April 4, 1939. A. T. SIGO 2,153,317

RECORDING APPARATUS

Filed June 2, 1934 3 Sheets-Sheet 1

FIG. 6

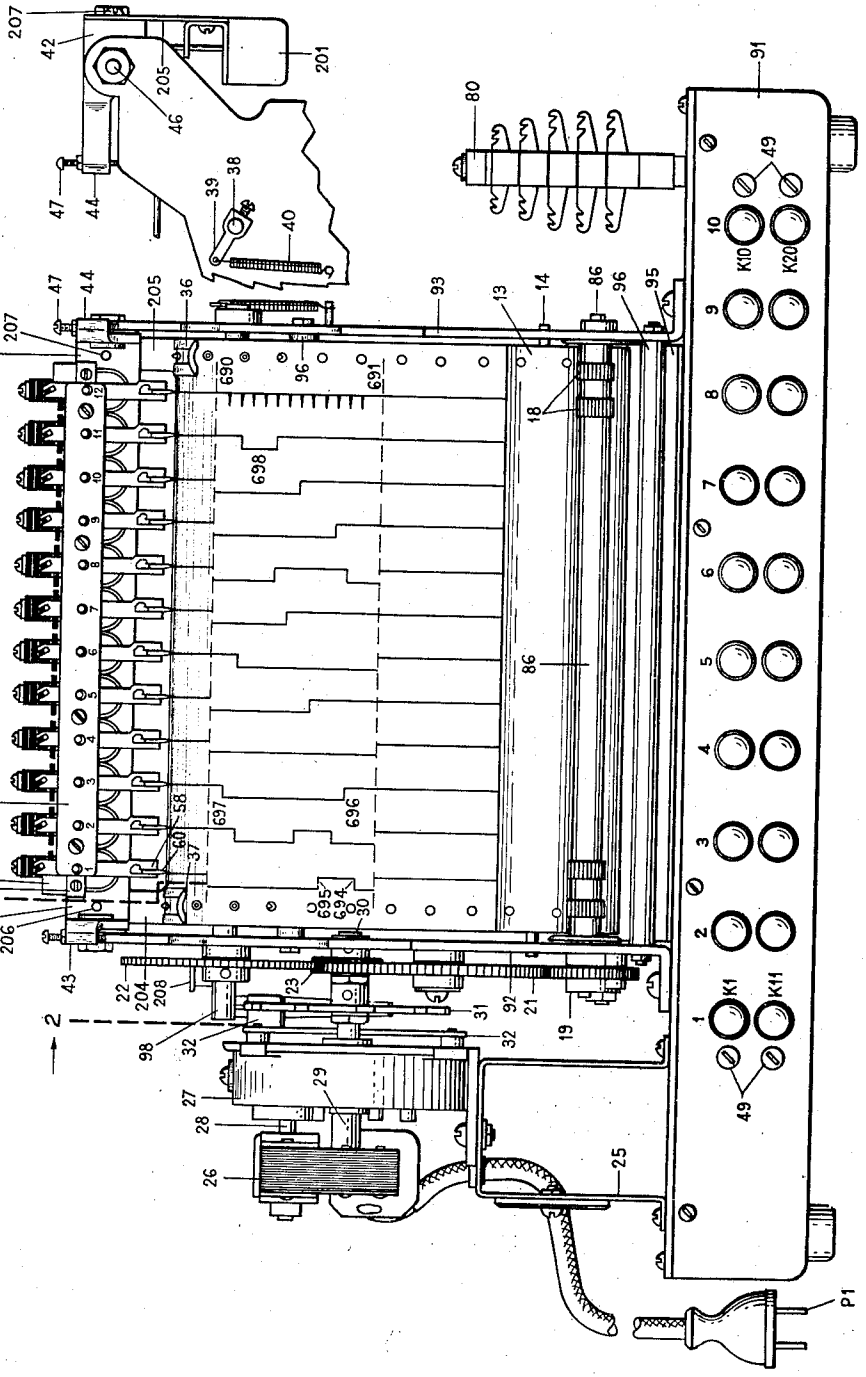


FIG. 1

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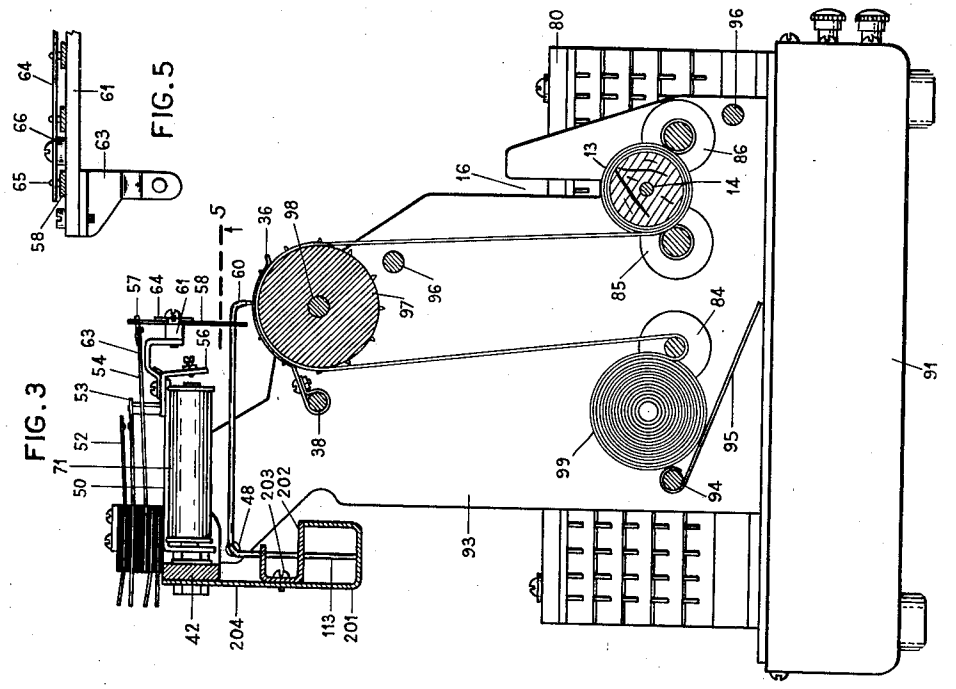


FIG. 5

FIG. 3

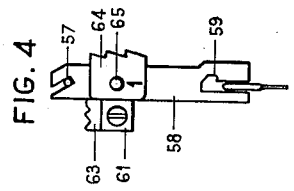


FIG. 4

FIG. 2

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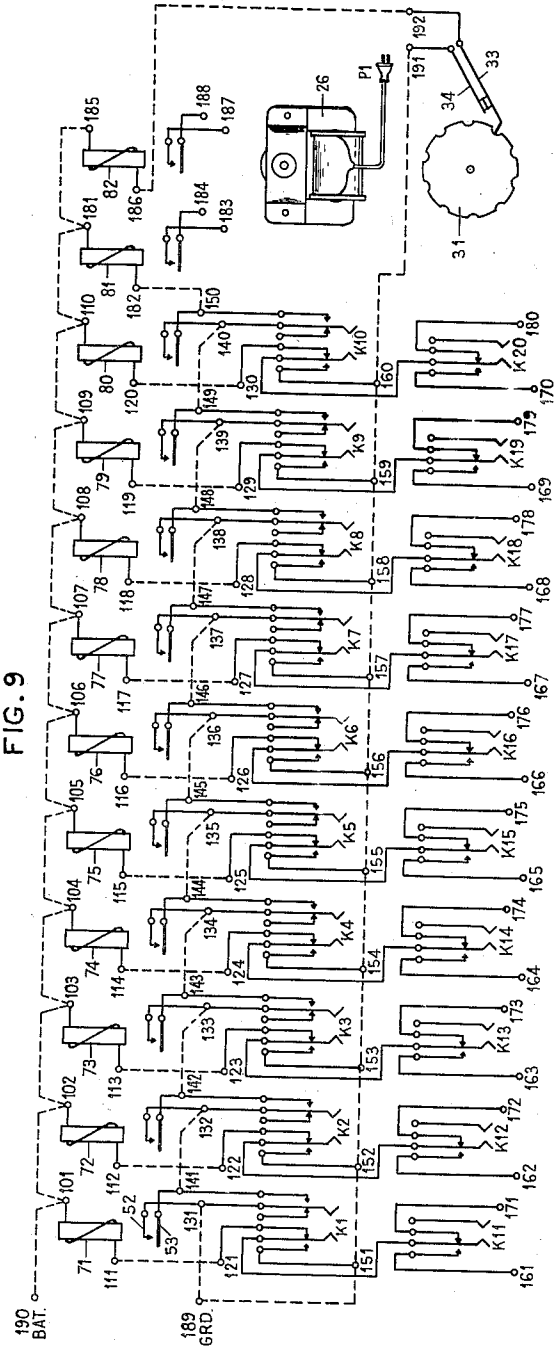


FIG. 9

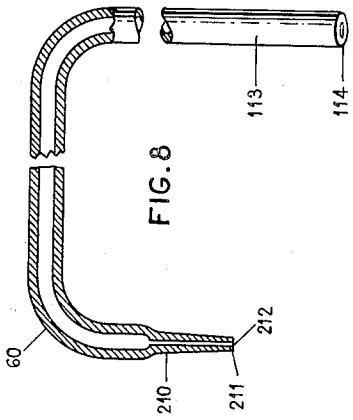


FIG. 8

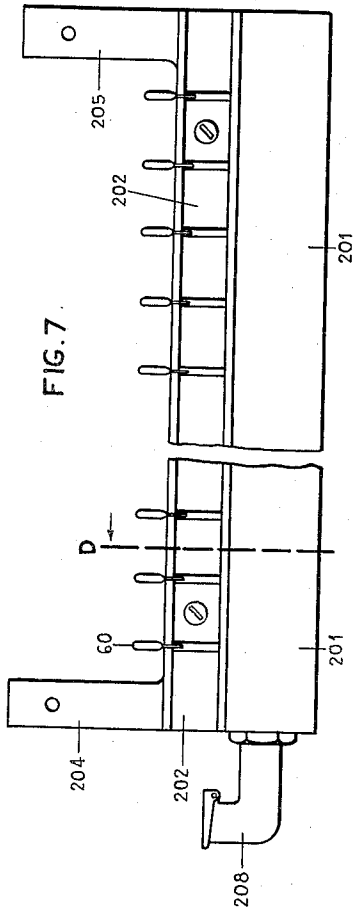


FIG. 7

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Patented Apr. 4, 1939 2,153,317

UNITED STATES PATENT OFFICE

2,153,317

RECORDING APPARATUS

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Application June 2, 1934, Serial No. 728,683

10 Claims. (Cl. 234—1.5)

The present invention relates in general to recording apparatus, and more in particular to apparatus of this character which may be used to make graphic records of events, operations of machines, etc., on charts or tapes in such form that they may be preserved for future reference and study. Specifically, the object of the invention is the production of a new and improved recording apparatus of the above character, referred to herein as a multiple pen recorder.

This application is a continuation in part of my prior application, S. N. 704,851, filed January 2, 1934.

The invention and its operation will be described hereinafter with reference to the accompanying drawings, in which:

Fig. 1 is a front view of the multiple pen recorder;

Fig. 2 is a section on the line A, Fig. 1, except for the base;

Fig. 3 is a section on the line B, Fig. 1, also excepting the base;

Fig. 4 is a detailed view of one of the pen operating levers;

Fig. 5 is a detailed view, partly in section, on line C, Fig. 3, of a portion of the pen operating lever assembly;

Fig. 6 is a view of a portion of the recorder shown in Fig. 1 as it appears from the right, a partial end view, in other words;

Fig. 7 shows the ink reservoir, approximately full size;

Fig. 8 shows one of the pens enlarged about three times actual size; and

Fig. 9 is a circuit drawing or wiring diagram showing how the relays, keys, etc., are wired to the terminal block.

The construction of the multiple pen recorder will now be described, reference being made to the drawings, Figs. 1 to 9, inclusive.

The apparatus is mounted on a hollow base 91 which is shown clearly in Figs. 1, 2 and 3. The base 91 may be made of sheet metal. Inside the base there is mounted a strip of ten pairs of keys, which may be of any well known type. The keys are in two rows. The buttons for actuating the first row of keys are indicated in Fig. 1 by the reference numerals K1–K10. The push buttons for actuating the second row of keys are similarly indicated by reference numerals K11–K20. It may be stated that the key strip is supported inside the base by four screws 49, with the rows of buttons extending through openings in the edges of the base which are provided for this purpose, all as is shown clearly in the drawings.

The main frame of the pen recorder includes two end plates 92 and 93, Figs. 1, 2 and 3. These end members are bent over at the bottom as shown in Fig. 1 so as to form two feet resting on the base 91, and secured thereto by heavy machine screws as shown in Figs. 1 and 2. In order to stiffen the frame, two heavy cross rods 96 are provided. These cross rods each have a portion at each end which is reduced in size and which is threaded. These reduced end portions pass through holes in the end plates 92 and 93, which are held firmly against the shoulders on the rods 96 by means of nuts screwed on the threaded ends of the rods. There is also provided a similar rod 94, which is rigidly secured between the two end members in the same manner as rods 96. The rod 94 supports one edge of a flat metal strip or apron 95. This member 95 has one end wrapped around the rod 94 and the other edge rests on the base 91. It extends clear across from the member 92 to the member 93, as shown in Fig. 1, and provides a support for the roll of paper 99.

The mechanism for handling the record paper comprises an idler spool 84, a driven roller 97, two take-up spools 85 and 86, and a take-up roller 13, shown in Figs. 1 and 3. The driven roller 97 is supported on a shaft 98, which is mounted in bearings in the two end plates 92 and 93. The take-up roller 13 is supported on a shaft 14. The two ends of the shaft 14 lie in slots 15 and 16, which are cut in the end plates 92 and 93, respectively. The take-up spool 86, which can be seen clearly in Fig. 1, is supported on a shaft 86, forming part of the spool. Bearings for the shaft are provided in the end plates 92 and 93. The shank of the spool is provided with knurled portions such as 18. The spool 85 is constructed the same as spool 86. The spool 84 is also constructed similar to spool 86, except that the shank thereof may be somewhat smaller in diameter and is not provided with the knurled portions such as 18. The paper supply roll 99 rests on the plate 95, and against the spool 84, as shown clearly in Fig. 3. The paper is brought around under spool 84, from which point it is carried upward and around over the driven roller 97. As shown clearly in Fig. 1, the paper is preferably perforated along each edge, and these perforations are engaged by pins on the two ends of the roller in order to provide for a positive drive. From the roller 97 the paper is brought down to the take-up roller 13. The roller 13, with the accumulated paper thereon, rests on the two take-up spools 85 and 86. These take-up spools are

positively driven by gears, as will be explained hereinafter, and the knurled portions thereon provide for rotating the take-up roller 13. As the paper accumulates on the take-up roller, the shaft 14 of the latter rises up in the slots 15 and 16.

As shown in Fig. 1, two curved clips 36 and 37 are provided, which hold the paper in position on the driven roller 97. These clips are desirable because the take-up roller 13 will have to be lifted from position from time to time to remove sections of the paper record, or is dispensed with altogether, and at these times the clips 36 and 37 keep the paper in position on the driven roll, with the pins at the ends thereof registering with the perforations in the paper. The clips 36 and 37 are mounted on a shaft 38, which is provided with bearings in the end plates 92 and 93. As shown in Fig. 6, the right-hand end of the shaft 38 is provided with a lever 39. Between the end of this lever 39 and a pin secured to the end plate 93 there is provided a coil spring 40 under tension, which tends to rotate the shaft 38 and hold the clips 36 and 37 in contact with the paper.

The power for driving the apparatus is furnished by a motor 26, shown in Fig. 1. The drawings show a bracket or support 25, on which is mounted a gear case 27. The motor 26 is mounted against the face of the gear case by means of two studs, such as 29. The shaft 28 of the motor extends into the gear case 27, as shown. By means of suitable reduction gears which are enclosed in the gear case, the motor transmits power to the shaft 30 which projects from the right-hand side of the gear case. The motor 26 may be of any suitable design, except that it should be of the synchronous type so that it will run at a constant rate of speed. The gear case 27 is also of well known construction and need not, therefore, be described in detail.

On the shaft 30 there is mounted a pinion 23, which may be held on the shaft by means of a set screw. The pinion is in mesh with the gear wheel 22, see Fig. 2, which is mounted on the shaft 98. Thus, the pinion 23 and gear wheel 22 provide for driving the roller 97. There is provided an idler gear 21 which is mounted on a stud secured to the end plate 92. Gear 21 is in mesh with gear 22 and is driven thereby. The spool 85 is provided with the pinion 20, secured thereto as shown in Fig. 2, which is in mesh with the gear 21. A small idler gear 17, mounted on a stud which is secured to the end member 92, serves to enable the pinion or gear 20 to drive the pinion 19 which is attached to the take-up spool 86. It will be seen that the spools 85 and 86 are driven in the proper direction so that they both tend to rotate the roller 13 in the proper direction to wind up the paper as it comes off the roller 97. These spools are driven at a speed which is somewhat higher than that which is required to rotate the roller 13 fast enough to keep the paper taut.

The shaft 30 which transmits power from the gear box 27 also has mounted thereon a circular cam 31, shown in Figs. 1 and 2. This cam may be mounted on a hub which is provided with a set screw so that it can be secured to the shaft 30 like the pinion 23. On the gear box there is mounted a bracket 32, to which are secured by the usual screws and washers a pair of contact springs 33 and 34. As shown in Fig. 2, the outer contact spring 33 has a bent-over end portion which engages the periphery of the cam 31. As the cam rotates the end of spring 33 will enter the successive notches which are cut in the edge of the cam, and spring 33 thus closes contact with spring 34. The gear ratio may be such that the shaft 30 makes one revolution per minute. Since there are ten notches cut in the periphery of the cam, the spring 33 wil make contact with spring 34 ten times per minute. A source of potential may be connected to spring 33 and an impulse lead may be connected to the other spring. With this arrangement impulses will be delivered to the impulse lead at the rate of ten impulses per minute.

It will be seen that the motor and gear box together with the cam and pinion carried by the shaft 30, form a detachable unit which is supported by the bracket 25 in the proper position so that the pinion 23 will engage the gear 22. However, this unit may be removed if desired, by merely taking out the screws by which the gear case is attached to the bracket 25. This permits the motor and gear unit to be used separately if desired in case a source of timed impulses is wanted for some purpose which does not require the use of the pen recorder, assuming, of course, that the latter is not in use at the time. The motor is preferably provided with a flexible cord, as shown in Fig. 1, which terminates in a plug so that the motor can be connected up to a source of power.

As shown in Fig. 1 there are twelve pen relays. These twelve pen relays control twelve recording pens, which are numbered from left to right as pens 1 to 12, inclusive. The pen relays are mounted in a row on a drilled cross member 42, Fig. 3. This cross member has two arms 43 and 44 which are formed integrally with it and which extend forward at right angles to it. The construction can be seen clearly from Figs. 1, 2 and 6. The arm 43 is pivoted in the end plate 92 of the frame at 45, while the other arm 44 is pivoted in end plate 93 of the frame at 46. A stop 48, Fig. 3, limits the rotation on the pivots in one direction. The arm 44, Fig. 6, has an adjustable stop screw 47 which limits the rotation in the other direction. There is a similar stop screw carried by arm 43. It may be stated that this limited movement of the cross member 42 is provided so that the recording pens can be lifted from the paper. The stop screws 47 are, of course, adjusted so that the pens will rest properly on the paper.

The pen relays are constructed along conventional lines. Each relay comprises a heel piece 50 and a coil 71, as shown in connection with the relay which can be seen in Fig. 3. Each relay core has a threaded extension which passes through the associated heel piece, and through the drilled cross bar 42, to which it is secured by a nut on each side of the cross bar. In this manner the pen relays are securely supported on the cross bar. Each pen relay has three springs such as 52, 53, and 54, which are attached to the heel piece by means of machine screws as shown in Fig. 3. The springs are suitably insulated from each other. The two upper springs are contact springs and are normally separated from each other. The lower spring 54, which is operated by the armature 56 of the relay, provides for operating the associated recording pen, and also by means of a bushing operates the spring 53. The recording pens such as 60 are each provided with an operating lever 58. These operating levers are supported on a cross bar 61, which can be seen in Figs. 1 to 5, the latter being a part sectional view which shows the left-hand end of the

bar 61. The bar 61 is supported on two brackets such as 63. The left bracket 63 is secured to the heel piece of the first pen relay 71 as shown in Fig. 3. There is a similar bracket at the other end of the bar 61 which is similarly attached to the heel piece of the last pen relay 82. The manner in which the operating levers are supported on the cross bar 61 is shown clearly in Figs. 4 and 5. The cross bar 61 is provided with twelve short studs or pivot pins, 65, which fit loosely in holes drilled in the operating levers 58 of the respective recording pens. There is also a bar 64 which is secured to the bar 61 by a number of machine screws, as seen in Figs. 5 and 1. The bar 64 is spaced away from the bar 61 by means of washers such as 66, the washers 66 being slightly thicker than the levers 58. Thus the operating levers are securely supported on the bar 61 in such a manner as to provide for movement around the pivots 65.

The operating levers are moved on their pivots by the associated pen relays. Each lever 58 has a diagonal slot cut in the end thereof, and in this slot there is positioned a round pin 57, which is securely attached to the operating spring 54 of the associated pen relay. Considering the first pen relay 71, shown in Fig. 3, it will be seen that when the armature 56 is attracted the end of spring 54 carrying the pin 57 will be moved upward. This pin engages the side of the slot in lever 58, associated with the first recording pen 60, and therefore moves the upper end of lever 58 to the right, as seen in Figs. 1 and 4. The member 58 is therefore rotated slightly on the pivot 65, and the pen 60 is moved to the left. When the relay deenergizes, the spring 54 resumes its normal position and accordingly moves the pen 60 back to its normal position.

The slot at the lower end of each operating lever 58 is carefully cut so that its width is just slightly greater than the diameter of the pen tubing. Each slot is enlarged at 59, as shown clearly in Fig. 4. Any pen which is not used may be raised off the paper and allowed to rest in the enlargement or side slot 59.

The ink reservoir and the arrangement for supporting the pens can be seen in Figs. 2 and 3, and in Fig. 7. The reservoir 201 is rectangular in cross section, as can be seen from Fig. 3, and is approximately equal in length to the driving roll 97. The reservoir may be made of heavy sheet brass. As shown in Fig. 7 the rear wall of the reservoir is extended upward at both ends, forming two brackets or hangers 204 and 205 by means of which the reservoir is attached to the cross bar 42. For this purpose two screws 206 and 207 are provided, which pass through holes in hangers 204 and 205 and are threaded into the cross bar 42. At the left-hand end there is a filler tube 208, closed with a hinged cap.

To form a cover for the ink reservoir 201, and also to provide a support for the pens, there is provided a U-shaped channel member 202. As can be seen from Fig. 3, the lower side of this channel is made of the proper width to close the top of the reservoir. Equally spaced holes are drilled through both sides of the channel member to receive the pens such as 60.

An enlarged view of one of the pens is shown in Fig. 8. The pen 60 is made preferably of nickel tubing about .062 inch in outside diameter, bent to the shape shown in Figs. 8 and 3. The portion 113 of each pen passes down through the holes drilled in the upper and lower side members of channel 202, which thus provides bearings in which the pen can rotate about the perpendicular portion 113 as an axis. The lower end portion 113 rests on the bottom of the reservoir and is cut away at an angle at 114, so as to permit the entrance of ink. The other end of the pen 60 is preferably reduced in size at 210 for a distance of about $\frac{5}{32}$ of an inch from the end, by a swaging operation. This substantially closes the bore of the tube, which is then carefully drilled out to the exact size required for the best results. Very satisfactory operation has been secured with a pen point having an over all diameter of .025 inch at the point 211, and a bore 212 of .0135 inch. The pen points could no doubt be made in other ways, but satisfactory operation seems to require a reduced bore at the end of about the dimensions given.

Before operating the pen recorder the pens have to be filled with ink. A considerable quantity of ink may be put into the reservoir 201 by way of the filler tube 208. The pen relay assembly is then tilted back on the pivots 45 and 46 so as to raise the pen points from the paper. A small rubber bulb is now required to which is attached a short length of fine rubber tubing. The bulb is first pressed together, then the rubber tubing is slipped over the point of the first pen. Releasing the bulb will now draw ink up into the pen by suction. Each of the pens may be filled in turn the same way. The pen relay assembly is now restored to normal position, with the pens resting on the paper. There is no tendency for the ink to run back, and when once filled as described above the pens require no attention for a long time.

The stop screws 47 should be adjusted so that the pen points press lightly on the paper. It will be observed that with the relays all deenergized the recording pens will trace straight lines on the paper, and it will be seen that when any pen relay energizes the associated pen will be moved to the left, so that the line traced by that pen will be offset to the left from its normal position. The stroke of the pen relay armatures is preferably adjusted so as to provide for a pen movement of about one-eighth of an inch. That is, the line drawn by a recording pen when its associated relay is operated may be offset one-eighth of an inch from the position of the line when the relay is normal. It is preferable to use a special kind of ink which does not readily evaporate, manufactured for use in apparatus of this kind.

The reference numeral 80 indicates a terminal block, which may be mounted on the base 91, as shown in Figs. 1, 2 and 3. This terminal block is of the usual type such as is used in telephone systems on distributing frames. It comprises five rows of terminals which are set in hard rubber or fiber blocks as seen clearly in Fig. 1, which shows an end view of the block. There are preferably twenty terminals in each row. The terminals in the upper row are numbered from 101 to 120, the terminals in the second row from 121 to 140, and so on. It will be understood that in actual practice the terminals may be numbered from 1 to 100, but in order to avoid confusion in the drawings the terminals are numbered herein as stated.

Fig. 9 shows how the pen relays and keys are wired to the terminal block. The conductors from the pen relays, the relay contacts, and the springs of the keys are preferably formed into cables which extend to the left-hand side of the terminal block shown at Fig. 1, or to the rear of

the terminal block, where they are separated and soldered to their respective terminal pins. These conductors are shown in solid lines in Fig. 9. In order to simplify the drawings the terminals are not shown in Fig. 9 in their proper relative positions as they are located on the terminal block **80**. This departure, however, is customary in wiring diagrams and will not cause any confusion. When the device is to be used, the proper connections to other apparatus and the necessary connections between the relays, keys, etc., which are not a part of the permanent wiring, are made by means of jumpers and by means of strapping on the front side of the terminal block **80**. Fig. 9 shows in dotted lines one particular system of strapping which is required for a certain particular use of the multiple pen recorder.

The construction of the multiple pen recorder having been described, its operation will now be explained. It will be assumed that the apparatus is in use in a telephone system, as for example, an automatic telephone exchange, and an explanation will be given of the operation of the unit in making a record of the calls occurring on a group of ten trunk lines during some selected period. It is generally desirable to make records of this nature at a time when the approximate peak load is being handled.

In automatic telephone systems a trunk line comprises two talking conductors and a release trunk conductor. Whenever the trunk line is taken for use the release trunk conductor is grounded and this grounded condition is maintained as long as the trunk line continues in use. The trunk lines originate at so-called terminal bays, where they are connected to the cables coming from the banks of the automatic switches through which traffic is directed to the trunk lines, and they terminate at automatic switchboards where they are connected to the jacks of automatic switches. It is convenient, therefore, in using the multiple pen recorder, to set the apparatus up on a table or shelf in the vicinity of the terminal bay, or the automatic switchboard, where ready access can be had to the release trunks of the trunk group which is to be studied. Assuming that this has been done, the ten release trunk conductors of the group under consideration are connected by means of jumpers to terminals **171** to **180**, inclusive, of the multiple pen recorder unit, reference being made to Fig. 9 of the drawings. If it has not already been done, certain of the terminals on the front of the terminal block of the multiple pen recorder are strapped together as shown by the dotted lines in Fig. 9. This strapping may be done by means of bare wire. The exchange battery should be connected across terminals **189** and **190**. This can readily be done by running jumpers from the terminals in question to some point where battery conductors are available, as at the jacks of some switch of the automatic switchboard. Finally the plug P**1** is inserted in some convenient socket which is connected to the source of lighting or power supply in the building. As soon as the motor **26** is connected up by plugging in the plug P**1**, the motor begins to operate, and rotates the driven roller **97** and also the two pick-up spools **85** and **86**. The paper on which the record is to be made may be started on to the pick-up roll **13** provided it is intended to run the apparatus for some time without any attention. However, in the event that only a short study is to be made, say for one hour, or if it is desired to inspect the record at frequent intervals while it is being made, the paper may be fed out from the front of the device, dispensing with the pick-up roller, and may be collected in a basket. It may be desirable to let the paper run out freely in this way even when making an extended study, particularly if portions of the record are wanted as soon as they are made. Lengths of record five or six feet long can readily be cut off with a pair of shears at intervals, so as to prevent too great an accumulation of paper and in order to make use of the record as fast as it is made.

Considering now the operation of the pen mechanism in making the record, it will be seen that each of the pens **1** to **12** will trace a line on the paper as the latter is advanced by the driven roller **97**. The type of record that is produced during the study which is being described now is illustrated in Fig. 1, on that portion of the paper which lies between the dotted lines **690** and **691**. The operation will readily be understood by reference to the circuit which is shown in Fig. 9, and by consideration of the record section referred to. Consider for example the first trunk of the group, the release trunk conductor of which is connected to terminal **171**. When this trunk line is taken for use, the release trunk becomes grounded, and a circuit is completed which extends from the grounded release trunk conductor of the trunk line by way of terminal **171**, springs of key K**11**, springs of key K**1**, terminal **121** strapped to terminal **111**, winding of relay **71**, terminal **101**, and thence by way of another strap to the battery terminal **190**. The pen relay **71** energizes over the above traced circuit, and closes its contacts **52** and **53**. At the same time the #**1** pen is moved to the left and the line traced by this pen thereafter until the trunk is released is offset to the left from its normal position. Obviously the length of the offset line is proportional to the duration of the call.

Referring to the fragmentary record which is shown between the dotted lines **690** and **691** of Fig. 1, and particularly to the line traced by the pen #**1**, the restoration of the offset line at **694** to its normal position indicates the termination of a call, while the resumption of the offset position of the line at **695** indicates the beginning of a new call. The line traced by the #**3** pen shows a record of a complete call which began and ended during the period of time shown on the record. The beginning of the call is indicated by the beginning of the offset position of the line at **696**, and the termination of the call is indicated at **697** where the line resumes its normal position. From the foregoing the meaning of the lines traced by all the pens Nos. **1** to **10**, inclusive, will readily be understood.

The #**11** pen is used in this study as an overflow pen. In order to explain this it may be pointed out that the various sets of contacts of the pen relays **1** to **10** are shown connected together by strapping as to form a chain circuit. The beginning of this chain is connected to ground by strapping between terminals **189** and **131**. The end of the chain is connected to the eleventh pen relay **81** by strapping between terminals **150** and **182**. It will be seen from the foregoing that when all ten trunks are in use, and all ten of the pen relays are energized, the chain circuit will be completed and pen relay **81** will be energized to move the #**11** pen to the left to cause it to trace its line on the paper in offset position. Referring to Fig. 1, it will be seen that at **698** the

#11 pen has traced an off-set line for a short distance which indicates that during the corresponding period of time all of the trunk lines of the group were busy.

The record made on the paper shows the relative lengths of the various calls as they are made, but it may be also necessary to know the actual length of each call. In order to make the record show this, it is only necessary to use ruled papers in which the lines are spaced apart a certain definite distance depending on the speed at which the paper is advanced. However, in making certain tests it is preferable to use unruled paper, and this paper is also somewhat cheaper than the other kind. In order to enable plain paper to be used on all these types of studies where the actual time between the beginning and end of calls has to be indicated on the record, the #12 pen is used to mark the paper as it advances in accordance with the elapsed time. As can be seen from Fig. 9, the spring 34 of the pair controlled by the cam 31 is connected to ground by strapping between terminals 191 and 160. Spring 33 is connected to the pen relay 82 by strapping between terminals 192 and 186. Therefore, impulses at the rate of ten per minute will be delivered by the springs 33 and 34 to the pen relay 82, controlling the #12 pen. At each impulse the #12 pen will be deflected momentarily to the left, and the marks thus produced on the paper will indicate time periods of six seconds duration. That is, the space between two consecutive marks produced by the pen #12 corresponds in length to a time interval of six seconds. It will be clear now that by comparing the record of any call with the timing marks on the same length of paper, the duration of such call can readily be ascertained. Further, if the starting time is entered on the chart, the actual time any call is made can be readily figured out.

After making a number of records on a group of ten trunks and finding no overflow periods, the person making the traffic study may desire to arbitrarily reduce the size of the group temporarily in order to ascertain whether or not the trunk group can safely be reduced in size. It may be assumed, for example, that the data obtained so far indicate that possibly a group comprising only eight trunks will satisfactorily handle the traffic. In order to determine whether such is the case or not the keys K9 and K10 may be operated. The left-hand springs of key K10 disconnect the incoming release trunk conductor circuit from the pen relay 80 and connect it instead to ground, thus marking the tenth trunk line of the group busy. At the same time the right-hand springs of key K10 close a shunt around the contacts of the pen relay 80. The key K9 performs similar functions in respect to the ninth trunk line of the group and the ninth pen relay 79. These operations convert the group of ten trunk lines into a group of only eight trunk lines, by busying artificially the ninth and tenth trunk lines of the group, and at the same time the chain circuit is completed past the ninth and tenth pen relays. Thus, if an overflow condition arises with only eight trunk lines in service such condition will be indicated on the record by the #11 pen which is the overflow pen. It should be stated in this connection that when the multiple pen recorder is being used in the situation just described, it is preferable to connect an alarm circuit of some kind to terminals 183 and 184, which are closed together by the operation of the contacts on the overflow pen relay. Thus, if an overflow condition takes place while the apparatus is not being observed, an alarm will be sounded, and another trunk line can be cut into service to prevent the loss of calls.

It will be clear that the keys in the row comprising keys K1 to K10, inclusive, are useful also in the event that a group of trunks comprising less than ten trunks is being tested. It is frequently the case that groups of six to nine trunks will be encountered and the apparatus is capable of being readily adapted to such small size trunk groups by operating the proper keys. It may happen also that while testing a group of ten trunks some one trunk will get out of order and have to be removed from service. If this should happen, the key in the row K1–K10 which corresponds to the defective trunk is thrown and the test can continue without interruption. A continuous straight line traced on the record by the pen corresponding to such trunk will indicate that the trunk was out of commission during the test.

If there are some small trunk groups in service of a size which does not exceed five trunks, traffic studies can be made on two of these small trunk groups at the same time. The manner in which the multiple pen recorder is connected up for making traffic studies simultaneously on two small trunk groups will therefore be described briefly, it being assumed that there is one group of five trunks and another group of four trunks on which traffic data is desired.

In order to connect up the apparatus, the release trunk conductors of the five trunk lines in the first group are connected to terminals 171–175. The release trunk conductors of the four trunk lines in group #2 are connected to terminals 177–180. These connections serve to associate pens 1 to 5 with the five trunks of the first group, respectively, and pens 7 to 10 with the four trunks of the second group, respectively. Pen #11 is preferably used as an overflow pen for the second group, while the #6 pen may be used as an overflow pen for the first group. The changes in the strapping which are necessary for the proper operation of the overflow pens is as follows: The strap which connects terminals 146 and 137 is removed, and terminal 137 is strapped to ground at some convenient terminal, such as 189, or preferably 157. By grounding terminal 137 in this manner a new chain is prepared through the contacts of the pen relays 77–80, so that when all these relays are energized a circuit will be completed for the #11 pen relay 81. In order to connect up the #6 pen relay 76 as an overflow pen, it is only necessary to strap terminal 116 to terminal 145. The chain circuit through contacts of pen relays 71–75 will operate relay 76 whenever all the relays 71–75 are energized.

From the foregoing explanation it will be readily understood that when the apparatus is put into operation by plugging P1 into a source of commercial supply, two traffic records will be made simultaneously.

The multiple pen recorder may be used for other purposes and to make other kinds of records, as described more fully in my co-pending application S. N. 704,851, filed January 2, 1934. Some situations in which the recorder is used demand a different paper speed from what is required for recording the occupation time on trunk lines as explained herein. In case a fairly high speed is wanted, this can be secured by the interchanging of gears 22 and 23. In making this change, gear 21 is removed altogether, and gears 22 and 23 are interchanged, the large

gear 22 being placed on the shaft 30, while the small pinion 23 is placed on shaft 98. Since gear 21 has been removed, the take-up spools 85 and 86 are not used, but the paper is merely fed out the front of the machine over the face of roller 13. This may be all right, if the apparatus is in operation only at intervals, so that no great quantity of paper will be used up. Furthermore, the observer will often want to see what is going on and it would then be objectionable to have the paper rolled up on the take-up spool 13.

An extra gear wheel 22 is furnished so that the take-up feature can be used if required. This extra gear is substituted for pinion 23 on shaft 30, while pinion 23 is placed on shaft 98, outside gear 22. The gear case and motor assembly is moved to the left on bracket 25 so that the gear 22 on shaft 30 engages pinion 23 on shaft 98. This leaves the gear 22 shown in Fig. 1 in engagement with gear 21, which latter does not have to be removed owing to the fact that the added gear 22 is operating in a different plane.

It will be clear that several other speeds could be obtained by providing spare sets of different sized gears.

Having described the invention, what is considered to be new and is desired to be protected by Letters Patent will be set forth in the following claims.

What is claimed is:

1. In a multiple pen recorder, a plurality of pens constituting a group, an overflow pen, pen relays for operating said pens, a chain circuit extending through contacts on said relays for operating said overflow pen, and means including terminals to which the relays and contacts thereof are connected which enables the pens to be readily formed into two groups, each group having an overflow pen, and a chain circuit for operating it.

2. In a multiple pen recorder having a plurality of pens with means for feeding paper along in contact with said pens and individual electromagnetic means for operating each pen to cause such pen to change the position of the line it draws on said paper, the provision of an overflow pen, and means responsive to simultaneous operation of all the pens of said plurality for operating said overflow pen.

3. A multiple pen recorder comprising marking pens, paper feeding mechanism, magnets for controlling said pens, contact springs also controlled by said magnets, circuit changing keys, a terminal block, and wires connecting the said magnets, the contact springs, and the said keys to individual terminals on said block, whereby said devices can be combined in different circuit arrangements by means of strapping at said terminal block.

4. In a multiple pen recorder having a closed ink reservoir, a paper driving roll adjacent said reservoir, and a series of tubes extending upward through openings in the top of said reservoir and thence horizontally to a point above said roll, with stylographic pen points formed on the ends of said tubes, the provision of a pivoted carriage supporting the reservoir and tubes, means for individually moving said pen points in the plane of the paper carried on said driving roll, and means for tilting the carriage about its pivot point to simultaneously lift said pen points off the paper without changing their relation to the reservoir.

5. In a pen recorder, a recording pen, record material with which said pen is normally in contact, means supporting said pen for movement in the plane of said material and also permitting a limited movement away from said material, and a lever arranged to move said pen in the plane of said material, said lever having a notch for supporting the pen out of contact with said material when the pen is not in use.

6. In a multiple pen recorder having a frame and a moving paper roll, a supporting strip, a row of magnets mounted on said strip, an ink reservoir also supported on said strip, a row of pens supported on said reservoir, means whereby each magnet controls one of said pens, and means pivotally supporting said supporting strip in said frame, whereby movement of the strip on its pivots will cause the pens to simultaneously approach or recede from the said roll without changing the relation of the pens to the reservoir.

7. In a multiple pen recorder, a plurality of pen controlling electro-magnets, contact springs operated by said magnets, a terminal block, and wires connecting both ends of each magnet winding and each contact spring to individual terminals on said block, whereby the said magnets and contact springs may be incorporated in different circuit arrangements by strapping at said block.

8. In a multiple pen recorder, a plurality of pen controlling electro-magnets, a terminal block, two sets of terminals on said block to which the opposite terminals of said magnets are wired, respectively, a third set of terminals to which control conductors for said magnets are connected, battery and ground terminals, strapping connecting the terminals of the third set with the terminals of either of said first mentioned sets, and strapping connecting the terminals of the other of said first mentioned sets to either the battery or ground terminal depending on the potentials to be applied to said control conductors.

9. In a multiple pen recorder, a plurality of electrical equipment items associated with each pen, a terminal block on which terminals are arranged in intersecting rows, and wires connecting the said equipment items with the terminals on said block in such manner that items of like character are connected to terminals in the same row, while items associated with the same pen are connected to terminals in another row intersecting the first row, thereby facilitating the connection of said items in circuits by strapping at said terminal block.

10. In a multiple pen recorder, a plurality of pens constituting a group, a group of magnets for controlling said pens, a pair of contacts operated by each of said magnets, a chain circuit including said contact pairs in series, and means including a key associated with each pair of contacts whereby any pair of contacts may be shunted by operation of the associated key, thus permitting any pen to be withdrawn from the group without destroying said chain circuit.

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