# United States Patent [19]

**Loucheur et al.**

[11] **3,710,106**

[45] **Jan. 9, 1973**


[54] **X-RAY FILM HANDLING APPARATUS**


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[73] Assignee: **Compagnie Generale de Radiologie,** Paris, France



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July 31, 1970 France.....7028428

[52] **U.S. Cl.**.....**250/66,** 250/62, 250/65 R, 250/67, 250/105

[51] **Int. Cl.**.....**G03b 41/16**

[58] **Field of Search**.....250/62, 65 R, 66, 67, 105



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*Primary Examiner*—William F. Lindquist
*Attorney*—Cushman, Darby & Cushman



[57] **ABSTRACT**

An X-ray apparatus for use with spool-mounted film enabling different film formats and different exposure patterns to be selected and comprising : a film supply section with a motor-driven feed roller and a film cutter assembly ; a film transfer section comprising two pairs motor-driven of belts located on a frame-shaped carriage mounted on rails for lateral displacements ; and a section for marking and storing the exposed film.


**8 Claims, 9 Drawing Figures**

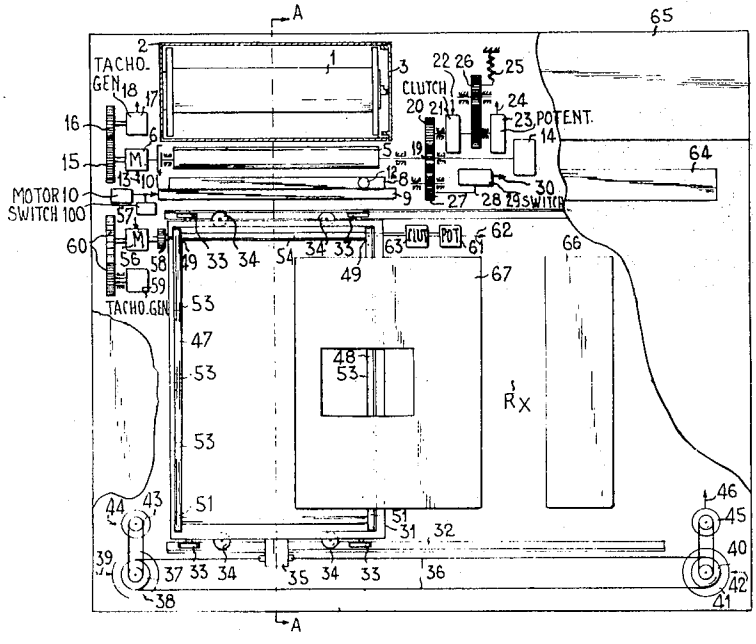
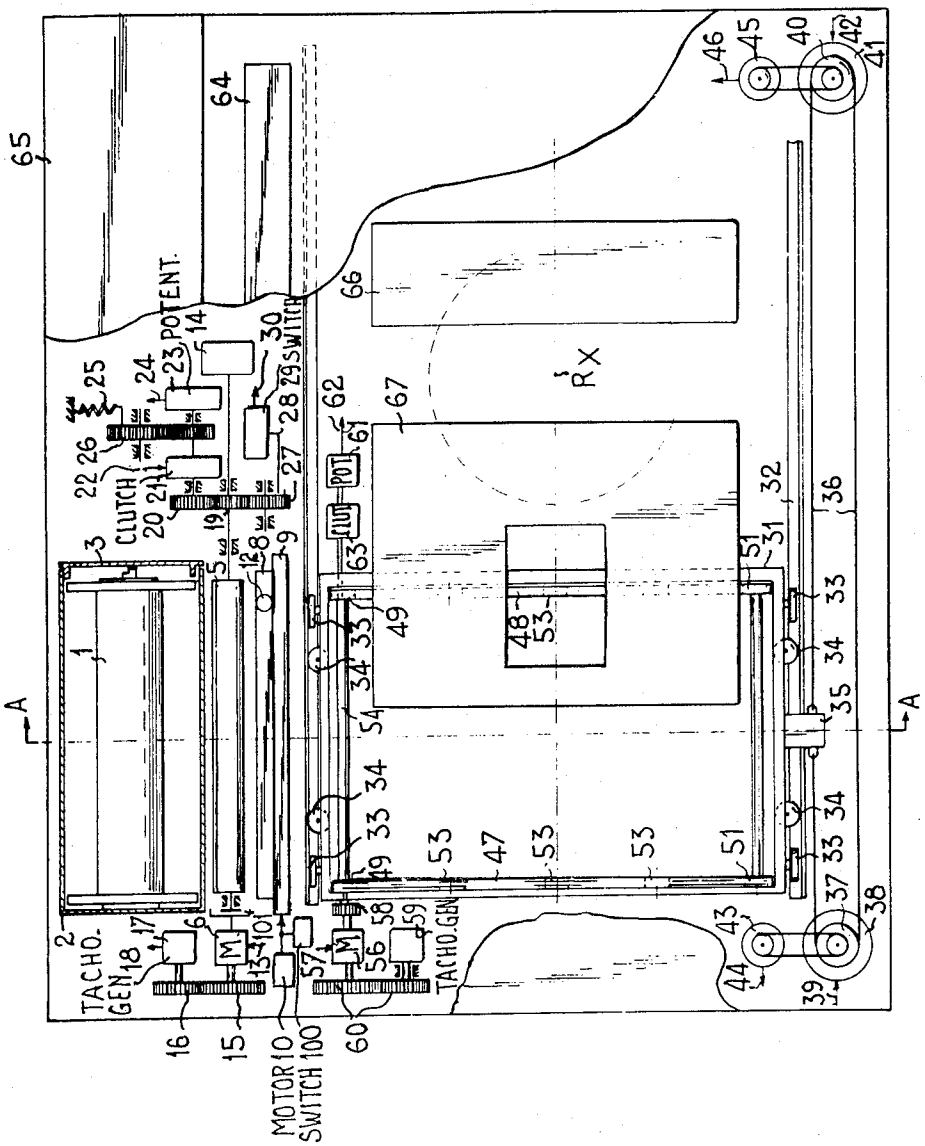


FIG. 1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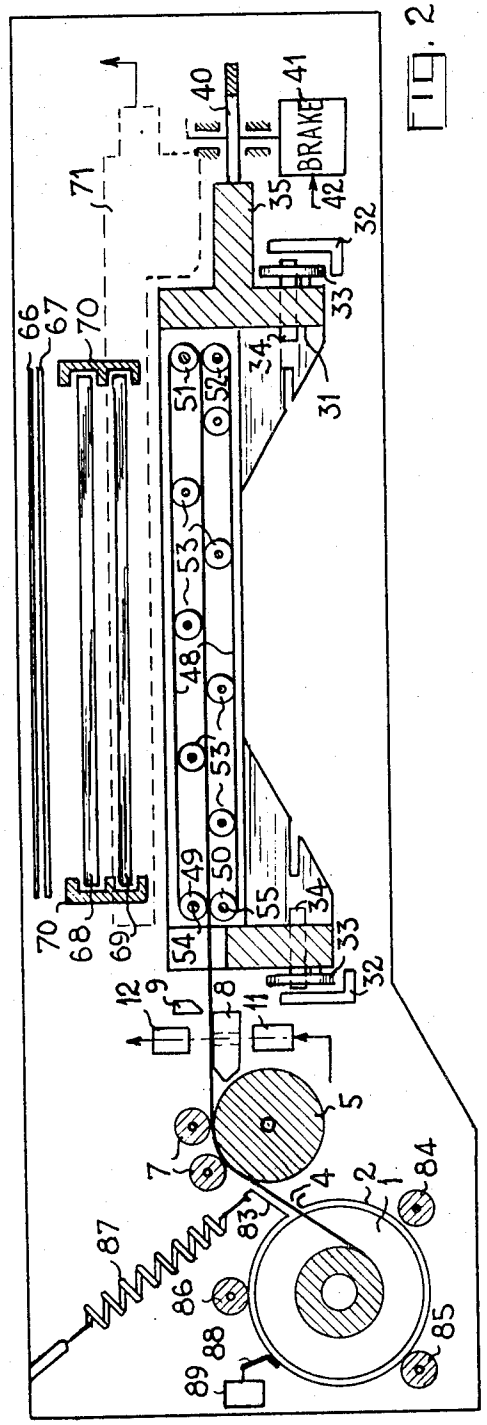


FIG. 2

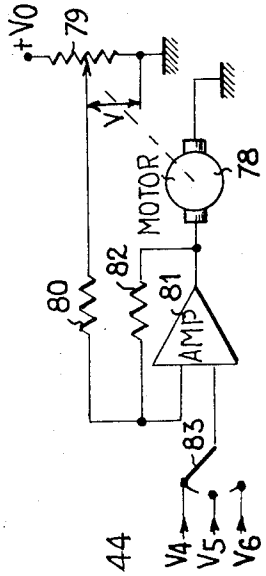


FIG. 4

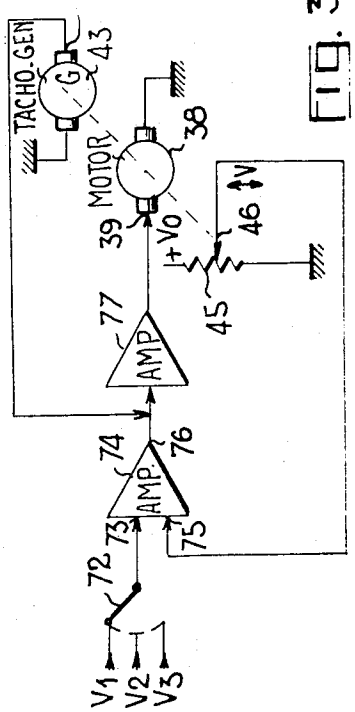


FIG. 3

FIG-5

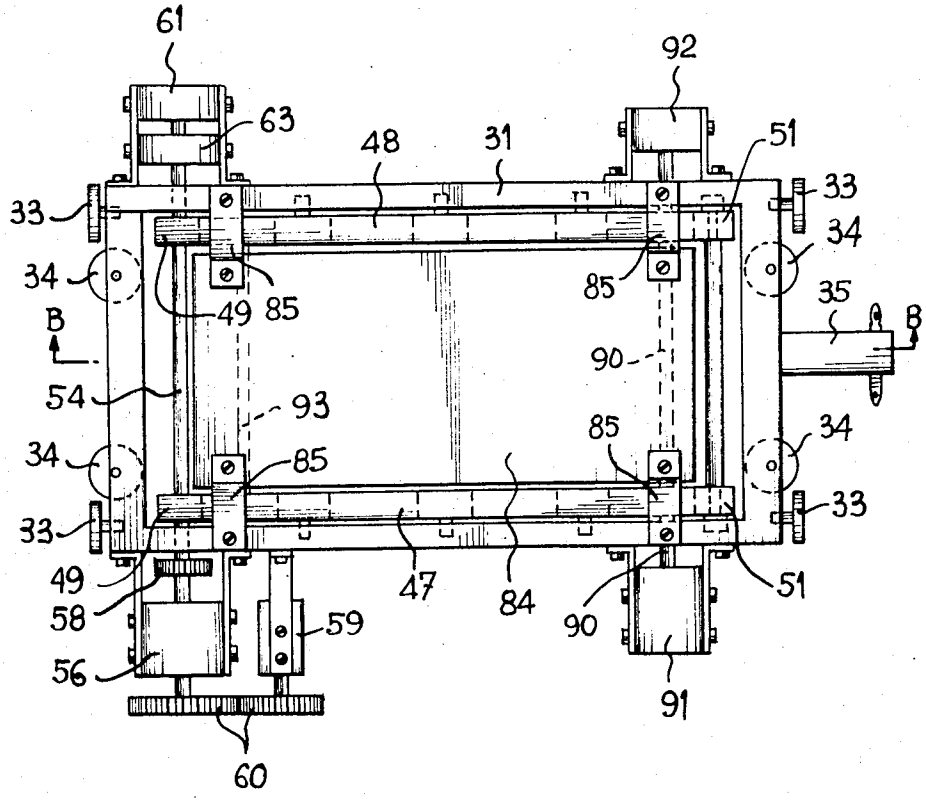
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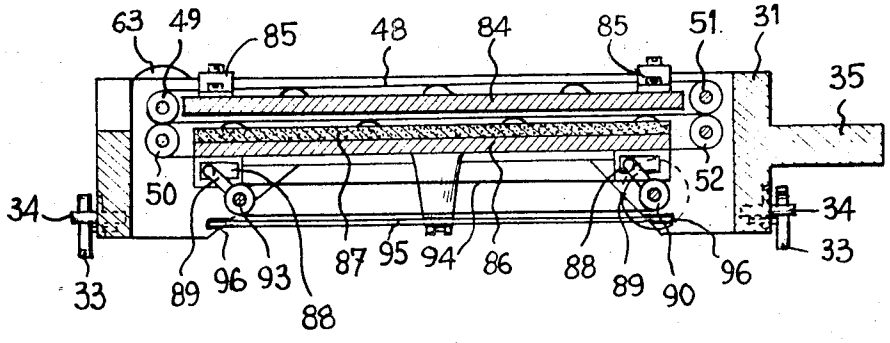
FIG-6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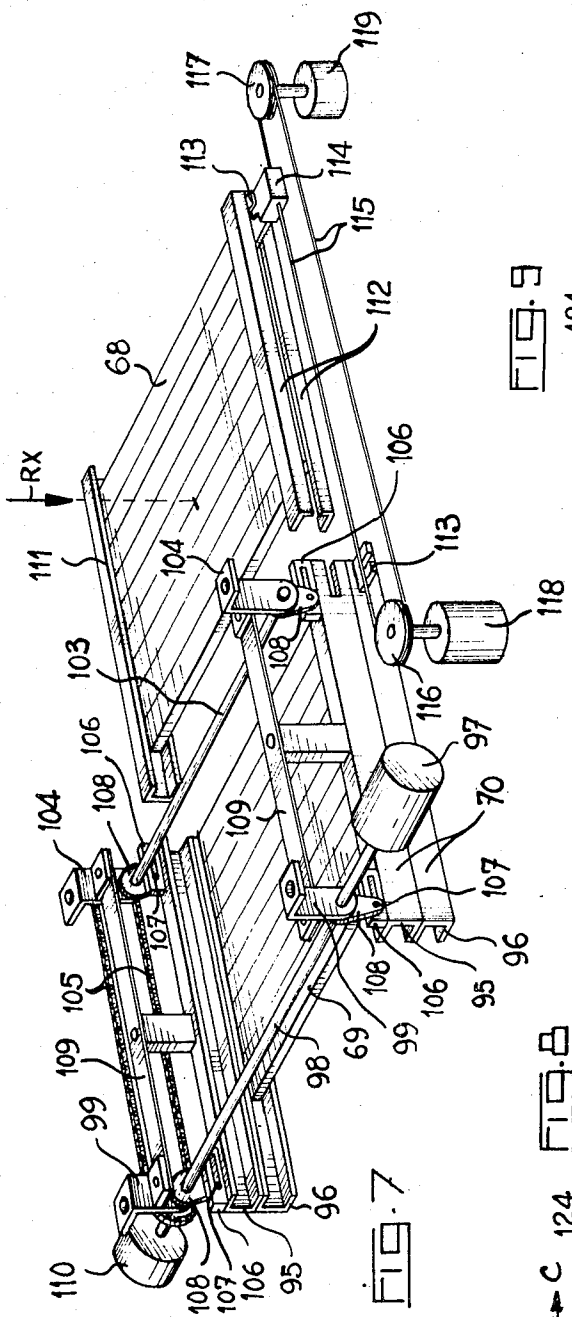


FIG. 7

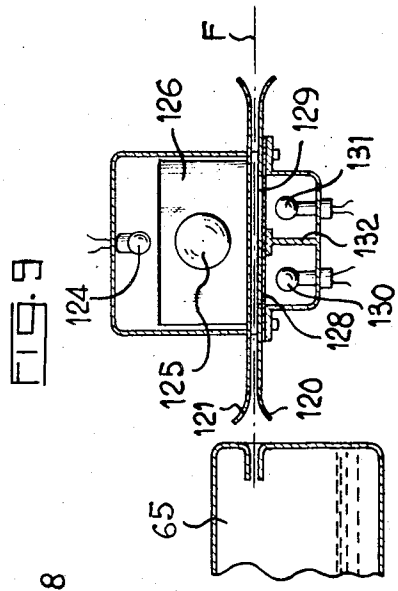


FIG. 9

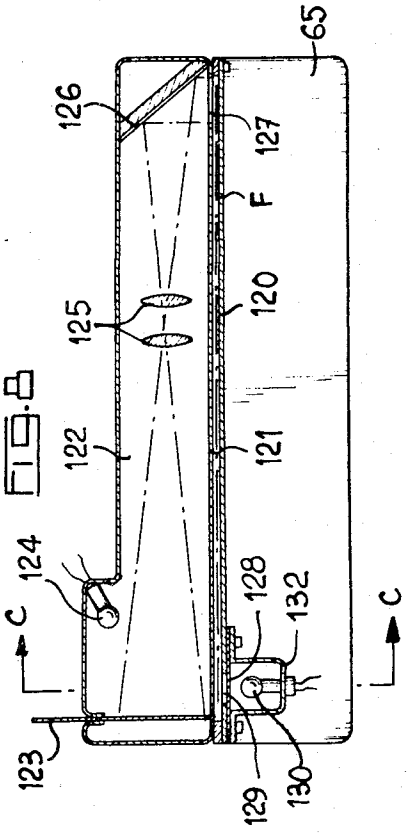


FIG. 8

# X-RAY FILM HANDLING APPARATUS

The present invention relates to X-ray diagnostic apparatus which make it possible, on the one hand, to choose the negative format and/or the number and format of the X-ray photographs, taken in each negative, and on the other hand, to introduce radisocopic X-ray examinations between the radiography sequences or between each X-ray photograph, if required, and relates more particularly to apparatus which utilize film supplies stored on spools.

In known devices of this type, described for example in German Patent No. **1,193,799** filed on July 20, 1961, the film is unreeled and transferred longitudinally using rollers, whilst its transfer from the parked position (outside the exposure field) to the exposure position is effected by lateral translation of an assembly comprising the film spool, a guillotine or film cutter and the magazine which stores the exposed negatives. The guillotine enables the film to be cut to the desired length and shutters are provided to make it possible to take up to three photographs in each format. The choice of format is generally effected using positional contacts. The mechanization of the transfer devices and their electrical control in accordance with a predetermined program, as well as the design of a light-proof system would appear to be difficult and complex.

The device in accordance with the invention enables these drawbacks to be overcome. Here it is possible to utilize an electronic control device by means of which to carry out a plurality of pre-programmed operations, each of the transfer movements of the film, of the shutter or shutters and/of the mask, as well as the choice of the format, being controlled in position and speed by means of an electrically controlled device.

In accordance with the invention there is provided an X-ray diagnostic apparatus for bare films including an X-ray source for irradiating an exposure field, a housing and whithin said housing, a film supply section for feeding out said film in form of sheets one by one, a film transfer section for receiving, in a parked position located outside of said exposure field, said film from said supply section and for transferring it from said parked position to an exposure position within said exposure field and therefrom to an ejection position, and a storage section for receiving said film said transfer section in said ejection position and for light-tightly storing a plurality of exposed films, wherein said transfer section comprises :

A pair of parallel rails mounted in said housing ;

a carriage having the shape of a rectangular frame and a width greater than that of said film sheets and mounted for displacement on said rails ;

a first electric motor having a shaft mechanically coupled to said carriage for driving it along said rails and an input ;

first means having a rotor for generating an electrical signal corresponding to the angular position thereof, said rotor being mechanically coupled to the shaft of said first motor, said first generating means having an output for delivering a signal corresponding to the position of asaid carriage on said rails;

first means for controlling said first motor having an input electrically coupled to said first means output and an output electrically coupled to said first motor input ;



a first and a second pair of superimposed shafts parallel to said rails traversing said frame-shaped carriage and disposed respectively at its opposite ends, each of said shafts having two rollers respectively located inside the frame at a distance corresponding substantially to the width of the film sheets, said rollers of said first shaft pair being respectively integral with said shafts ;

a pair of gears mutually mechanically coupling said two shafts of said first pair for driving them in opposite directions ;

two pairs of contiguous flat belts respectively stretched between the rollers of said first and said second shaft pairs for transferring said film sheets perpendicularly to said rails ;

a second electric motor having a shaft mechanically coupled to one of said shafts of said first pair, a stator fixed to said carriage frame and an input ;

second means having a rotor for generating an electrical signal corresponding to the angular position thereof, said rotor being mechanically coupled to the shaft of said second motor by means of an electrically controlled clutch, said second generating means having an output ; and

second means for controlling said second motor having an input coupled to the output of said second generating means and an output coupled to the input of said second motor.

In a variant embodiment in which the X-ray apparatus according to the invention comprises a column for variable local length, it is also fitted with a plurality of antidiffusion screens adapted to the various focal lengths. These screens are normally in their parked position (outside the exposure field). One of them can be selected and moved into the path of the X-rays by means of two electric motors.

These and other objects and features of the present invention will become more apparent, from the following description and its accompanying drawings, given by way of illustrative example, wherein :

FIG. **1** schematically illustrates a plan view of an embodiment of an apparatus in accordance with the invention ;

FIG. **2** is a schematic partial cross-sectional view along the line A—A of FIG. **1** ;

FIG. **3** shows a schematic diagram of a control circuit for positioning the film or the film transfer carriage **31**, of FIGS. **1** and **2** ;

FIG. **4** schematically illustrates a circuit for controlling the position of the shutter or shutters or of the mask, of the apparatus shown in FIG. **1** ;

FIGS. **5** and **6** respectively illustrate a plan view and a section along the line B—B, of the film transfer carriage **31** of FIGS. **1** and **2** ;

FIG. **7** provides a perspective view of the device shown in FIG. **2** for selecting the anti-diffusion screens **68** and **69** ; and

FIGS. **8** and **9** schematically illustrate two perpendicular sections through the marking device **64** of FIG. **1**.

The apparatus which forms the object of the present invention and is illustrated in FIGS. **1** and **2**, comprises three main sections housed in a light-tight housing :

a loading or film supply section wherein the spool-mounted film can be fed out and cut in lengths to the desired format ;

a transfer section enabling the film, after it has been cut to format, to be transported from the parked position in which it is outside the exposure field into the exposure position and, subsequently, into the marking and ejection positions;

a section for storing the exposed negatives, comprising a magazine preceded by a marking device.

In FIGS. 1 and 2, the reference 1 indicates the spool carrying the roll of film inserted in a cylindrical cassette 2 closed off by a cover 3. The cassette 2 contains a slot 4 through which film passes through a feed roller 5 driven by a first motor 6, the feed roller 5 being rotatably mounted in bearings fixed to the housing. Two small-diameter rollers 7 are applied against the feed roller 5 in order to direct the film towards the transfer section.

It should be noted that the shaft of the first motor 6 can be connected to that of the feed roller 5 through an idle wheel 101, enabling the film to be simultaneously driven by another motor, located for example in the transfer section.

The film supply or loading section comprises, other than the elements enumerated hereinbefore, a film cutter or guillotine including a fixed blade 8 and a moving blade 9, the latter being driven by a second motor 10, and a device which indicates the presence of the film at the guillotine 8, 9, said device being composed for example of an infra-red source 11 and an infra-red radiation detector 12, located at either side of the film.

The expression "motor" should be understood here in the widest possible sense of the word, that is to say a motion generating mechanism. It may, for example, be constituted by a pair of electromagnets, by an electric motor fitted with an eccentric, or any other electrically controlled mechanism which will bring about the vertical displacement of the moving blade 9.

The moving blade 9 or the motor 10, is coupled to at least one contact breaker 100 which indicates, on the one hand, the open or up position of the blade 9 and, on the other hand, the fact that the film has been cut.

The transfer of the film from the cassette 2 to the guillotine at the start of each new roll, is effected by means of the first motor 6 whose input 13 is supplied with a direct voltage and which is braked, for example, by friction using an electromagnetic torque-limiter 14 one of whose shafts is coupled to the shaft of the motor 6, and whose other shaft is maintained fixed in relation to the frame or chassis of the selector. The shaft of the first motor 6, is, on the other hand, coupled through gears 15 and 16 to the shaft of a first tachogenerator 17 whose output 18 supplies a voltage of predetermined polarity, the value of which is proportional to the speed of rotation of its rotor and consequently likewise to that of the motor 6.

The shaft of the first motor 6 is also coupled by gears 19 and 20 and through a clutch 21 electrically controlled through its input 22, to a first potentiometer 23. The cursor or sliding contact 24 of the potentiometer 23 furnishes a voltage proportional to the length of film fed to the transfer section, with each loading operation, which voltage is used to control the first motor 6 in a manner described hereinafter. At the end of each loading operation, the clutch 22 is operated in order to uncouple the spindle of the potentiometer 23, the latter being returned to its initial (reference position by means of a spring 25 known as the zeroing spring, which is connected to said spindle for example through gears 26.

The potentiometer 23 could, of course, be replaced by a digital coder. In this case, control would involve the use of a least one analogue-to-digital converter.

The loading section likewise comprises a device for counting the film unreeled from the spool, which device is coupled to the shaft of the first motor, for example through a gear provided with a dog 28 which operates a contact breaker 29 with each revolution of the gear 27. Said contact breaker 29 produces at its output 30 pulses each of which corresponds to a constant length of film. The read-out of the total film fed out can likewise be effected using luminous numerical display arrangements electronically controlled by another single-revolution coding disc (without any dog) coupled to the shaft of the roller 5 by means of an appropriate reduction gear.

The transfer section comprises a carriage 31 placed on a pair of parallel rails 32 by means of two sets of rollers 33 and 34 which are perpendicular to one another, located at either side on the shorter sides of the carriage, thus enabling transverse displacements of the film. In order to carry out such displacements, the carriage 31 has a boss 35 to either side of which there are attached the two ends of an endless belt, cable or chain 36, extending around a first pulley or gear 37, whose spindle is coupled to the shaft of a third motor 38 (the armature of the latter being supplied with a voltage applied to the input 39), and a second pulley or gear 40 whose spindle is coupled to the shaft of a no-current electromagnetic brake 41 controlled by its input 42. These two pulleys or gears 37 and 40 are respectively located near the two opposite corners of one of the longer sides of the rectangular frame of the apparatus thus enabling the carriage 31 to carry out substantial displacements.

In order to enable control of the speed and position of the third motor 38 to be carried out, the shaft of this motor is coupled directly (through gears, chains or belts) or indirectly, (through the shaft of the brake 41), to the shaft of a second tachogenerator 43 and to the spindle of a second potentiometer (or coder) 45, whose respective functions, already well known per se, will be explained hereinafter.

The carriage 31 takes the form of a rectangular frame carrying inside with two pairs of contiguous flat belts 47 and 48 respectively located along the longer sides thereof these belts being responsible for the longitudinal transport of the film.

The belts of each of the two pairs 47 and 48, being respectively carried by four pairs or rollers 49 to 52 and supported by carrier rollers 53 disposed in an alternating arrangement are applied against one another so that they trap the film between them in order to displace it. The two first pairs of rollers 49 and 50 are attached respectively to two shafts 54 and 55. The shafts 54 and 55 are driven in opposite directions by means of a fourth motor 56, the inversion of the direction of rotation of the shaft 55 being effected by means of a pair of gears 58.

The shaft (rotor), of the fourth motor 56, whose armature is supplied through the input 57, is coupled on the one hand to a third tachogenerator 59 (through gears 60), and on the other hand, to a third poten-

tiometer (or coder) **61** through an electromagnetic clutch **63**.

The two other pairs of rollers **51** and **52** as well as the supporting rollers **53** can rotate freely about their respective spindles.

The thirs section of the apparatus comprises a marking device **64** enabling the exposed negative to be identified, which will be described hereinafter (see FIGS. **8** and **9**), and a magazine **65** for storing the exposed, marked negatives. The marking device will preferably be associated with a safety device which prevents ejection of the film into the magazine **65** if marking has not been carried out and if the negative has been exposed in the absence of a card carrying data requiring to be transcribed onto the film.

The apparatus in accordance with the invention furthermore comprises a shutter **66** (or a pair of shutters) and a single or multiple lead mask **67** (or one made of any other X-ray opaque material), in order to enable individual photographs to be framed both in the longitudinal and transverse directions of the film. The drive and positional control thereof are effected, for example, by means of a motor, a potentiometer and a no-current brake (not shown in FIGS. **1** and **2**), utilizing a circuit of the kind described hereinafter and illustrated in FIG. **4**.

Also provided are several anti-diffusion screens or gratings **68** and **69**, located in slides **70** and each corresponding to a predetermined range of focal lengths (that is to say the distance between the focus of the X-ray tube and the center of the X-ray picture in the film plane). The device for selecting the screen as a function of the focal length used, will be described hereinafter (see FIG. **7**).

THe apparatus is also equipped with a conventional exposure timer **71** (FIG. **2**), which controls the energizing of the X-ray tube as a function of the total energy received by the film.

In order to control the X-ray diagnostic apparatus, to select a predetermined program, and to control and synchronize the various operations involved, a control console and a circuit cabinet are provided, which respectively comprise the various control elements (push buttons contact breakers, switches) and monitoring arrangements (pilot lamps, measuring instruments), and the electronic control and safety circuits etc., these generally in the conventional form of analogue circuits (control functions) and logic circuits (safety circuits, and eventual data processing circuits).

FIG. **3** illustrates a motor-control circuit using a tachogenerator, which can be employed in the loading and transfer sections, for example for the displacement of the carriage **31**.

As already explained, the shaft of the motor **38** is coupled to the shaft of the tachogenerator **43** and to the spindle of the potentiometer **45**, the latter being supplied with direct voltage plus $V_o$, and its thus-controlled cursor **46** producing a voltage V which is proportional to position of the carriage **31**. If, for example, by means of a switch **72**, a set point value is supplied to it in the form of a voltage $V_1$ ( $V_2$ or $V_3$) corresponding to a predetermined position of the carriage **31**, the said voltage $V_1$ is supplied to one of the inputs **73** of the differential amplifier **74** whose other input **75** is supplied with the voltage V appearing at the cursor **46** of the potentiometer **45**. The differential amplifier **74** produces at its output **76** an error signal voltage proportional to the difference between $V_1$ and V, that is to say to the distance between the theoretical and actual positions of the carriage **31**. This voltage is amplified in a power amplifier **77** and applied to the input **39** which supplies the armature of the motor **38**. Because of the fact that at the instant of establishment of the set point value $V_1$, the discrepancy between $V_1$ and V is maximum, the speed of rotation of the motor **38** may become very high and the set point position may not be reached until after a certain number of hunting oscillations, unless precautions to avoid this are taken. In order to prevent this happening, the shaft of the motor **38** is coupled to a tachogenerator **43** producing at its output **44** a voltage which is proportional to the speed of rotation of its rotor. This voltage is supplied with opposite polarity to that of the error signal, to the input of the amplifier **77** for example. The feedback thus produced will have the effect of controlling the maximum speed of the motor whilst retaining a high system gain at low speeds and effecting positional control under conditions of such high gain, that is to say with high accuracy.

In another application, where the required precision is not so high, for example where the positioning of the shutter **66** or the mask **67** is concerned, the motor control circuit is of the kind shown in FIG. **4**.

In FIG. **4**, **78** represents the motor responsible for driving the mask **67** or the shutter **66**. The shaft of the motor **78** is coupled to the spindle of a potentiometer **79** (supplied with a voltage + $V_o$) whose cursor produces a voltage V corresponding to the actual position of the component being displaced. This voltage V supplied across the resistor **80** to one of the inputs of the differential amplifier **81** whose other input is supplied with the set point value in the form of a voltage $V_4$ ($V_5$ or $V_6$) corresponding to the desired theoretical position, across a switch **82** for example. The output of the amplifier **81** produces the error signal which is applied to he armature of the motor **78**. In order to control the speed of the latter, negative feedback is created with the help of a resistor **82** which reduces the amplifier gain approximately in the ratio of the resistances of the resistors **82** and **80**.

In order to start the apparatus shown in FIG. **2**, after having changed the film spool **1**, the cassette **2** is provided with a lip **83** and is assembled in bearing rollers **84**, **85** and **86** in order to be able to rotate about its own axis. The cassette **2** is normally held in position by means of a spring **87** and a stop (not shown in FIG. **2**), and is provided with a dog **88** which actuates a contact breaker **89** when the cassette is pivoted in the clockwise direction (see FIG. **2**). This pivoting movement can be produced manually or by means of a motor (or electromagnet), this function not being shown in FIG. **2**.

The operation of the apparatus in accordance with the invention, and shown in FIGS. **1** and **2**, is as follows : after inserting a full spool **1** into the cassette **2**, the leader of the film is bent to pass through the slot **4**. By pivoting the cassette **2**, the lip **83** applies the film leader against the feed roller **5** and the dog **88** operates the contact breaker **89**, the latter in turn producing rotation of the first motor **6** by applying a direct voltage to

the input 13 thereof. The feed roller 5 picks up the film leader and drives it with the help of the pressure rollers 7, towards the cutter 8, 9. In this phase, the clutch 21 is disengaged. When the film arrives at the level of the cutter and interrupts the infrared beam emitted by the source 11, the detector 12 produces a control signal at its output, halting the motor 6 and possibly also the motor responsible for pivoting the lip 83, and initiates the automatic operations sequence.

As soon as a certain film format has been set up on the control console, the clutch 21 is actuated, and the first and fourth motors — 6 and 56 — are started by means of two control circuits as shown in FIG. 4, this by applying to the inputs of the two differential amplifiers on the one hand the set point value set up on the control console, in the form of an analogue voltage, and on the other hand, the voltage picked up from the cursor 24 of the potentiometer 23, the spindle of which latter is coupled to the spindle of the feed roller 5.

When the voltage produced by the cursor 24 of the potentiometer 23 is substantially equal to the established set point voltage, the first and fourth motors 6 and 56, are halted, the moving blade 9 of the cutter is then operated by the second motor 10 and, the clutch 22 being disengaged, the potentiometer 23 is reset to zero by the spring 25.

Film-cutting having been carried out and recorded by means of a signal produced by the contact breaker 100, the clutch 63 is engaged, the control circuit is established between the fourth motor 56, the tachogenerator 59 and the third potentiometer 61 and the set point value set up on the control console in the form of an analogue voltage is applied to one of the inputs of the differential amplifier. This set point value is determined on the one hand by the choice of film format, this already having been set up in order to control guillotining, and, on the other hand, by the choice of breakdown of the selected format into individual photographs (for example, into four adjacent rectangular blocks).

If it is chosen to produce negatives without subdividing them into individual photographs or if the subdivision is confined to production of a certain number of strips, obtainable by the lateral displacement of the carriage 31, the set point value supplied to the fourth motor 56 will correspond to the position in which the film is centered in relation to the carriage.

If the exposure of the negative is to be effected in the form of adjacent square blocks (pattern of four squares within a square) using the opening formed in the mask 67, the first set point value supplied to the transfer device will be designed to bring the film into a position where one of the ends of the film is in line with one of the edges of said opening.

The following set point values for these framing arrangements, will be explained hereinafter.

The transfer of the film to the exposure position is effected after the stopping of the fourth motor 56, the film being for example in the position in hich it is centered over the carriage 31. This transfer is effected by means of the third motor 38 and the position and speed control circuit comprising the potentiometer 45 and the tachogenerator 43. For a simple format (without any sub-division into separate photographic frames), the first set point value consists in aligning the center of the film with the center $R_X$ of the X-ray field. After exposure of the negative, the carriage is brought into the position in which the exposed film is ejected. In this position, the film is first of all fed into the marking device 64 by means of the belts 47 and 48.

The marking device 64 makes it possible to record upon those parts of the film which have been masked off during exposure, by the belts 47, 48 data which will enable the negative to be identified. The marking operation once effected, the exposed and marked negative is ejected into the storage magazine 65. The apparatus in accordance with the invention comprises, for example, a safety interlock circuit which prevents ejection of the film prior to proper marking. The marking device 64 will be described hereinafter in more detail.

FIGS. 5 and 6 respectively illustrate a plan view and a section on the axis BB, of the carriage 31 of FIGS. 1 and 2, these views illustrating details which are not shown in said Figures.

In these Figures, the carriage 31 also comprises a first rectangular plate 84 made of a homogeneous X-ray transparent material, to the bottom face of which there is attached a fixed image-intensifying screen referred to as the top screen. The plate 84 is attached to the carriage by fixing lugs 85 for example. Another image-intensifying screen, known as the bottom screen, has to be brought into contact with the film and this screen is stuck to the top face of a supple lining of flexible layer 87 attached to a second rectangular plate 86 referred to as the bottom plate. Said bottom plate 86, which is cylindrically curved, is made of a light metal exhibiting low X-ray absorption (aluminum or some other light weight alloy for example), its bottom face being flat and uniform over a band covering the area of the screen of an image intensifier which can be mounted beneath the carriage, said arrangement being designed to enable short-duration radioscopic examinations during the radiography. The bottom plate 86 is vertically movable (that is to say in relation to the top plate 84) by means of two pairs of eccentrics 89 fixed respectively to two shafts 90 and 93 driven by a fifth motor 91, one of the shafts 93 being coupled to the other by at least one endless chain or belt 94. Said eccentrics 89 engage four bearings 88 fixed to the bottom plate 86 and located at the four corners thereof. the bottom plate 86 is maintained in the open (or down) position by two leaf springs 95 located at the two sides parallel to its major axis. The center of each leaf spring 95 is attached to the center of the plate 86, their ends being held in slots 96 formed in the frame of the carriage 31. The clockwise rotation of the eccentrics under the control of the motor 91, lifts the bottom plate 86 and presses the film against the top plate 84. The cylindrical curvature of the bottom plate 86 has the effect of preventing any air from being trapped between the film and the image intensifier screens. One of the shafts 90 and 93 carrying the eccentrics 89, is coupled to an electromagnetic brake 92 which is controlled in order to maintain the bottom plate 86 in its up position, this likewise being indicated by a signal coming from a monitoring device either in the form of a potentiometer or a contact-breaker (not shown in FIGS. 5 and 6), which is operated by the movement of the shafts 90, 93 or of the bottom plate 86.

As soon as the selected format has been positioned by the transfer belts **47, 48**, the motor **91** is operated in order to move the bottom image-intensifier screen towards the top screen, thus trapping the film between them. When the two screens are pressed into contact with the film, the signal produced by the monitoring device on the one hand locks the brake **92** and stops the motor **91**, and on the other hand supplies a piece of logic information to the safety interlock circuits, enabling the carriage to transfer into the exposure position, whereupon the X-ray tube supply is switched on.

Where the negative is to be exposed in bands, it is exclusively the carriage **31** which is utilized, and the set-point value are supplied sequentially and exclusively to the carriage transfer device constituted by the motor **38**, the dynamo **43** and the potentiometer **45**, this preferably using a stepping switch and an electronic storage device, these being devices of known design.

Where individual exposures are to be made in blocks of four with the help of the opening formed in the mask **67**, it is necessary on the one hand to carry out the transfer of the carriage **31** and on the other the transfer of the film by means of the belts **47** and **48** in accordance with predetermined sequences. For the latter transfer function in fact, it is necessary to move the bottom plate **86** away from the top one **84** during the operation. All the operations required are carried out with the help of well known electronic memory, switching and control circuits.

As already explained, the apparatus in accordance with the invention includes a table comprising a variable-focus tube mounting column, and this set-up is fitted with two or more anti-diffusion screens or gratings **68** and **69**, illustrated in FIG. **7**.

In FIG. **7**, these screens **68** and **69** are respectively located in the parked position, in a unit **70** made up of two pairs of superimposed slides **95** and **96**. The slides **95** and **96** are vertically displaceable in order to allow the screen corresponding to the particular focal length in operation, to be selected. They are movable by means of a sixth motor **97** whose shaft **98** is located in fixing lugs **99** attached to the chassis. The motor **97** also drives a further shaft **103** carried in fixing lug **104**, through by means of a chain **105**. The upward movement of the superimposed slides **95** and **96**, which are attached together, is effected in a manner similar to the upward movement of the bottom plate **86** of the carriage **31**. To this end, the unit **70** comprises at its four corners vertical plates **106** containing rectangular slots operating as bearings in which there are engaged pins **107** fixed to eccentrics **108** which are respectively attached to the shaft **98** and the shaft **103**. The rotation of the motor **97** drives the eccentrics **108** with the pins **107**, thus producing a vertical displacement of the unit **70** incorporating the slides **95, 96**. The assembly of slides **95, 96** is attached by two parallel leaf springs **109** to the fixing lugs **99** and **104**, the ends of the springs **109** being respectively attached to the slides **95, 96**. This kind of suspension arrangement limits the lateral displacement of the slides. The shaft **98** is also connected to a (no-current) brake **110**, which enables the assembly of slides **95, 96** to be halted in one or the other position, depending upon the focal length used, that is to say depending upon which screen is selected.

The apparatus in accordance with the invention furthermore comprises a third pair of slides **111** and **112** the center of which coincides with that of the X-ray field, and which enables the selected screen to be positioned over the film in the exposure position. In FIG. **7**, it is the top screen **68** which has been inserted into the exposure field. In order to effect the transfer of the screens **68, 69** into the field of the X-ray radiation each of them comprises a part **113** of dovetail form, which fits into a slot formed in the slide **112**.

When the screen **68** or **69** is selected, that is to say the slide **95** or **96** carrying it, this is moved opposite the slides **111** and **112**. A coupling component **114**, matching the shape of the portion **113**, is engaged with the latter. The component **114** is carried by an endless chain or belt **115** between two sprockets or pulleys **116** and **117**, the first of which is fixed to the shaft of a seventh motor **118** controlling the transfer of the selected screen from the parked position to the exposure position, and vice versa.

It will be observed here that it is equally possible to make exposures without using any screen (for example when carrying out X-ray examinations on children).

A potentiometer **119** indicating whether a screen is present in or absent from the exposure position, is coupled through the shaft to the motor **118**.

Of course, any other system suitable for raising the assembly of slides **95, 96**, could be used.

It should also be noted that the anti-diffusion screen, when in the exposure position in the slides **111** and **112**, must carry out oscillatory movements during the exposure time. These movements can be produced either by the motor **118** or by another device which can be used to impart the reciprocating motion to the screen through the chain (or belt) **115**.

When the film has been exposed, the transfer carriage **31** is brought into its ejection position, opposite to the parking position and disposed vis-a-vis the opening of the magazine used to store the exposed film negatives **65**. The marking device **64** is arranged in front of this opening in order to apply identification marks to the negative.

An embodiment of this kind of marking device **65** is illustrated in FIGS. **8** and **9** which show sections through it. The marking device of FIGS. **8** and **9** is located in the space between the carriage **31**, when same is in the ejection position, and the magazine **65**. In this space, the film F is guided over the whole of its width between two deflectors **120** and **121**. The top deflector **121** forms part of the bottom wall of an optical system **122** which enables the photographic transcription onto the film of the data recorded on a card **123**. The marking operation consists in photographically recording the desired data relating to the patient, on the bands of film F covered by the belts **47** and **48**, that is to say the bands masked by these belts during the X-ray exposure.

The optical system **122** comprises a first light source **124** constituted by one or more miniature lamps illuminating the surface of the card **123**. This card contains the information to be transcribed onto the film and is inserted into a slot **133** formed in the wall of the optical system **122**.

The image of this surface of the card **123** is projected by an optical device **125** embodying lenses, onto a mir-

ror **126**. The mirror **126** reflects the image onto one of the margins of the film F through an opening **127** formed in the bottom wall **121** (top deflector) of the optical system **122**.

Other information concerning the exposure can be marked on the other margin of the film. These pieces of information, indicating the position of the patient, for example "left-right" or "procubitus-decubitus" etc., are marked by means of screens for example upon a transparent film **128** attached to the bottom deflector **120** and covering an opening **129** formed therein.

Two sources of visible light **130** and **131** contained in a unit **132**, are designed to illuminate this margin of the film F and transcribe the data defined by masks placed over the transparent film **128**.

The apparatus in accordance with the invention comprises in its preferred embodiment, a safety interlock circuit for the marking function, which prevents the ejection of the film to the magazine **65** if marking has not been carried out. This kind of safety interlock circuit necessarily comprises elements which signal the presence of the film at the opening **127**, the presence of a card **123** in the slot **133**, and the energizing of the light source **124**, and is easily realizable in a manner known per se.

In a more sophisticated variant embodiment of the apparatus in accordance with the invention, the cards **123** can be replaced by a purely electronic marking device comprising for example a character-generator located at the level of the marking band and remote-controlled by a keyboard installed in the control console.

The apparatus in accordance with the invention is usable for general X-ray diagnostic purposes. It enables all the operations to be automated thus facilitating the work of the radiographer.

What is claimed, is :

**1**. An X-ray diagnostic apparatus for bare films including an X-ray source for irradiating an exposure field, a housing and, within said housing, a film supply section for feeding out said film in the form of sheets one by one, a film transfer section for receiving, in a parked position located outside of said exposure field, said film from said supply section and for transferring it from said parked position to an exposure position within said exposure field and therefrom to an ejection position, and a storage section for receiving said film from said transfer section in said ejection position and for light-tightly storing a plurality of exposed films; wherein said transfer section comprises :

a pair of parallel rails mounted in said housing;

a carriage having the shape of a rectangular frame and a width greater than that of said film sheets and mounted on said rails ;

a first electric motor having a shaft mechanically coupled to said carriage for driving it along said rails and an input ;

first means having a rotor for generating an electrical signal corresponding to the angular position thereof, said rotor being mechanically coupled to the shaft of said first motor, said first generating means having an output for delivering a signal corresponding to the position of said carriage on said rails ;

first means for controlling said first motor having an input electrically coupled to said first generating means output and an output electrically coupled to said first motor input ;

a first and a second pair of superimposed shafts parallel to said rails traversing said frame-shaped carriage and disposed respectively at its opposite ends,each of said shafts having two rollers respectively located inside the frame at a distance corresponding substantially to the width of the film sheets, said rollers of said first shaft pair being respectively integral with said shafts ;

a pair of gears mutually mechanically coupling said two shafts of said first pair for driving them in opposite directions ;

two pairs of contiguous flat belts respectively stretched between the rollers of said first and said second shaft pairs for transferring said film sheets perpendicularly to said rails ;

a second electric motor having a shaft mechanically coupled to one of said shafts of said first pair, a stator fixed to said carriage frame and an input ;

second means having a rotor for generating an electrical signal corresponding to the angular position thereof, said rotor being mechanically coupled to the shaft of said second motor by means of an electrically controlled clutch, said second generating means having an output ; and

second means for controlling said second motor having an input coupled to the output of said second generating means and an output coupled to the input of said second motor.

**2**. Apparatus as claimed in claim **1**, wherein said transfer section further comprises :

an upper flat rectangular X-ray transparent plate fixed to said carriage frame and equipped on its bottom face with a first image intensifying screen ;

a lower rectangular cylindrically curved plate provided upon its top face with a flexible layer covered by a second image intensifying screen, said lower plate being movable perpendicularly to said upper plate and maintained in a position away from said upper plate by elastic means ;

and third electric motor means having a movable part mechanically coupled to said bottom plate for pressing it against said upper plate and said film sheets between said first and said second screens during exposure.

**3**. Apparatus as claimed in claim **1**, wherein said film supply section is particularly adapted for film carried on spools and comprises :

a feed roller for transferring the film from said spool to said transfer section having a shaft rotatably mounted in bearings fixed to said housing ;

a third electric motor having a shaft mechanically coupled to that of said feed roller ;

third means having a rotor for generating an electrical signal corresponding to the angular position thereof, said rotor being mechanically coupled to the shaft of said feed roller by means of an electrically controlled clutch, said third means having an output ;

third means for controlling said third and said second motors having a first input coupled to said third generating means output and a second input for

receiving voltage corresponding to the desired dimension of the film sheet for delivering a predetermined length of film to said transfer section ;

a film cutting assembly comprising a fixed and a movable blade inserted between said feed roller and said transfer section for cutting said film to a predetermined length ; and

fourth electric motor means for operating said movable blade.

4. Apparatus as claimed in claim 3, wherein said control means comprise a third tachogenerator having a shaft coupled to that of said feed roller and an output, and a differential and an output amplifier stage in series, the latter one having an input ; said generator output being electrically coupled to said output stage input.

5. Apparatus as claimed in claim 1, wherein said first and said second control means comprise a first and a second tachogenerator having shafts respectively mechanically coupled to those of said first and said second motors, said tachogenerators respectively having outputs for delivering a voltage proportional to the speed of rotation of their shafts ; each of said control means further comprising in series a differential and an output amplifier stage, the latter having an input, said tachogenerator outputs being respectively coupled to said output stage inputs.

6. Apparatus as claimed in claim 1, wherein it further comprises :

a shutter and a mask of X-ray opaque material juxtaposed, in the exposure position, above said carriage, for allowing a plurality of X-ray photographs to be taken on any one sheet of film ;

two further electric motors having rotors respectively mechanically coupled to said shutter and said mask for the respective displacements of said shutter and said mask parallel to that of said carriage ;

two further means having rotors respectively coupled to those of said further motors for respectively generating electrical signals corresponding to the angular position of their rotors ; and

two further motor control circuits respectively fed by said electrical signal generating means and respectively feeding said further motors for respectively positioning said shutter and said mask within said exposure field accordingly to electrical control voltages respectively feeding said control circuits.

7. Apparatus as claimed in claim 1, wherein said storage section comprises : a magazine for light-tightly storing said film after exposure and, ahead of said magazine, a marking device for carrying out photographic recording of identification data on those locations of the film sheets which were masked during exposure by said belts, said marking device including a light-tight housing, light sources and an optical system for focusing said data written on a card onto said locations.

8. Apparatus as claimed in claim 1, further comprising:

a plurality of antidiffusion screens ;

an assembly composed of a plurality of superimposed pairs of slides located above said carriage parking position for holding said antidiffusion screens, said slides being movable perpendicularly to said screens ;

third electric motor means having a mobile part coupled to said slide assembly for controlling the motion thereof ;

a further pair of slides located above said carriage exposure position for receiving one of said antidiffusion screens ; and

fourth electric motor means having a mobile part for controlling the transfer of the antidiffusion screen normally lodged in that slide pair of said assembly which is opposite said further pair of slides; and mechanical means for coupling said mobile part of said fourth motor means alternately to each one of said plurality of screens.

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