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Erbach et al.

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[54] DRIVE ARRANGEMENT FOR VARIABLE WIDTH Z-FOLD CHART PAPER

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[51] **Int. Cl.** **G01d 15/30**

[58] **Field of Search** ..... 346/136; 226/198, 199; 197/133 F; 270/61 F, 52.5

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[57] **ABSTRACT**

A drive arrangement for Z-fold chart paper is provided in which spaced apart guide means positioned between the back tensioning roller and the chart supply provide a positive lateral reference for the chart web just prior to its engagement with the back tensioning roller. The guide means may be conveniently changed in spacing to accommodate chart paper of different widths without requiring any readjustment of the drive rollers or the back tensioning roller.

9 Claims, 4 Drawing Figures

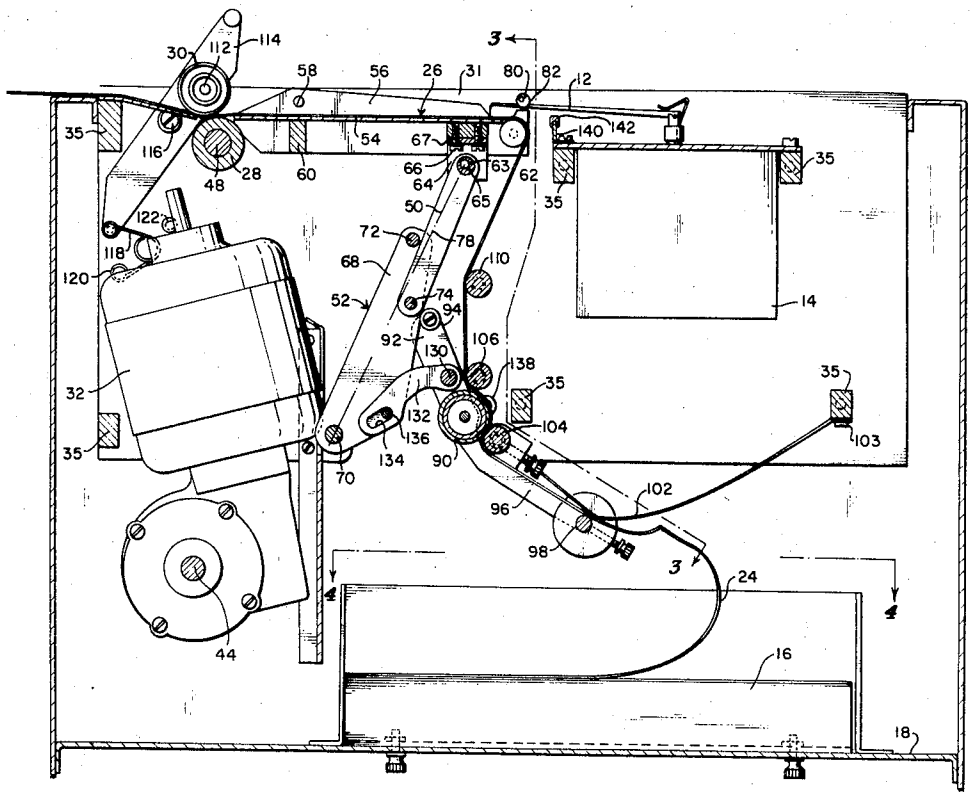
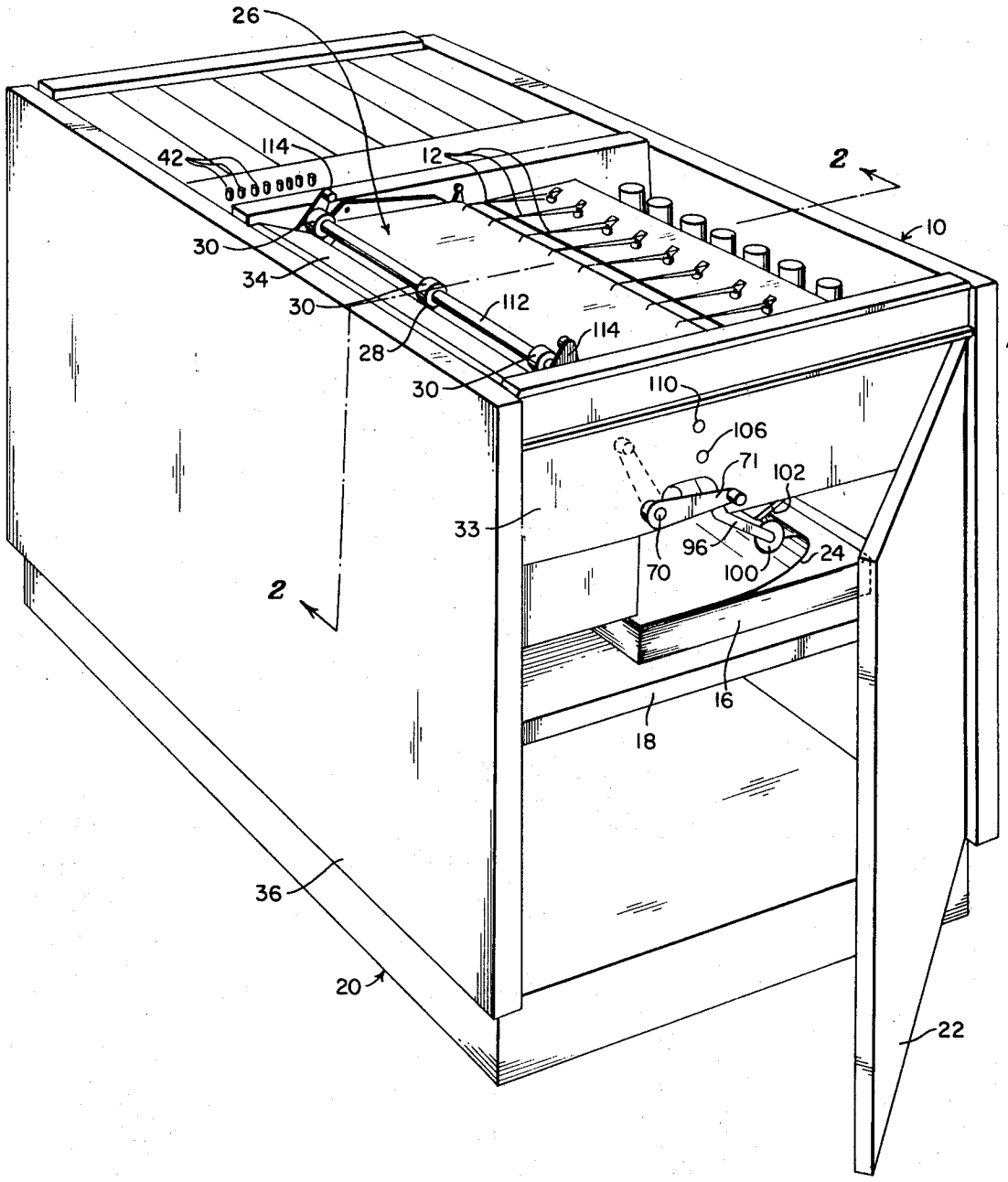


FIG. 1



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FIG. 3

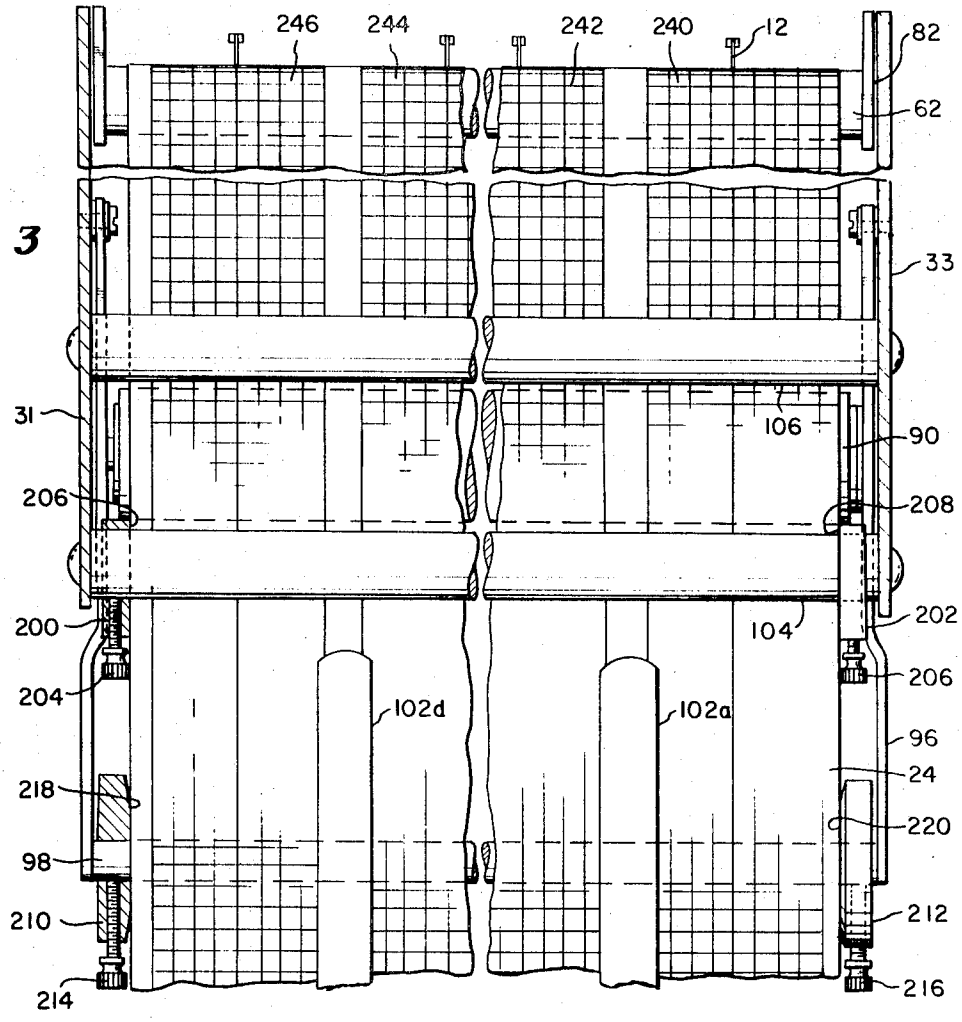
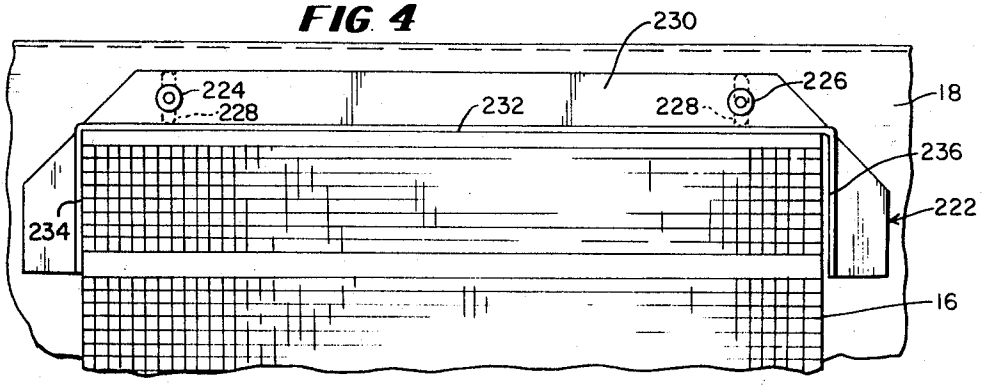
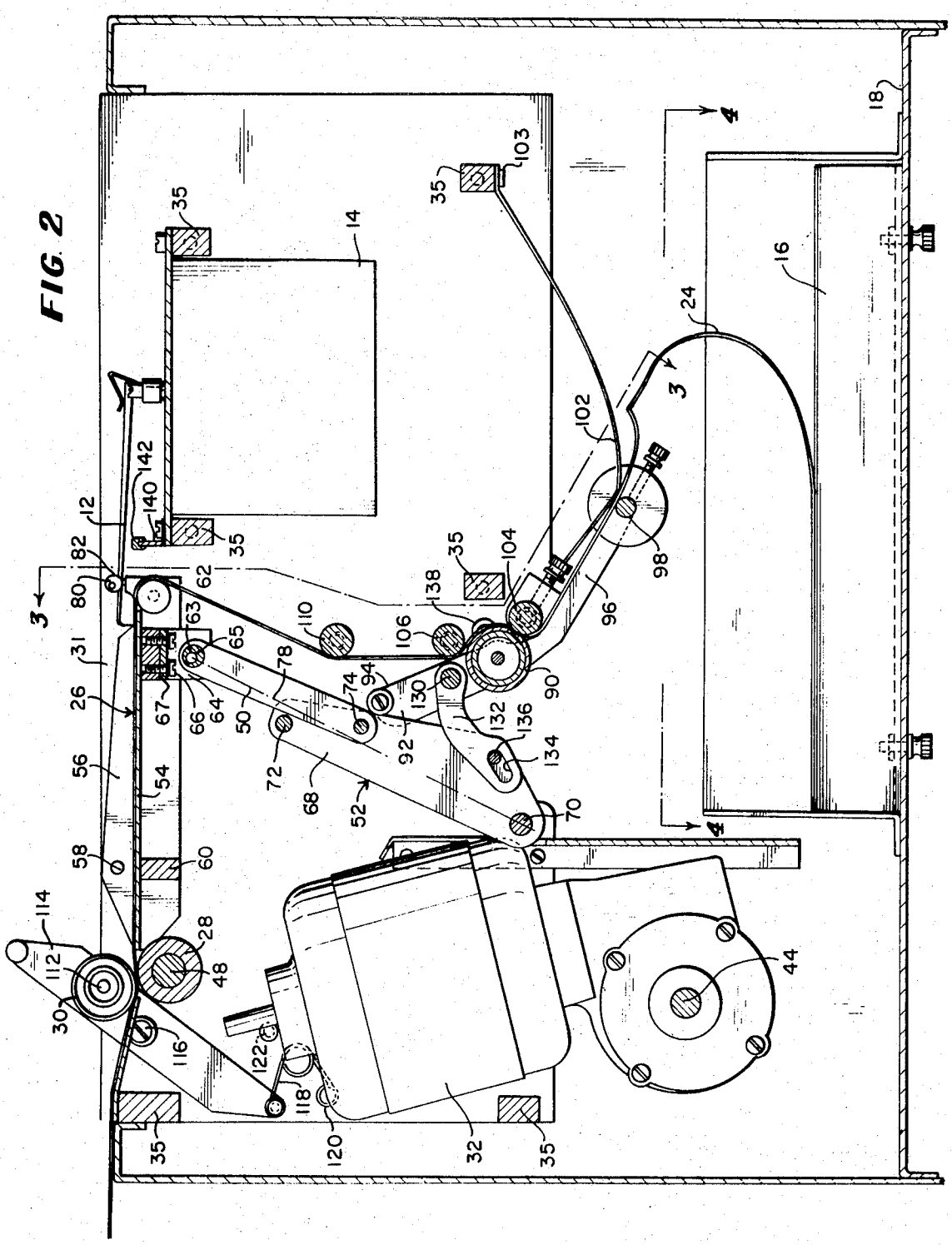


FIG. 4



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FIG. 2



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DRIVE ARRANGEMENT FOR VARIABLE WIDTH Z-FOLD CHART PAPER

The present invention relates to direct writing oscillograph recorders, and, more particularly, to a drive arrangement for such recorders which is adapted to accommodate different widths of Z-fold chart paper.

Some recorder chart transport mechanisms utilize drive roller means which are constructed to correct for minor lateral motions of the moving chart, thus providing a nonskew, or so-called zero-weave motion of the chart. While these arrangements work satisfactorily when the chart is in a roll form, which can be positively located on a shaft and oriented properly to the drive path, these mechanisms are generally less effective in controlling skew, or weave, when the chart is in the form of a flat package of Z-fold sheets. Nonskew drives usually are arranged to correct the motion of the chart by minute slippage of one or several roller sections. This slippage occurs when lateral motion of the chart creates increased tension on one edge of the chart and decreased tension on the opposite edge. The drive roller section or sections experiencing the increased load will slip, or stall, momentarily, allowing the rollers on the slack side to balance the edge tensions, after which normal drive is resumed.

Since all normal drive conditions for such nonskew or zero-weave drive mechanisms are based on some reference position of the chart, full effectiveness of a nonskew drive requires a constant reference location for the chart edges. When Z-fold paper begins to unfold from the base pack to travel through the transport mechanism, it is extremely compliant and unstable in the lateral direction. In most chart drives designed for Z-fold chart paper, edge guides are placed at the forming edge, or lead edge of the writing table in an effort to orient the chart immediately before it passes beneath the recording pen. This form of guiding the edges of the chart is reasonably satisfactory if no significant back-tension is maintained in a chart web passing through the transport mechanism. However, in order to reduce distortions of the record at the folds of Z-fold chart paper, it is necessary to greatly increase the back-tension of the chart web and this increased back-tension causes any non-parallelism of guide members to produce lateral forces on the chart which will cause skewing of the chart unless it is controlled by a nonskew drive system. However, the forming edge guides associated with the writing table do not provide a satisfactory reference position for the chart and thus the nonskew drive is not fully effective. The addition of a locating wall against which the chart package is registered does bring the reference condition up to a usable level. The drive will then correct skewing, but the result is usually an alternate weaving, or hunting, about some mean point and the amplitude of weave is objectionably high, often up to as high as 5 percent of the recording channel width on the paper.

In many instances it is also economically desirable to record information using a chart paper of a width which is less than the maximum chart width that the chart transport will drive. If, for example, only 3 parameters are being recorded, it is more economical to use four-channel chart paper than the higher cost eight-channel paper, even though the recorder will accept the eight-channel chart. Two difficulties arise in most recorder transport mechanisms under these conditions. Either the chart must be centered in a nonskew drive system, with the attendant mechanical adjustment of drive rollers, pressure rollers and guides, or in the alternative a simple edge drive must be used, thus eliminating the advantages of a zero-weave drive arrangement. In either case, there is usually some adjustment necessary for the back-tension required with charts of different widths. These various adjustments are often so time consuming as to offset the difference in the cost of the chart paper used.

It is, therefore, an object of the present invention to provide a new and improved Z-fold chart paper drive arrangement which eliminates one or more of the above discussed disadvantages of prior art arrangements.

It is a further object of the present invention to provide a new and improved Z-fold chart paper drive arrangement which is arranged to drive chart paper of various widths with a minimum number of adjustments required to adapt the drive mechanism to different widths of chart paper.

It is another object of the present invention to provide a new and improved chart paper drive arrangement which is adapted to function with a Z-fold chart paper pack and wherein spaced apart guide means are positioned between the back tensioning roller and the chart pack to provide a positive lateral reference for the chart web prior to its engagement with the back tensioning roller.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a direct writing oscillograph recorder embodying the features of the present invention;

FIG. 2 is a sectional view taken along the lines 2—2 of FIG. 1 and showing the chart drive mechanism in recording position with a pack of Z-fold chart paper inserted and threaded through its path to the drive rollers of the recorder;

FIG. 3 is a sectional view taken along the lines 3—3 of FIG. 2 and illustrating the edge guide arrangement of the present invention; and

FIG. 4 is a sectional view taken along the lines 4—4 of FIG. 2.

Referring now to the drawings, the horizontal table chart drive mechanism of the recorder is shown installed within a floor type console enclosure, indicated generally at **10**, and cooperates with a plurality of recorder pens **12** which are driven by means of individual pen motors **14** in response to electrical input signals which are to be recorded on the common chart **16** of the recorder. In the illustrated embodiment, the chart **16** comprises a pack of eight-channel Z-fold or fan-fold chart paper, which is positioned at a reference location on a shelf **18** within the console cabinet **20** of the recorder and is accessible through a door **22** provided in the end of the cabinet **20**. The active chart web **24**, of the chart pack **16** extends upwardly through the various rollers and guide bars of the chart drive mechanism to be described in more detail hereinafter, and over a horizontal writing table indicated generally at **26**, to a chart drive mechanism comprising a series of spaced drive rollers **28** and mating pressure rollers **30**.

The drive rollers **28** are preferably of cartridge-type construction, as described in more detail in a copending application of Albert Kupferschmidt, Ser. No. 757,016 filed Sept. 3, 1968, now U.S. Pat. No 3,552,621 which is assigned to the same assignee as the present invention. As described in more detail in said copending application, these rollers are arranged to be driven from an electric motor **32** and are designed individually to slip at a predetermined, adjustable maximum torque so that the Z-fold chart is pulled over the writing table **26** against the force of a back tensioning member, to be described in more detail hereinafter, in a nonskew or so-called zero-weave manner. The chart is moved at a selected speed so that the recording pens **12** may trace out appropriate lines on the chart **16** corresponding to the applied input signals, the free end of the chart moving over an exit ramp **34**, and then over the front wall **36** of the cabinet **20**. More particularly, the motor **32** is mounted on one of the side support members **31** of the chart transport and is connected to an eight-speed gear box which is electrically controlled by means of a series of push buttons **42** mounted in the top wall of the console **10**. The output shaft **44** of the gear box **40** is connected by means of the intermediate gearing to the drive roller shaft **48** on which the drive rollers **28** are mounted. The side support members **31** and **33** are connected together through a number of side bars **35** to form the main support structure of the chart transport mechanism.

Referring now more particularly to the arrangement provided for ease in loading and threading the chart pack into the

recorder, under normal recording conditions the writing table 26 is held in a horizontal position by means of an overcenter toggle mechanism comprising a table coupler link 50 and a drive link 52. More particularly, the writing table 26 comprises a writing plate or platen 54 and a pair of side members 56 which are pivotally mounted to the side support members 31, 33 of the chart transport mechanism by means of the pins 58. A forward crossbar 60 is provided to give rigidity to the forward end of the plate 54 and a forming bar 62 is provided at the rear of the table 26 over which the chart web extends. The upper end of the table coupler link 50 is pivotally mounted on an adjustable eccentric cam 65 carried on a pin 63 which is supported between the arms 64 of a U-shaped bracket 67 secured to the under side of the writing plate 54 by means of the screws 66. The drive link 52 comprises a pair of side members 68 which are connected to a drive link shaft 70 which is rotatable mounted in the side support members 31 and 33 of the chart transport mechanism and has an actuating crank 71 (FIG. 1) connected to the end thereof exteriorly of the side support 33. A pin 72 connects the upper ends of the side members 68 together and the bottom end of the table coupler link 50 is pivotally mounted on a pin 74 which extends between the side members 68.

It will be noted that when the pin 72 engages the edge of the table coupler link 50, as shown in FIG. 2, the pivot pin 74 at the bottom end of the link 50 is positioned beyond the centerline 78 connecting the centers of the drive link shaft 70 and the eccentric cam 65 so that an overcenter toggle action is provided whereby the writing table 26 is locked in a horizontal position. The spring compliance necessary to achieve this overcenter toggle action is provided by flexure of the drive link shaft 70 due to the fact that the toggle mechanism 50, 52 is mounted approximately midway of the shaft 70, and this shaft may have a length of approximately 16 inches in the case of a recorder using eight-channel chart paper. The amount of flexure of the shaft 70 and hence the force with which the toggle mechanism 50, 52 is held in locked position, may be adjusted by adjustment of the eccentric cam 65. Also, the final position of the writing table 26 and its parallelism to the other guide elements of the system is established by means of a pair of eccentric cams 80 which are mounted on the side support members 31 of the chart transport and engage flat shoulder portions 82 on the side members 56 of the writing table 26.

In order to provide a back tensioning mechanism against which the chart web may be pulled by the drive rollers 28 so that the chart may be pulled smoothly over the writing table 26 during the recording operation, a back tensioning roller 90 is provided which is rotatably mounted on a pair of roller support links 92 the upper end of which is pivotally mounted on the side support members 31, 33 by means of the bearing studs 94. The roller support links 92 are provided with offset end portions 96 which carry at the free end thereof a guide bar 98 over which the chart web passes as it is drawn from the chart pack 16. The chart web 24 is held against the bar 98 by means of a series of spring fingers 102 which are secured to one of the crossbars 35 by means of the screws 103.

The back-tension roller 90 is provided with an outer surface having a very high coefficient of friction and this roller is constructed so that an adjustable amount of torque is required to rotate the roller, as will be readily understood by those skilled in the art. The chart is held against the outer surface of the roller 90 by means of a second guide roll 104 which is mounted between the side support members 31, 33 of the chart transport, and a freely rotating guide roller 106 which is also rotatably mounted in the side support members 31, 33. The guide roll 104 is positioned so as to control the entrance angle of the chart web 24 to the outer surface of the back-tension roller 90 and the guide roller 106 is located so as to hold the chart web 24 against the surface of the roller 90 and to control the point at which the chart leaves this surface. After the chart web 24 leaves the roller 106, it moves over a guide bar 110, which is supported on the side supports 31 and 33, over the forming bar 62 of the writing table 26 under the recording pens 12 and over the writing plate 54 between the side members 56.

The pressure rollers 30 are rotatably mounted on a shaft 112 which is carried by a pair of support arms 114 which are pivotally mounted on the side support members 31, 33 by means of the studs 116. The pressure rollers 30 are normally urged against the drive rollers 28 by means of a pair of coil springs 118 one end of each of the springs 118 being connected to the bottom end of the support members 114 and the other end thereof being connected to the side support members 31, 33 as indicated at 120. The pressure rollers 30 may be moved away from the drive rollers 28 by moving the support members 114 to the loading position in which position these members engage the stops 122 on the side supports 31, 33. The chart lead may then be inserted between the rollers 28 and the rollers 30, and the rollers 30 moved into engagement with the upper surface of the chart web so that the drive rollers 28 can pull the chart web through the chart transport against the drag of the back-tension roller 90.

Considering now the manner in which the back-tension roller 90 is positioned in correct relation with respect to the rollers 104 and 106 so as to provide the above-described back-tension drag on the chart web, a separator bar 130 is connected to and extends between the roller support links 92 and a roller coupler link 132 is employed in conjunction with the drive link 52 to provide a second overcenter toggle mechanism which functions to lock the back-tension roller 90 and the guide bar 98 in their respective positions during the recording operation. More particularly, the roller coupler link 132 is rotatably mounted on the separator bar 130 at the middle thereof and the other end of the link 132 is provided with a slot 134 within which is positioned a pin 136 which is secured to the side members 68 of the drive link 52.

When the drive link 52 is positioned in the locking position for the writing table 26, the pin 136 is positioned beyond the centerline connecting the centers of the shaft 70 and the separator bar 130 so that an overcenter toggle mechanism is provided which accurately holds the back-tension roller 90 at the desired position with respect to the rollers 104 and 106. The spring compliance necessary to achieve this overcenter toggle action is provided by the flexure of the separator bar 130, and to some extent the flexure of the drive link shaft 70. The correct position of the back-tension roller 90 may be adjusted by means of a pair of eccentric cams which are mounted on the side support members 31, 33 and engage the edges of the roller support links 92.

In accordance with an important aspect of the invention, the guide bars 98 and 104 are provided with adjustable guide flanges which constitute spaced-apart guide means positioned between the back tensioning roller 90 and the chart pack 16 to provide a positive lateral reference for the chart web prior to its engagement with the back tensioning roller. Furthermore, this guide means is adjustable to accommodate chart paper of different widths without requiring adjustment of the torque settings of the drive rollers 28. More particularly a pair of guide blocks or collars 200 and 202 are adjustably positioned on the guide bar 104 by means of the thumbscrews 204 and 206, respectively. The portions of the guide blocks 200 and 202 which are on the opposite side of the shaft 104 from the thumbscrews 204 and 206 are in close proximity to the back tensioning roller 90 so that the inner edges 206 and 208 of the members 200 and 202 act as a first pair of guide flanges to establish a positive lateral reference point for the edges of the Z-fold chart paper 24.

In a similar manner a pair of guide flanges 210 and 212 are adjustably positioned on the guide bar 98 by means of the thumb screws 214 and 216. The guide members 210 and 212 are of relatively large diameter, so as to provide the guide edges 218 and 220 which act as a second positive lateral reference point for the chart web 24 as it is being withdrawn from the chart pack 16.

In accordance with a further aspect of the invention, a reference wall or fence is provided for the chart pack 16 by

means of a bracket indicated generally at **222** which may be adjustably positioned on the shelf **18** by means of the thumbscrews **224** and **226** which extend through slots **228** in the rear flange **230** of the bracket **222**. The bracket **222** includes an end wall **232** against which the rear edge of the chart pack **16** may be positioned when the chart pack is loaded into the recorder, the position of the rear wall **232** providing the basic reference location for the inner edge of the chart web **24** relative to the upper elements of the transport mechanism. The end walls **234** and **236** of the bracket **222** are provided for approximate location of the chart pack in this dimension and are spaced apart an amount sufficient to provide adequate clearance to permit the chart pack **16** to be referenced against the end wall **232**.

After the chart pack **16** has been moved into engagement with the rear wall **232** the actuating crank **71** is moved to the position shown in dotted lines in FIG. **1** in which position the above-described overcenter toggle linkages are actuated to permit insertion of the chart lead between the guide bar **104** and the back tensioning roller **90** and upwardly over the tilted writing table **26**. When the chart lead is threaded through the transport mechanism the crank **71** is moved back to the normal operating position and the guide members **200** and **210** are positioned on the guide bars **104** and **98**, respectively, so that the guide edges **206** and **218** are positioned at the correct point to control the outer edge of the chart web **24**. The guide members **202** and **212** are initially positioned in alignment with the reference wall **232** of the bracket **222** and remain in this adjusted position irrespective of the width of the chart paper which is used.

Since the guide bar **104** must be held in close proximity to the back-tension roller **90** in order to prevent the chart from slipping relative to this roller during changes in chart speed and at high chart speeds, the guide flanges **206** and **208** are necessarily of relatively limited height. The Z-fold chart will not readily follow the rounded contours of the guide bars **104** and **98**, especially at the folds of the chart paper, and if only the guide flanges **206** and **208** were provided, the chart paper might escape over these edges thus resulting in a loss of lateral reference. In accordance with a further feature of the invention, the leaf springs **102** provide an additional small amount of load on the chart web **24** at the guide bar **98** and produce a sufficient amount of friction between the chart web **24** and the guide bar **98** to hold the chart in conformity to the contour of guide bar **104** and thus within the control of the edge guides **206** and **208**. The edge guide **206**, **208** and **218**, **220** thus act as four spaced-apart reference points which establish a positive lateral position for the chart web even though Z-fold chart paper is used. Accordingly, the nonskew drive rollers **28** will produce an essentially zero-weave delivery of the chart.

In accordance with a further aspect of the invention, different widths of chart paper may be used while requiring a minimum number of adjustments by the operator and without requiring readjustment of the back-tension roller **90** or the drive rollers **28**. More particularly, it has been found that by using only three drive roller cartridges **28** properly spaced across the width of the transport, zero-weave delivery of charts of several different widths may be provided without changing the drive roller locations. One of the three drive roller cartridges is placed so as to be centered on the eight channel, i.e., maximum width chart, as shown in FIG. **1**. The other two drive roller cartridges are placed at the outer edges of the first and last channels of eight-channel-width chart paper. For eight-channel chart paper, weave is controlled by the two outer rollers **28**, the center roller having relatively small effect under these conditions. For four- and six-channel-width charts, the outermost one of the drive roller cartridges, i.e., the one closest to the sidewall **33** (FIG. **1**) does not engage the chart since the inner chart edge is referenced against the locating fence **232** for all widths of chart paper, and is used as a constant reference position for the inner edge of all charts. The two engaged rollers, i.e., the center roller and the innermost roller, while not exactly symmetrical on the width of the chart, are sufficiently off center to effect a zero-weave delivery of both four-channel- and six-channel-width charts. For two-channel-width charts, only the innermost roller **28** engages the chart paper but the narrow width of the paper allows the edge guides **206**, **208** and **218**, **220** to control the chart position with essentially zero-weave delivery.

When the width of the chart paper is changed to either six-channel chart paper or four-channel chart paper the guide members **200** and **210** are moved along the length of the guide bars **104** and **98**, respectively, so that the guide edges **208** and **216** contact the edge of the new width of chart paper used in the recorder after which the setscrews **204** and **214** are tightened. These two adjustments are the only ones required to adapt the transport mechanism to a different width of chart paper, the members **202** and **212** remaining in their originally adjusted positions which are in alignment with the reference fence **232**.

In order to eliminate the need for readjustment of the back-tension roller **90** and readjustment of the slip torque of the drive roller cartridges **28** when different widths of chart paper are used, the leaf springs **102** are provided in the form of four independent spring members different numbers of which are arranged to contact the chart paper depending upon the width of chart paper which is being used. More particularly, four independent leaf springs are secured to the crossbar **35**. The first of these leaf springs **102***a* (FIG. **3**) is positioned to engage the chart paper between the channel **1** portion of eight-channel chart paper, which is identified as the area **240** in FIG. **3**, and the second channel area **242**.

The second leaf spring (not shown) is arranged to engage the chart paper between the third and fourth channels of eight-channel-width chart paper. The third leaf spring (not shown) is arranged to engage the chart paper between the fifth and sixth channel areas of the chart and the fourth leaf spring **102***d* (FIG. **3**) is arranged to contact the chart paper between the seventh channel area **244** and the eighth channel area **246**. With this arrangement all four leaf springs **102** will contact eight channel width chart paper, only three of these springs will contact six-channel chart paper, only two will contact four-channel chart paper, and only the leaf spring **102***a* will contact two channel width chart paper. The setting of the back-tension roller **90** and the load rate for the leaf springs **102** is determined by testing with each width of chart paper so that the web tension provided by the leaf springs **102**, for each width of chart, added to the tension provided by the back-tension roller **90**, is sufficient to provide zero-weave delivery of each width of chart with no adjustment of the back-tension roller **90** or readjustment of the slip torque of the drive roller cartridges **28**.

The user of the recorder need change only the outer two guide members **200** and **210**, as described heretofore, in changing from one width of chart to another. In this connection, it is pointed out that during initial loading of a chart pack of any width into the recorder, the crank **71** is actuated to the loading position in which position the leaf springs **102** are spaced from the guide bar **98** and the back tensioning roller **90** to permit easy loading of the chart paper into the transport mechanism with any width of chart, as described in more detail in the above-identified copending application of Albert Kupferschmidt.

While but a single embodiment of the present invention has been here specifically disclosed, it will be apparent that many variations may be made therein, all within the true spirit and scope of the invention, as defined in the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a chart recorder, the combination of, a supply of Z-fold chart paper, a back-tension roller system including a back-tension roller and a guide roller for holding the chart paper against the outer surface of said back-tension roller and for controlling the point at which the chart paper leaves said outer surface, a writing table positioned above said back-tension roller system, means for positioning said chart supply relative

to said back-tension roller system, a plurality of drive rollers and mating pressure rollers positioned at the forward end of said writing table and arranged to pull the chart paper over said writing table against the force of said back-tension roller system, said drive rollers being arranged individually to slip when a predetermined torque is exerted thereon so that a non-skew drive system for the chart paper is provided, and spaced-apart guide means positioned between said back-tension roller and said chart supply to provide a positive lateral reference for the chart paper prior to its engagement with said back-tension roller, said guide means being adjustable to accommodate chart paper of different widths and to provide the proper positive lateral reference for each width of chart paper used.

2. The combination of claim 1, wherein said guide means includes a first guide bar in close proximity to said back tensioning roller and having guide flanges on the ends thereof which are adapted to guide the edges of the chart paper as it is engaged by said back tensioning roller.

3. The combination of claim 2 wherein a second guide bar is positioned between said first guide bar and said chart supply, said second guide bar having guide flanges on the ends thereof which are also adapted to guide the edges of the chart paper.

4. The combination of claim 2, wherein one of said guide flanges on said first guide bar is adjustable along the length thereof to accommodate chart paper of different widths.

5. The combination of claim 3, wherein one of said guide flanges on said second guide bar is adjustable along the length thereof to accommodate chart paper of different widths.

6. The combination of claim 3, wherein leaf spring means is positioned to engage the chart paper passing over said second guide bar to hold the edges of the chart paper in engagement with said guide flanges on said first guide bar.

7. The combination of claim 1, wherein said plurality of drive rollers comprise three drive rollers one of which is positioned to engage chart paper of maximum width at the center thereof and the other two of which are positioned to engage the edges of chart paper of maximum width.

8. The combination of claim 7, wherein said guide means includes a guide bar over which paper is drawn from said chart supply by said drive rollers, and chart paper tension means adapted to engage the chart paper as it is drawn over said guide bar, said chart paper tension means being adapted to engage chart paper of different widths.

9. The combination of claim 8, wherein said chart paper tension means comprises a plurality of leaf spring fingers spaced along the length of said guide bar so that chart paper of different widths is engaged by different members of said spring fingers.

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