement with a perforation of the tape.

12. In an impulse transmitter, the combination with opposed contact members, and a pivoted contact arm arranged to move from one to the other, of perforated-tape controlled means comprising a finger and a pivoted support therefor, and elastic pressure means tending to cause such finger to engage perforations of the tape when such perforations are opposite said finger, and means for moving said finger back and forth, said movable contact arm having a portion which is in the path of movement of the finger when the latter is in engagement with a perforation of the tape, and which is out of the path of movement of such finger when the latter is not in engagement with a perforation of the tape, and restoring means for said contact arm comprising means carried by the finger-support and arranged to engage and restore said contact arm upon return movement of said support.

13. In an impulse transmitter, the combination with opposed contact members, and a pivoted contact arm arranged to move from one to the other, of perforated-tape controlled means comprising a finger and a pivoted support therefor, and elastic pressure means tending to cause such finger to engage perforations of the tape when such perforations are opposite said finger, and means for moving said finger back and forth, said movable contact arm having a portion which is in the path of movement of the finger when the latter is in engagement with a perforation of the tape, and which is out of the path of movement of such finger when the latter is not in engagement with a perforation of the tape, and a loop depending from said finger support to beneath the contact arm and arranged to engage and restore said contact arm upon return movement of the finger support.

14. In an impulse transmitter, the combination with opposed contact members and a movable contact arm, adapted to engage one side or the other of said contact members at will, and a case inclosing said contact members and contact arm, of a rock shaft projecting from the outside of the case thereinto, means carried thereby for moving said contact arm, a magnet and an armature therefor, both external to the case, and means for communicating motion from said armature to said rock shaft.

15. In an impulse transmitter, the combination with opposed contact members and a movable contact arm, adapted to engage one or the other of said contact members at will, and a case inclosing said contact members and contact arm, of a rock shaft projecting from the outside of the case thereinto, means carried thereby for moving said contact arm, a magnet and an armature therefor, both external to the case, and means for communicating motion from said armature to said rock shaft, comprising a rocker arm on said rock shaft, a pusher intermediate said rocker arm and armature, and a retractile spring connected to said rocker arm.

16. In an impulse transmitter, the combination with tape-controlled contact means, and operating means therefor, comprising a magnet and an armature therefor, and means operated by said armature for operating said contact means, of mechanical armature-locking means controlled by the tension of the tape and arranged to lock said armature in attracted position when the tape becomes too taut.

17. In an impulse transmitter, the combination with tape-controlled contact means, and operating means therefor, comprising a magnet and an armature therefor, and means operated by said armature for operating said contact means, of mechanical armature-locking means controlled by the tension of the tape and arranged to lock said armature in attracted position when the tape becomes too taut, and to release said armature when the tape slackens from such taut condition.

18. In an impulse transmitter, the combination with tape-controlled contact means, and operating means therefor, and means operated by said armature for operating said contact means, of a detent arranged

to move into engagement with said armature when the latter is in attracted position, and means, controlled by the tension of the tape, normally holding such detent out of engaging position, but arranged to permit the detent to move to engaging position when the tape becomes too taut.

19. In an impulse transmitter, the combination with tape-controlled contact means, and operating means therefor, comprising a magnet and an armature therefor, and means operated by said armature for operating said contact means, said armature having a hook-shaped locking portion, of a detent arranged to move into position for engagement with said hook-shaped locking portion when said armature is in attracted position, and when in such position to permit slight freedom of movement of the armature, said detent having a hook which engages with the said hook of the armature when the latter retracts slightly.

20. In an impulse transmitter, the combination with tape-controlled contact means, and operating means therefor, comprising a magnet and an armature therefor, and means operated by said armature for operating said contact means, said armature having a hook-shaped portion, of a detent which, in the vicinity of said armature, is of non-magnetic material, said detent having a hard projecting hook-shaped portion, said detent arranged to move its hook-shaped portion into position for engagement with the hook-shaped armature portion when said armature is in attracted position, and when in such position to permit slight freedom of movement of the armature, but not sufficient movement of said armature to cause operation of the contact means.

21. In an impulse transmitter, the combination with tape-controlled contact means, and operating means therefor, comprising a magnet and an armature therefor, and means operated by said armature for operating said contact means, of a spring actuated armature-locking means, control means, operated by the tension of the tape, and a spring connection between said control means and armature-locking means, said armature locking means being balanced between said spring connection and the actuating spring of such armature locking means.

22. The combination with a tape perforator arranged to deliver perforated tape in a substantially vertical direction, of an impulse transmitter arranged to receive such tape in an approximately vertical direction opposite that of delivery of the tape from the perforator, said transmitter being located in close proximity to said perforator, whereby a tape loop is formed between the perforator and the transmitter, said transmitter having feed means arranged to cause motion of the tape into the transmitter in substantially the direction of delivery of that tape to the transmitter.

23. The combination with a tape perforator arranged to deliver perforated tape in a substantially vertical direction, of an impulse transmitter arranged to receive such tape in an approximately vertical direction opposite that of delivery of the tape from the perforator, said transmitter being located in close proximity to said perforator, whereby a tape loop is formed between the perforator and the transmitter, said transmitter having feed means arranged to cause motion of the tape into the transmitter in substantially the direction of delivery of that tape to the transmitter, and control means for said transmitter comprising a movable control member adapted for acting upon the tape loop so formed between the perforator and the transmitter, and tending to maintain that loop, said control means arranged to be actuated by tightening of the tape loop and consequent motion of the control member.

In testimony whereof I have affixed my signature in presence of two witnesses.

DONALD MURRAY.

Witnesses:
P. A. OUTHWAITE,
H. D. JAMESON.