Dec. 20, 1966 D. C. HAUSSER 3,293,654

PRINTING TAPPER-HEAD FOR RADIOACTIVITY SCANNERS

Filed April 14, 1964 4 Sheets-Sheet 1

FIG. 1

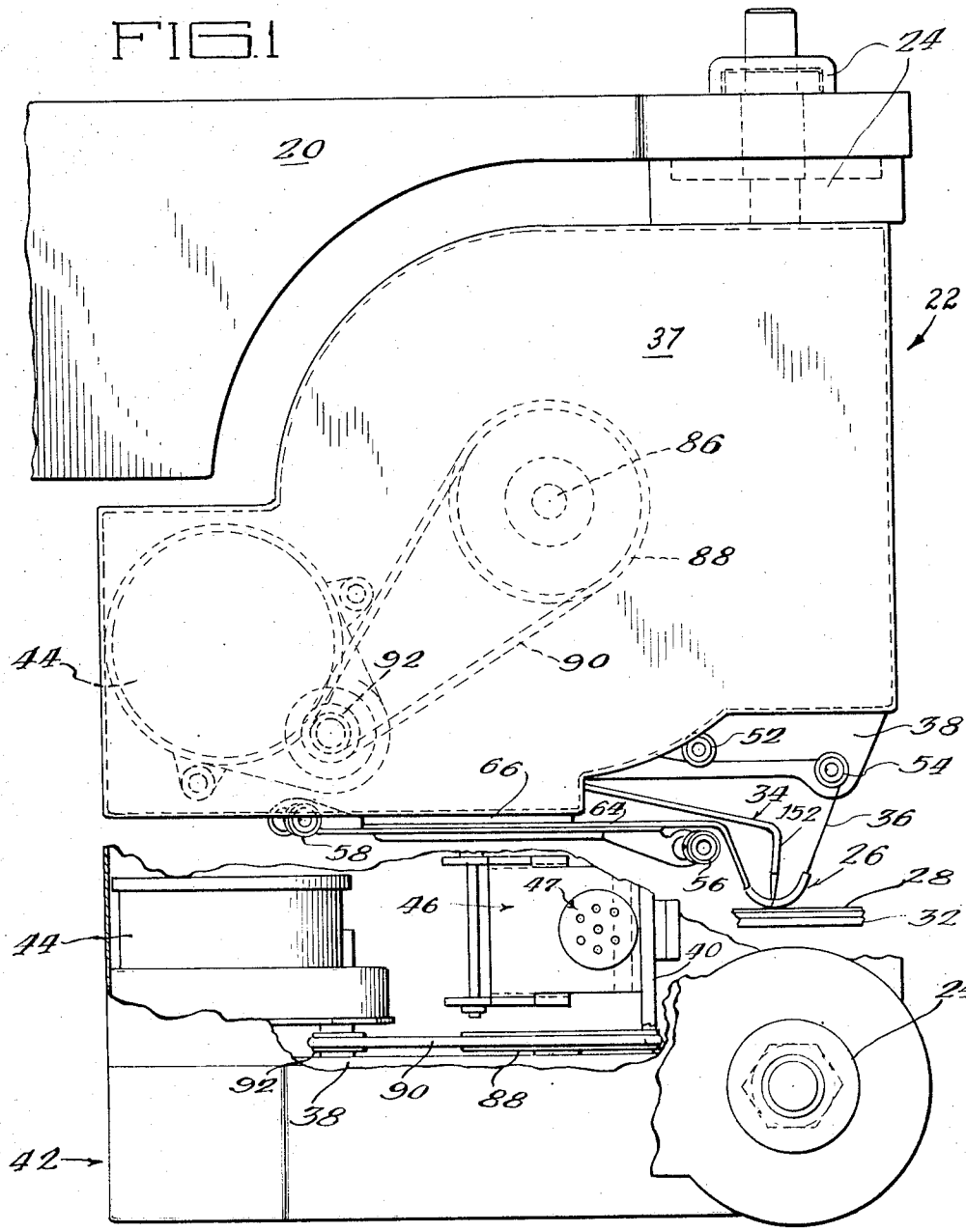
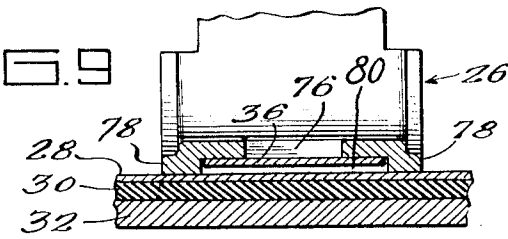


FIG. 2

FIG. 9



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PRINTING TAPPER-HEAD FOR RADIOACTIVITY SCANNERS

Filed April 14, 1964 4 Sheets-Sheet 2

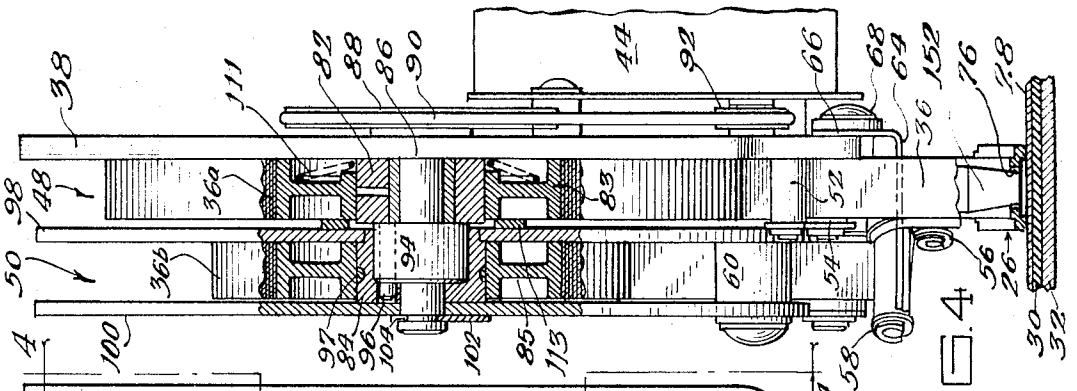


FIG. 4

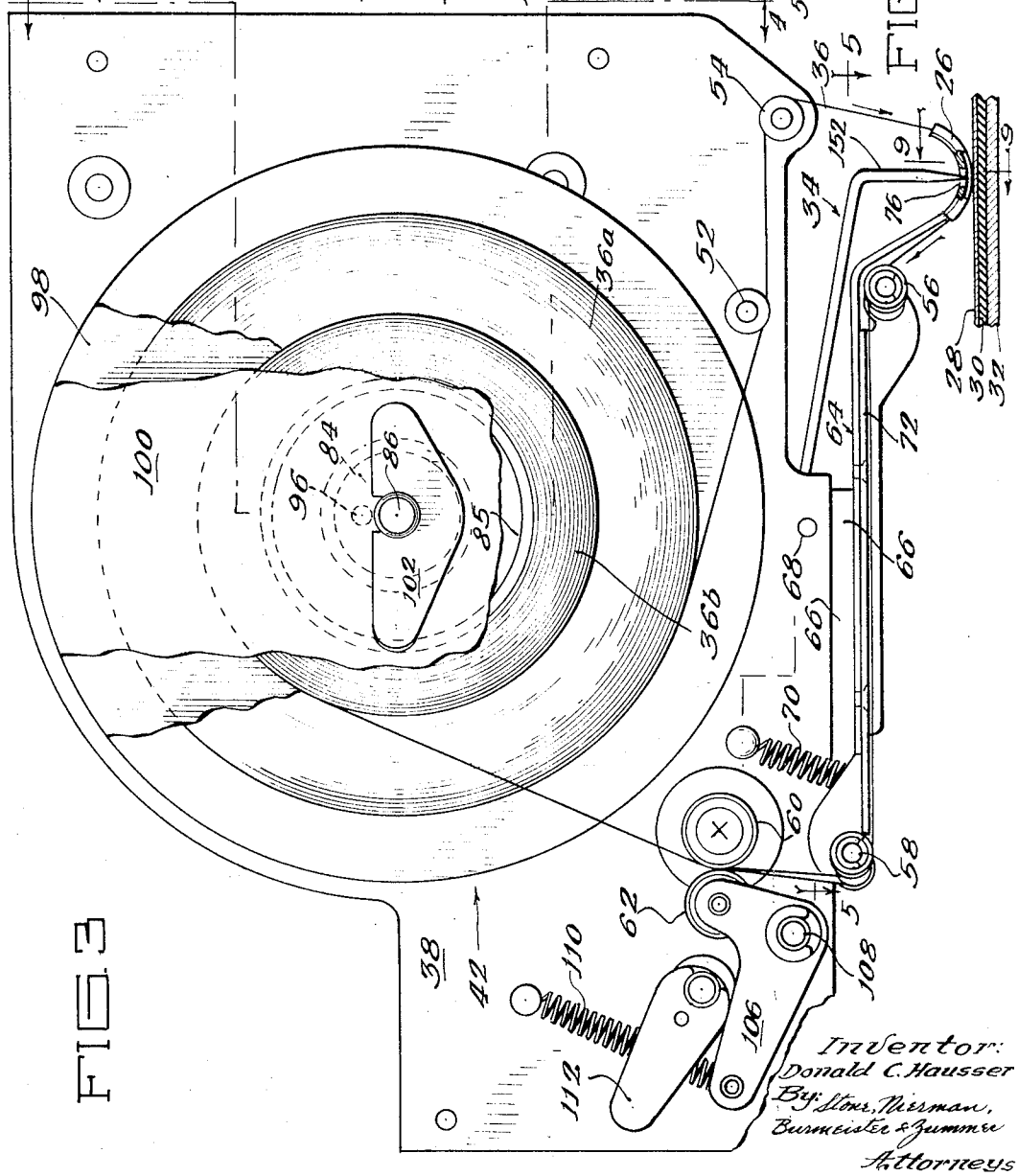


FIG. 5

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PRINTING TAPPER-HEAD FOR RADIOACTIVITY SCANNERS

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FIG. 5

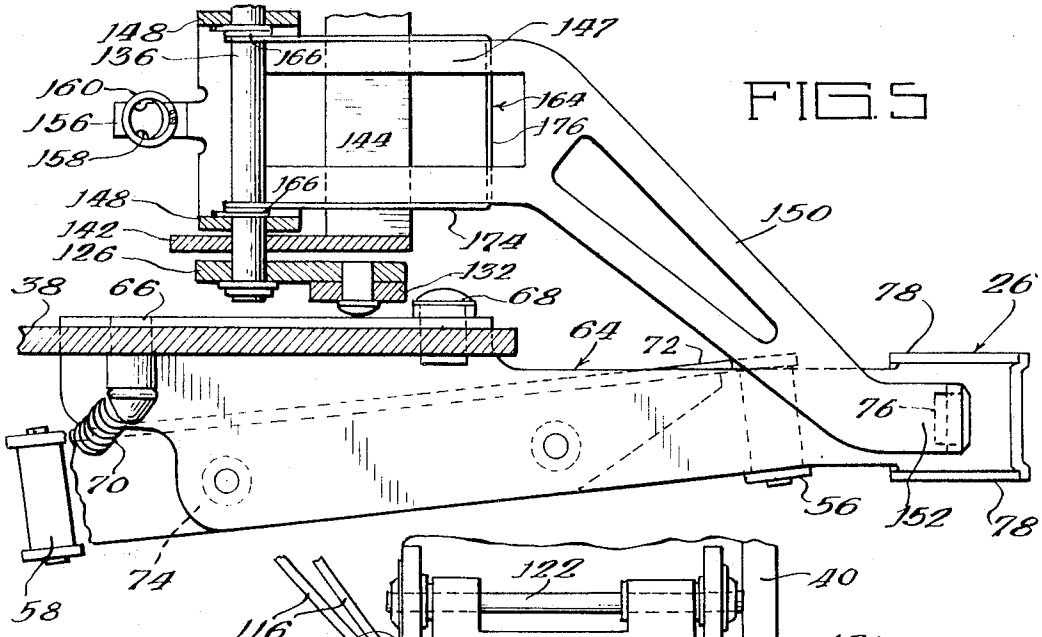
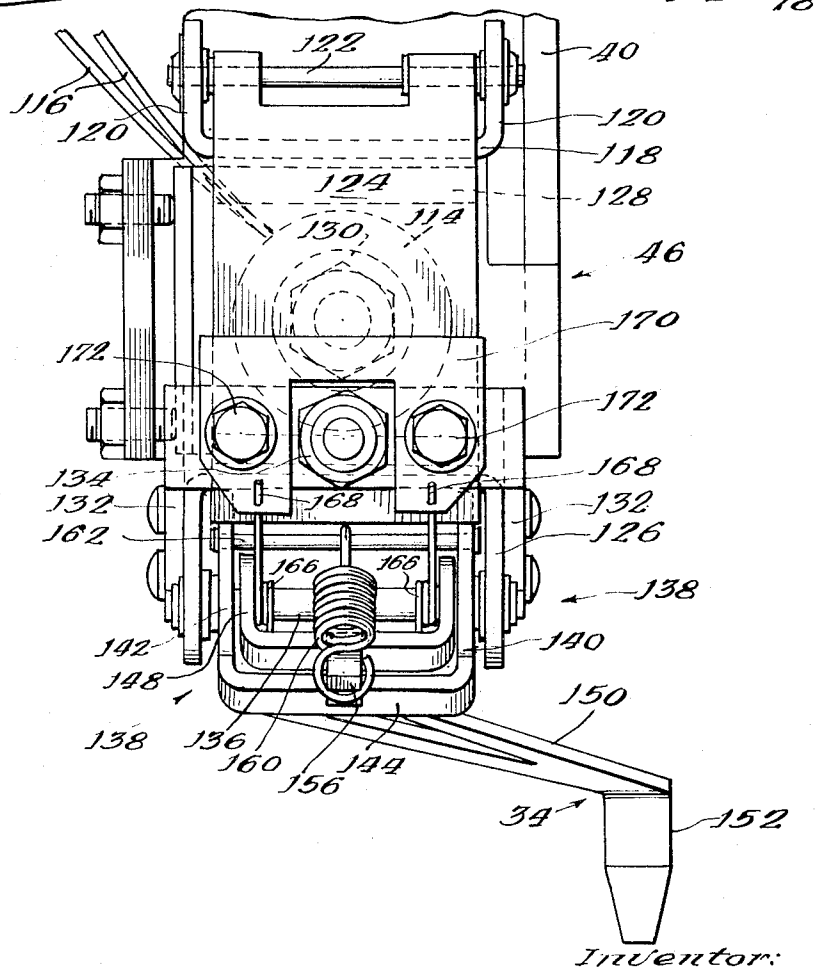


FIG. 6



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PRINTING TAPPER-HEAD FOR RADIOACTIVITY SCANNERS

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FIG. 7

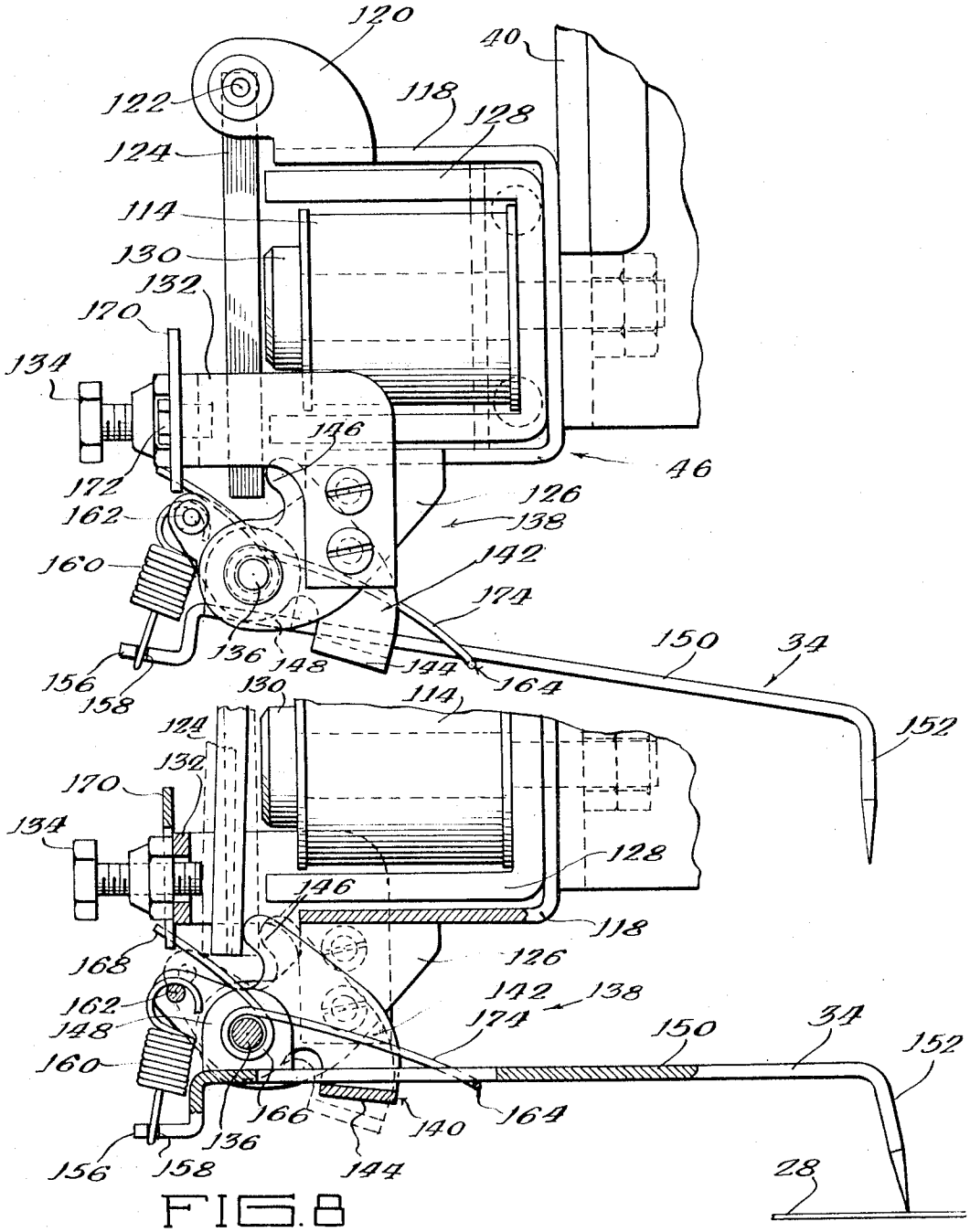


FIG. 8

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3,293,654

PRINTING TAPPER-HEAD FOR RADIOACTIVITY SCANNERS

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Filed Apr. 14, 1964, Ser. No. 359,635
16 Claims. (Cl. 346—105)

This invention relates to radioactivity pattern plotting devices of the type known as "scanners," in which a more or less photographic representation of radioactivity distribution patterns is formed by the printing of dots, lines, or similar marks on a paper or similar recording medium which is scanned by a marking-head simultaneously with the scanning of the radio-activity pattern by a directional scintillation counter or other radioactivity detection device. The invention relates more particularly to a novel construction for the printing or marking head of such a device.

The radioactivity scanner is now a widely used type of equipment, particularly for medical purposes, where it is used for a variety of purposes in connection with both research and routine diagnosis and treatment. Used in connection with radio-active isotopes incorporated in compounds and compositions which concentrate in particular organs, the radioactivity scanner is employed for such purposes as the inspection of the size, functioning, and other information regarding internal organs (kidneys and the thyroid being common examples), in addition to the many other uses which have had this type of instrument fairly universal in modern hospitals and similar installations.

In the usual radioactivity scanner, there is employed a moving arm or carriage which carries a radioactivity detector, normally a scintillation counter with a collimator adapted to produce response to radiations in a highly localized region. This arm scans the patient (normally a particular localized part of the anatomy) by moving back and forth in a pattern covering the entire area to be pictured. In the conventional scanner, the same arm or carriage also bears a printer or tapper head which scans a suitable piece of paper or other recording medium and makes marks or impressions at a rate proportional to the rate of detection occurring in the counter. When an entire area is scanned at constant speed, the resultant dot pattern is a picture of the radioactivity distribution, with "-tones" formed by the density of the marks.

There are a number of variables commonly provided in commercial scanners, permitting variation of the relation between marking rate and detection rate (normally variation of the scaling factor of a scaler whose output drives the printer or tapper), the scanning speed, the fineness of the scanning pattern, and similar variables which produce results which are optimum for particular conditions and requirements, when radioactivity intensity, permitted time, desired resolution and contrast, etc., are considered in each case.

It will be seen that with any design of the type described, employed with patterns of sufficient intensity so that with the particular detector and the particular degree of localization of its response, statistical variations constitute no problem, the limitation on the speed with which a scan can be accomplished (with a given "blackness" in the highest-intensity regions) is the response rate of the printer, i.e., the shortness of the interval within which it can respond to a new input signal.

The speed of response of the tapping action of the printing head determines the scaling factor (or other relation between detector response and tapping speed) which must be used in order to avoid loss of detail due to the analogue of photographic overexposure, and thus the

speed of response of the head may be considered the vital factor in what may be called "detector utilization" as regards speed of making of scan pictures, for any given dimensions of the dot or mark.

In order to avoid the response-speed limitations of mechanical systems heretofore known for the purpose, there have been devised various non-mechanical marking systems utilizing electrical pulses. Commercial scanner systems are normally provided, for example, with an auxiliary provision for scanning a photosensitive film with a pulsed light source. Another electrical system employs the type of marking utilizing electrical pulses with a specially sensitized sheet, known as Teledeltos. The relatively high cost and inconvenience of such manners of forming the image, as compared with the employment of a mechanical tapper and a sheet of carbon paper to form the image on ordinary paper, have largely restricted the use of such nonmechanical marking systems.

Another limitation which has existed in previous systems has, as will later be seen, been eliminated by the present invention. Where the image is formed by the employment of carbon paper or some similar provision, it is of course in general difficult to observe the pattern in the course of formation, particularly the portion in the immediate vicinity of the momentary position of the tapper. It is of course possible to use special types of pressure-responsive recording papers, or to employ ink or a similar marking medium in the tapper stylus. The disadvantages of special papers, etc., are obvious, as it the fact that burdening a striker or stylus with a marking provision beyond mere impact is in general inconsistent with the desired high speeds of response.

The construction of the present invention provides a marking provision on the scanning head itself, while at the same time avoiding the introduction of any slowing of the response. This has been done by incorporating in the head a pressure-responsive marking medium which is interposed between the tapper end and the paper. This medium is an ordinary typewriter ribbon which is continuously driven by a motor, rather than being advanced after each impression, as in the case of a typewriter, adding machine, etc. In this manner, there is eliminated the problem of speed of response which would be involved in using such a ribbon with the types of drive mechanisms most often employed with it. The provision of the ribbon, and the special structure to be described for driving, storing, and utilizing the ribbon, may of course be advantageously utilized with any type of tapping mechanism. However, it must be observed that the best performance of the ribbon system which is one aspect of the present invention is obtained only with a tapper mechanism in which the withdrawal of the tapper after making of the impression is extremely rapid, since otherwise the relative motion must inevitably produce smearing. It should be noted that this problem cannot be avoided by synchronizing the ribbon speed with the scan speed in most commercial scanners, the reversal of line scan direction with each successive line scanned being virtually universal.

It is an additional requirement, for full utilization of the advantages of such a ribbon system, that the ribbon must be driven and stored in and by an extremely compact mechanism, since much of the advantage of use of this marking medium would be lost if it were necessary to make the head large and bulky, thus obscuring the immediate observation of the portion of the picture over which the tapper has just passed at any moment. The construction associated with the ribbon in accordance with the present invention not only provides such compactness, but also does so in such a manner as to eliminate any mechanisms of substantial complexity, thus reducing both the cost and the problems of maintenance; at the same

time, the operations involved in changing ribbons are made extremely simple.

The aspect of the invention relating to the use of the ribbon eliminates to a large extent the bulk (and consequent obscuring ofthe view which would be here involved) normally associated with a feed spool and a take-up spool. In the present construction, the two spools require very little more space than a single spool, being side-by-side on a common axis. This of course requires a transition between planes in the path of the ribbon, which is accomplished in a very simple manner. The adjacency of the ribbon spools, in addition to providing compactness, is employed to simplify the mechanism normally associated with maintaining constancy of tape or ribbon tension in such systems; the two spools are made to rotate in opposite directions with a frictional coupling between them, so that the retarding or tension friction on the feed spool itself is altered in the proper direction to keep the ribbon tension relatively constant as the diameter of the feed ribbon winding diminishes.

Further understanding of the general advantages of the invention described above, together with certain further purposes served by the invention, and together with more detailed description of the manner in which these are obtained, will be seen from the description given below of the particular embodiment of the invention illustrated in the drawing, in which:

FIGURE 1 is a full side elevational view showing the general construction of a printing or tapping head embodying the invention, as mounted on a scanner carriage;

FIGURE 2 is a top plan view generally similar to FIGURE 1, with the cover of one side of the device omitted;

FIGURE 3 is a side elevational view of the internal construction of the head;

FIGURE 4 is a front end elevational view of the ribbon drive and storage portion of the device, partially broken away in section taken along the line **4—4** of FIGURE 3;

FIGURE 5 is a horizontal sectional view taken along the offset line **5—5** of FIGURE 3, in the direction indicated by arrows;

FIGURE 6 is a view in end elevation of the tapper drive mechanism;

FIGURE 7 is a view in side elevation of the mechanism of FIGURE 6;

FIGURE 8 is a detailed view illustrating the manner of operation of the tapper mechanism; and

FIGURE 9 is an enlarged fragmentary scetional view taken along the line **9—9** of FIGURE 3.

The general organization and operation of the type of scanner for use with which the present head is designed are well-known, and accordingly require no detailed description. Accordingly, there are illustrated merely the mounting and general orientation in the simple showing of FIGURE 1. As there seen, the arm **20** of a radioactivity scanner bears the tapping or printing head **22**, secured by suitable mounting means **24**. A foot **26** at the bottom of the head bears down upon a suitable sheet of paper **28**. This rests upon a platen or surface lining **30** of rubber or other suitable backing material, supported by a table or housing **32**.

A tapper **34** impresses the marks constituting the "picture elements" on the paper by means of a ribbon **36**, such as a typewriter ribbon. The mechanism of the head **22** is of course covered by ornamental and protective covers **37**, details of which are herein omitted.

As seen in the general views of FIGURES 1 and 2, the mechanism is mounted on a housing plate **38**, which is secured by a mounting bracket **40** and associated mounting means (not illustrated in detail) to secure the head to the scanner arm **20**.

On one side of the housing plate **38** is the ribbon system **42**, while the opposite side of the plate **38** bears a motor **44**, employed to drive the ribbon system, and also the assembly **46** which drives the tapper **34**. The pulses which actuate the tapper drive assembly **46** are fed by means of a conventional electrical connector **47**.

The ribbon system is best illustrated in FIGURES 3 through 5 of the drawing. In general terms, it consists of a ribbon feed **48** bearing the unused portion **36***a* of the ribbon **36**, a ribbon take-up **50**, bearing the used portion **36***b*, a series of rollers **52**, **54**, **56** and **58** guiding the ribbon past the tapper **34**. The ribbon is driven by a drive wheel **60** with a suitable back-up or pressure roller **62**. The ribbon, it is important to note, should be of the type employing an impermeable base, such as Mylar, the properties of which are not merely desirable because of factors of convenience as compare with ink-impregnated textiles, etc., as in the case of use on typewriters and similar machines, but in the present case are a practical requirement for satisfactory operation.

The motor **44** is a constant-speed motor directly coupled to the drive wheel **60**, a speed of one foot per minute being a typical value, and providing approximately fifteen hours of operation with ribbons of types commercially sold for use with typewriters. Although the ribbon speed is not highly critical, its selection, it will be observed, is not merely arbitrary. This speed should be sufficiently fast so that with the given shape of the mark made by the tapper, and with the maximum repetition rates of which the tapper is capable, there will be no overlapping of the portions of the ribbon used in alternate successive strokes, i.e., no point on the ribbon can be struck more than twice. It must be noted that the objection to such overlapping, and consequent weakening of individual characters, is not merely the more-or-less aesthetic one which exists in the case of the dimming of characters on a typewriter, for example. In the present case, the effect of permitting such overlap is to limit the span of tone value which the "picture" is capable of showing with true proportionality between visual density and radioactivity. It is necessary to remember that at high mark concentrations, the visual impression in reading the "picture" is not inspection of the spacing, but a mere impression of shades of darkness. As will hereafter be seen, the necessary ribbon speed may be much slower than the scanning speed, and strokes overlapping on the ribbon may nevertheless make completely separate impressions on the paper. The ribbon speed may, it is found, permit striking of the same point twice by partial overlap of successive strikes of the tapper on the ribbon, but ribbon speeds permitting double-overlap (triple striking of the same point) are found to produce appreciably lighter marks at the highest repetition rate.

The matter of speed of operation of the ribbon, and the factors which determine it, are of substantial importance in understanding in full the benefits and advantages of this aspect of the construction of the invention. Obviously, typewriter ribbon such as here employed is substantially more expensive per unit area than, for example, carbon paper, and the use of ribbon by mere substitution for carbon paper in any common manner could well be excessively undesirable in cost. However, the nature of the occurrences or phenomena in a scanner are found to be such that comparison of costs on this basis can be highly misleading. Such a comparison is based on the assumption (largely warranted in the case of typewriters and similar devices) that the required length of ribbon for a one-line scan is essentially the same as the width of the carbon paper used for the same scan, i.e., that the ribbon length must be at least substantially equal to the distance scanned. Actually, this is not true. The required ribbon speed is substantially less than the scan speed, overlap (so long as not excessive) of strikes on the ribbon representing fuller utilization. Thus the actual area of ribbon used will be much less than the area of carbon paper which would be required for the same number of scans. As an example of this, the speed of one foot per minute, found to be desirable with the particular

construction to be described, is employed in a commercial scanner which is enabled to make high-resolution scans at a much greater speed because of the fast response time achieved by the tapper drive to be discussed later.

The ribbon feed **48** and the ribbon take-up **50** are arranged to occupy a minimum of space, and also to simplify the mechanism as regards number and complexity of parts, as compared with constructions previously known. The feed **48** and the takeup **50** are on a common axis and directly adjacent to each other, thus being in different planes. The path of the ribbon from the plane of the feed **48** to that of the takeup **50** is accomplished in the passage between the rollers **56** and **58**. These rollers define the path of the ribbon between the foot **26** which is at the forward end of the housing and the drive wheel **60**, which is in the rearward portion. The foot **26**, like the rollers **52** and **54**, traversed by the ribbon as it leaves the feed, is in the plane of the feed, i.e., the ribbon is fed from the feed **48** to the foot **26** in the same general manner as would be the case were the feed and takeup storage in the same plane. The foot **26** is supported by a bracket **64** having an upwardly extending web **66** which is pivoted on the lower edge of the mounting or housing plate **38** by a pivot **68**. A spring **70** biases the bracket in the direction of lowermost position of the foot **26**. When the position of the head is vertically adjusted properly (by provision in the mounting means **24**, not illustrated), the foot **26** is slightly upward from this outermost position and accordingly is held in firm engagement with the paper by the spring **70**.

To the underside of the bracket **64** is secured a roller support **72**, having the rollers **56** and **58** mounted at the opposite ends thereof. As best seen in FIGURE 5, the support **72** is mounted to produce a small angle (substantially less than ten degrees) in the path of the ribbon, so that the ribbon is brought out to the plane of the takeup without any twisting or similar complexity. This manner of making the transition between the planes is particularly advantageous as regards simplicity of threading on a new ribbon by a user.

The lowermost portion of the foot **26** has a window opening **76**, and the foot is formed with shallow flanges or rims **78** in the region contacting the paper, thus forming a shallow channel **80** through which the Mylar backing readily slides, the outer or carbon surface of the ribbon being out of contact with the underlying paper except when urged by the tapper striking it through the window **76**.

The feed ribbon **36***a* rotates about a hub **82** in the form of a nylon-lined bearing affixed to the plate **38**. The ribbon **36***a* is wound on a core **83** (as supplied by the manufacturer with the ribbon) which is rotationally isolated from the hub **84** of the takeup system. The latter bears a core **85** on which the used portion **36***b* of the ribbon winds. The drive shaft **86** extends through the bearing **82** and the plate **38** and bears, on the opposite side of the plate **38**, a pulley **88**.

An O-ring belt **90** interconnects the pulley **88** with a pulley **92** on the shaft of motor **44**, to which the drive wheel **60** is secured as previously indicated.

An enlarged portion **94** on the shaft **86** serves to mount the hub **84**, and a key-pin **96** engages the hub for rotation. An O-ring **97** on the circumference of the hub **84** provides secure rotational coupling of the hub to the ribbon core **85**.

A flange **98** is secured by cement or other suitable permanent fastening to the end of the hub **84** adjacent to the feed hub, and a cover flange **100** on the opposite end of the hub **84** is secured longitudinally by a pivoted thumb latch **102** on its outer face, this latch snapping into a groove **104** in the outer end portion of the shaft **86** to secure the entire assembly.

The pressure wheel **62** is mounted on a support arm **106**, which is pivoted at **108**, and a spring **110** urges the pressure wheel into secure frictional engagement of the ribbon with the drive wheel **60**. A thumb-operated cam **112** engages the support arm **106** to release the ribbon from the drive when the ribbon is to be changed.

The simplicity and compactness of the tape storage and drive system, and its advantages in operation, may readily be seen. The O-ring belt **90** and the pulleys **88** and **92** are selected to produce slippage at a point far short of the permissible tension on the ribbon. The pulley ratio is selected for normal synchronous operation when winding of a new ribbon on the takeup is first commenced, i.e., proportionally to the diameters of the wheel **60** and the core **85**. As the radius of the takeup portion **36***b* increases, the difference is compensated by the permitted slippage of the drive. The tension of the ribbon in the region between the drive and the takeup is accordingly governed largely by the slippage friction of the belt **90**, which is always less than the breaking tension. The ribbon tension at the more critical region of striking by the tapper is controlled by simple friction. With constant friction, the tension would, of course, vary with winding radius. In the present construction, a friction member **113** is secured to the flange **98**, and a conical spring **111** urges the core **83** into contact with this. The changing speed of the oppositely rotating flange **98** acts to decrease the effective frictional retardation of the feed and thus hold the tension at the struck portion sufficiently constant so that even the downwardly open channel creates no problem.

As will be obvious, replacement of the ribbon is simple. Unlatching and removal of the front flange **100** permits removal of the takeup hub and ribbon, along with the flange **98**, thus permitting removal of the core **83**. The used ribbon, and the core upon which it is wound, may be discarded, a new ribbon and core installed on the feed, and the old core previously used in the feed **48** may now be used in the takeup **50**, the end of the new ribbon being secured thereto. Threading of a new ribbon is greatly simplified by the open channel in the foot and the simple transition between the planes of the spools.

The tapper drive is shown more completely in FIGURES 6 and 8. The external energizing electrical pulses are fed to a solenoid **114** by means of leads indicated at **116**, these, of course, actually being connected to connector **47**. The solenoid **114** is mounted in a U-shaped support bracket **118** having upper ears **120** from which is pivotably supported at **122** a clapper or armature **124**. Lower ears **126** on the bracket **118** are employed for the support of further structure presently to be described. The solenoid is provided with a flux-return shell or yoke **128** and also, of course, with a center core-piece **130**, as is conventional in electromagnets.

A yoke or bracket **132** secured to the lower ears **126** contains an adjustment screw **134** which acts as a limit stop for outward movement of the clapper or armature **124**.

The tapper **34** and its associated mechanism are supported for rotary motion by a support pin **136** extending between the lower ears **126** of the bracket **118**, the tapper assembly being designated **138**, and being described now as to structure and mode of operation.

An actuator yoke **140** consisting of side members **142** and a cross piece **144** is journaled for rotation on the pin **136**. The side members **142** have striker portions **146** at their upper ends, engaging the clapper **124**. The support portion **148** of the tapper **34** has vertical ears journaled about the support pin **136** inwardly of the side members **142** of the actuator. The generally plane horizontal body of the tapper (apertured to minimize weight) has an angular or diagonal portion **150** which extends beneath the housing or mounting plate **38**, so that the stylus portion **152** at the outer end is located directly above the window **76** in the foot. The stylus is formed with a tip approximately six mils wide (in the direction of scan) and one-eighth inch long.

The support portion **148** of the tapper has at the inner end an offset extension **156**, notched at **158** to receive one end of a coiled spring **160**, the opposite end of which is connected to cross-pin **162** extending between the arms **142** of the actuator yoke **140**.

A U-shaped restoring spring **164** has coiled central portions **166** of its arms around the support pin **136**, the outer ends **168** of this U-shaped spring being fixed in an adjusting plate **170** secured by screws **172**. The inner portions **174** of the arms of the spring **164** extend forwardly and the transverse central portion **176** of the U underlies the body of the tapper.

The manner of operation, and the advantages, of the tapper actuating structure, may best be understood by consideration of FIGURE 8. The parts are there shown in a transient or intermediate condition wherein the tapper **34** has been stopped by contact with the ribbon and paper (indicated by the latter only), but the cross-piece **144** of the actuator remains in contact with the tapper **134**. This represents a convenient intermediate condition for illustration of the sequence of operation.

In the absence of an input pulse to the solenoid, the restoring spring **164** holds the assembly in a position counterclockwise of that illustrated, with motion limited by abutment of the clapper **124** against its end-stop **134**. Upon occurrence of a drive pulse, the rotary system is first driven to the position illustrated and then proceeds to the further dotted condition in which the tapper remains in the position illustrated, but the actuator continues to rotate to the dotted position. The end of the path of the actuator is not set by a fixed stop (the clapper should not strike the magnetic shell or flux member **128**), but is determined by equilibrium between the elongation now produced in the spring **160** and the force acting on the clapper.

The portion of the cycle occurring on termination of the input energizing pulse is not merely the reverse of the forward cycle. The force of the spring **160** is at all times greater than that of the restoring spring **164**, so that the acuator **140** and the tapper **34** move as a unit in the downward portion of the cycle, until the position of FIGURE 8 is reached, beyond which the cross-piece **144** departs from the tapper **34** and the tension of the spring **160** is increased. Upon release of the clapper, the powerful spring **160** immediately starts rapid counter-rotation of the actuator. The spring **164** applies lifting force to the tapper, but this is at first opposed by the reaction force exerted on the tapper by the spring **160**. The rotation of the actuator, however, with its powerful spring, accomplishes the return of the entire system to the original position, prepared for a new actuation, long before such equilibrium could be reached by the spring **164** alone.

In effect, this structure constitutes a rotary unit which is biased to the position awaiting actuation by a relatively weak spring, thus providing very little resistance to the initiation of actuation, introducing the strong spring opposing the clapper only after the tapper has struck, and then using this strong spring to accelerate the restoring action, even though it presented no opposition to the original actuation. The speeding of the resolution or response time thus achieved is large.

Obviously, the illustrated embodiment is only one of a large variety that can be designed utilizing one or more of the novel features of the invention. Many other types of embodiments will immediately be obvious, while others will become apparent only after study. Accordingly, the protection to be afforded the invention should not be considered as limited in any manner by the particular embodiment shown, but should extend to all utilization of the teachings of the invention as described in the appended claims, and equivalents thereof.

What is claimed is:

1. A marking head for a radioactivity scanner comprising:

(a) a housing adapted to be mounted for scanning of a recording sheet,

(b) a pivotally mounted tapper having a stylus portion adapted to mark the recording sheet,

(c) an actuator member rotationally mounted on the pivotal axis of the tapper and abutting against the tapper in the direction away from the recording sheet, the actuator member being rotatable relative to the tapper in the direction of actuation after the tapper strikes the sheet,

(d) a first spring connecting the actuator member and the tapper and urging the actuator member and the tapper into such abutment,

(e) a second spring acting between the tapper and the housing and independent of the actuator member urging the tapper away from the sheet with force less than that of the first spring, the tapper thus following rotation of the actuator member toward the recording sheet against the force of the second spring, and

(f) pulse-responsive drive means engaging the actuator member to rotate the actuator member in the downward direction substantially beyond the striking point of the stylus portion of the tapper and thus increase the tension on the first spring,

(g) the second spring thus readily yielding to the drive means for motion of the tapper toward the striking point but being aided by the first spring in accelerating the tapper away from the striking point upon termination of a pulse.

2. The marking head of claim **1** further characterized by:

(h) the motion of the actuator in the direction of actuation being limited by equilibrium between the forces of the first spring and the electromagnet.

3. A marking head for a radioactivity scanner comprising:

(a) a housing adapted to be mounted for scanning of a recording sheet,

(b) a tapper mounted on the housing and having a stylus portion adapted to mark the recording sheet,

(c) an actuator member mounted for motion along a path corresponding to that of the tapper and abutting against the tapper in the direction away from the recording sheet, the actuator member being movable relative to the tapper in the direction of actuation after the tapper strikes the sheet,

(d) a first spring connecting the actuator member and the tapper and urging the actuator member and the tapper into such abutment,

(e) a second spring acting between the tapper and the housing and independent of the actuator member urging the tapper in said direction with force less than that of the first spring, the tapper thus following rotation of the actuator member toward the recording sheet against the force of the second spring, and

(f) pulse-responsive drive means engaging the actuator member to rotate the actuator member in the downward direction substantially beyond the striking point of the stylus portion of the tapper and thus increase the tension on the first spring,

(g) the second spring thus readily yielding to the drive means for motion of the tapper toward the striking point but being aided by the first spring in accelerating the tapper away from the striking point upon termination of a pulse.

4. A marking head for a radioactivity scanner comprising:

(a) a housing adapted to be mounted for scanning of a recording sheet,

(b) a tapper movably mounted on the housing for marking the sheet,

(c) an actuator member having a portion abutting the tapper in the direction to drive the tapper away from

the sheet, the actuator member being movable relative to the tapper in the direction of actuation after the tapper strikes the sheet,

(d) a first spring free of the housing and acting between the tapper and the actuator and holding them in such abutment,

(e) a second spring free of the actuator and acting between the housing and the tapper and holding the tapper away from the sheet, and

(f) pulse-operated means for driving the actuator in the downward direction, the first spring exerting sufficient force to maintain the abutment against the force of the second spring so that the tapper is driven until it is stopped by the sheet, the actuator thereupon continuing its motion and increasing the stress on the first spring, the latter thus aiding the second spring in returning the tapper.

5. A marking head for a radioactivity scanner comprising:

(a) a vertical housing plate adapted to be mounted for horizontal scanning of a paper,

(b) a foot resiliently mounted on the housing plate and adapted for traversal of the paper,

(c) a channel on the bottom of the foot,

(d) a ribbon in the channel having an impervious backing and bearing a recording medium, the foot being apertured,

(e) a feed spool and a takeup spool rotationally mounted on one side of the housing plate on a common axis,

(f) a frictional coupling between the spools,

(g) the ribbon having opposite ends wound on respective spools in the same rotational direction, the directions of rotation of the spools accordingly being opposite,

(h) rollers guiding the ribbon and forming a path therefor from the feed spool to the channel and from the channel to the takeup spool,

(j) a drive wheel rotatable on the housing plate and frictionally engaging the ribbon,

(k) a constant-speed motor on the opposite side of the housing plate rigidly coupled to the drive wheel,

(l) pulleys on the drive wheel and the takeup spool of diameters proportional to the respective diameters thereof,

(m) a pulley belt engaging the pulleys to wind the driven ribbon on the takeup spool and slipping in response to tension on the ribbon,

(n) a tapper having a mounting portion pivotally mounted on the opposite side of the plate and a stylus portion striking the ribbon upon downward pivotal motion of the tapper,

(p) an actuator member rotationally mounted on the pivotal axis of the tapper and upwardly abutting against the tapper,

(q) a first spring connecting the actuator member and the tapper and urging the actuator member and the tapper into such abutment,

(r) a second spring independent of the actuator member urging the tapper upwardly with force less than that of the first spring, the tapper thus following downward rotation of the actuator member against the force of the second spring, and

(s) pulse-responsive drive means engaging the actuator member to rotate the actuator member in the downward direction substantially beyond the point of striking of the ribbon by the stylus portion of the tapper and thus increase the tension on the first spring,

(t) the second spring thus readily yielding to the drive means for downward motion of the tapper but being aided by the connecting spring in accelerating the tapper upward upon termination of a pulse,

(u) the ribbon moving over the foot at a speed producing single overlap, but free of double overlap, of successive strikings of the ribbon by the tapper at its fastest repetitive speed.

6. A marking head for a radioactivity scanner comprising:

(a) a housing adapted to be mounted for scanning of a paper,

(b) a ribbon guide mounted on the housing adapted for closely adjacent traversal of the paper,

(c) a ribbon in the guide,

(d) a feed spool and a takeup spool rotationally mounted on the housing,

(e) a direct frictional engagement between the spools,

(f) the directions of rotation of the spools being opposite so that the frictional engagement retards the feed,

(g) means for continuously pulling the ribbon from the feed spool and driving it over a path including the ribbon guide to the takeup spool,

(h) the frictional engagement between the spools decreasing the frictional retarding of the feed spool to reduce the variation of ribbon tension with unwinding of the feed ribbon, and

(j) a pulse-responsive tapper mounted on the housing and striking the ribbon to mark the paper.

7. A marking head for a radioactivity scanner comprising:

(a) a housing adapted to be mounted for scanning of a paper,

(b) a ribbon guide mounted on the housing for traversal of the paper,

(c) a marking ribbon on the guide having its ends rolled on feed and takeup spools on the housing,

(d) a pulse-responsive tapper striking the ribbon to record each mark,

(e) means for pulling the ribbon through the guide at substantially constant speed, and

(f) means for decreasing frictional retardation of the feed spool as the winding radius decreases to hold the tension of the struck portion of the ribbon relatively constant.

8. The head of claim 7 wherein the guide comprises a recessed outwardly open channel through which the ribbon passes.

9. A marking head for a radioactivity scanner comprising:

(a) a housing adapted to be mounted for scanning of a paper,

(b) a ribbon guide mounted on the housing for traversal of the paper,

(c) a marking ribbon on the guide having its ends rolled on feed and takeup spools, said spools being mounted closely adjacent and in frictional engagement, and the direction of rotation being opposite at the point of friction,

(d) a pulse-responsive tapper striking the ribbon to record each mark, and

(e) means for pulling the ribbon through the guide at substantially constant speed, the speed of the takeup spool being changed as the winding radius increases,

(f) said change in rotational speed of the takeup spool decreasing the frictional retardation of the feed spool as the winding radius of the feed spool decreases, whereby the tension of the struck portion of the ribbon is held relatively constant.

10. The head of claim 9 wherein the spools are side-by-side on a common axis.

11. A marking head for a radioactivity scanner comprising:

(a) a housing adapted to be mounted for scanning of a paper,

(b) a feed spool and a takeup spool rotatioanlly mounted in adjacent planes on a common axis on said housing, the feed spool supplying ribbon to the takeup spool,

(c) a stylus-receiving foot at one end of the housing guiding the ribbon in the plane of one of the spools,

(d) rollers disposed at a small angle adjacent said one end of the housing and adjacent the opposite end to guide the ribbon between the planes of the respective spools, and

(e) an elongated tapper having a stylus portion in the region of the foot and a support position substantially spaced from said end.

12. A spool-feed system for radioactivity scanners and analogous uses comprising:

(a) a feed spool and a takeup spool adapted to hold a rolled medium,

(b) means for defining a path of the rolled medium between the spools, said path including a utilization portion,

(c) means for pulling the medium from the feed spool past the utilization portions of the path, and

(d) variable friction means applied to the feed spool decreasing its frictional load with unrolling of the medium to compensate for the decreasing winding radius and maintain the tension relatively constant at the utilization portion.

13. The system of claim **12** wherein the variable friction means comprises a frictional sliding contact between the spools, the spools moving in opposite direction at the point of the sliding contact.

14. The system of claim **13** wherein the spools are side-by-side on the same axis.

15. A marking head for radioactivity scanners and analogous uses comprising:

(a) a tapper member movably mounted to a fixed structure for the making of marks on a record sheet,

(b) first resiliently yielding means acting between the tapper and said fixed structure holding the tapper away from the sheet,

(c) an actuator member movably mounted to said fixed structure for motion corresponding to that of the tapper member and being movable relative thereto in the direction of actuation after the tapper strikes the sheet,

(d) abutment means limiting motion of the actuator member relative to the tapper member in the direction away from the sheet,

(e) means for driving the actuator member, and

(f) second resiliently yielding means, of greater restoring force than the first, acting between the actuator member and the tapper member and holding the members in substantially fixed relation until the tapper member strikes the record sheet, the actuator member thereupon continuing its motion in response to the driving means to stress the second resiliently yielding means,

(g) said actuator member applying a force to the tapper member in the direction away from the sheet upon release of said driving means,

whereby said members are driven toward the record sheet against the force of only the first resiliently yielding means, but are moved away from the record sheet by the restoring force of the first and second resiliently yielding means.

16. A marking head for radioactivity scanner comprising:

(a) a housing adapted to be mounted for scanning of a paper,

(b) a foot mounted on the housing and adapted for traversal of the paper,

(c) a channel on the surface of the foot adjacent to the paper,

(d) a ribbon in the channel having an impervious backing and bearing a recording medium, the foot being apertured,

(e) a feed spool and a takeup spool rotationally mounted on the housing on a common axis,

(f) a frictional coupling between the spools,

(g) the ribbon having opposite ends wound on respective spools in the same rotational direction, the directions of rotation of the spools accordingly being opposite,

(h) rollers guiding the ribbon and forming a path therefor from the feed spool to the channel and from the channel to the takeup spool,

(j) a drive wheel rotatable on the housing plate and frictionally engaging the ribbon,

(k) a constant-speed motor rigidly coupled to the drive wheel,

(l) pulleys on the drive wheel and the takeup spool of diameters proportional to the respective diameters of said wheel and spool,

(m) a pulley belt engaging the pulleys to wind the driven ribbon on the takeup spool and slipping in response to tension on the ribbon, and

(n) a tapper having a stylus portion striking the ribbon through the aperture,

(o) the ribbon moving over the foot at a speed producing single overlap, but free of double overlap, of successive strikings of the ribbon by the tapper at its fastest repetitive speed.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,293,654 December 20, 1966

Donald C. Hausser

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 31, for "had" read -- made --; line 48, for "with "-tones"" read -- with "tones" --; column 2, line 29, for "it" read -- is --; column 3, line 5, for "ofthe" read -- of the --; column 7, line 19, for "134" read -- 34 --; column 11, line 18, for "portions" read -- portion --.

Signed and sealed this 12th day of September 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents