

Singapore

PATENT SPECIFICATION

(11) 1424042

1424042

- (21) Application No. 13822/73 (22) Filed 22 March 1973
 (31) Convention Application No. 7210192 (32) Filed 23 March 1972 in (19)
 (33) France (FR)
 (44) Complete Specification published 4 Feb. 1976
 (51) INT CL² G03B 1/18 1/24//H02P 8/00
 (52) Index at acceptance

G2E A11D A11E2 A20A1 A20A2 A20C2 A20C7 A27
 H2J 12H2 12N3B 12N3Y 12NX 13 5 9D



(54) IMPROVED FEEDING DEVICE FOR STRIP-FORMED IMAGE OR PATTERN SUPPORTS

(71) We, **PIERRE REGIS MARIE HENRI IRISSOU**, a French Citizen, of 2 rue Albert de Mun, Meudon-Bellevue Hauts de Seine, France; and **PIERRE JEAN FRANCOIS JACQUES SARDA**, a French Citizen, of 26 rue du Parc de Clagny, Versailles, Yvelines, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a variable speed feeding device for a strip-formed image or pattern support, in particular for cinematographic films, but also for supports on which the images or patterns are recorded by other means, for example magnetically.

Although the feeding device according to the invention is more particularly intended for employment in the reproduction of the images, that is to say to projection in the case of a cinematographic film, it may also serve for the recording of these images, that is to say at the time of taking pictures.

In cinematographic projectors of known kind, it is known that variation of the speed of projection and, *a fortiori*, reversal of the direction of transport of the film cannot be either instantaneous or arbitrary. If the projector has a universal motor, it is only possible to obtain slow and progressive variations in speed or reversal of the direction of transport of the film, or, on certain projectors to change from a speed of twenty-four frames per second to a speed of sixteen frames per second and *vice versa*.

In order to allow the taking of pictures at variable speed, it has been proposed in French Patent Specification 1,426,870, to control the running speed of a camera by means of a synchronous motor supplied with a current whose frequency matches that of the required running speed. To this end a variable frequency oscillator controls a current converter which generates a polyphase current from a d.c. current supply.

This synchronous motor, which can be

operated continuously at a chosen speed, or else used intermittently frame by frame for taking pictures at spaced intervals, is directly coupled to the camera shutter and drives the film via the intermediary of a well-known mechanism for producing intermittent movement of the film. An electromagnetic brake ensures that the motor stops in a position which approximately represents the end of the line of images during continuous operation, or of each image when pictures are being taken frame by frame.

Such a known arrangement exhibits all the practical limitations normal in apparatus of this type. In addition such an arrangement does not allow, because of the inertia of the synchronous motor, either an instantaneous change in the speed, or, more particularly, an instantaneous reversal, during operation, of the direction of advance of the film.

Finally, for slide projection, it has already been proposed to use step motors, possibly controlled by a programming device, for directly projecting the successive images.

In the known apparatus, the slides are separate one from another, so that a precise superimposing of successive images, even where these relate to the same scene, is not required.

Similarly with images on a continuous strip, this precision of superimposition would not be possible with known step motors and the methods of motor control which are used with the latter. Such precision is however essential for the projection of the images on a screen to be satisfactory. This precision clearly cannot be obtained using synchronous motors which are associated with electromagnetic brakes.

The present invention aims to provide a feeding device for a continuous image bearing support in the form of a strip which enables a precision of movement of the images permitting cinematographic, optical or electronic projection.

According to the invention, a feeding device for a strip-formed support bearing a series of images or patterns comprises a

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driving wheel for driving said strip by contact therewith and driving means for intermittently rotating said wheel by imparting thereto consecutive angular displacements to ensure the lengthwise progression of the strip image-by-image or pattern-by-pattern, wherein said driving means comprises a step motor having a rotor mechanically coupled to said driving wheel and a stator coaxial with said rotor and provided with a multiplicity of electromagnetic poles, and comprises energizing means comprising a generator for providing consecutive sequences of pulses, each sequence comprising a given number of successive pulses for successively exciting the stator poles of the step motor to cause the step motor to accomplish a number of steps equal to said number of pulses and necessary to ensure the lengthwise progression of the strip by one image or pattern, said number of pulses being chosen so that each time the motor stops, following a lengthwise progression of the strip by one image or pattern, a same set of stator poles remains excited.

The driving engagement between the strip and the wheel may result from simple friction. Preferably, in the case of a strip carrying optical images which is regularly perforated with a pitch spacing of the perforations which is compatible with that of the images which it carries, the driving wheel is provided with teeth to engage in the perforations.

The step motor is preferably a variable reluctance motor the stator of which is formed of $2n$ sectors, each provided with p poles, and the rotor of which is ferromagnetic and is also formed of $2n$ sectors each provided with $p-1$ poles, the stator poles of each stator sector having windings connected to said energising means to be excited individually and in succession by said successive pulses, and the windings of correspondingly positioned stator poles of two adjoining stator sectors having opposite winding directions.

In such a step motor, each of the stator poles, rendered active in its turn, attracts the nearest rotor pole, so that the rotation of the motor progresses in a discontinuous manner each time by a step equal to the angular difference between the pitch of the poles of the rotor and the pitch of the poles of the stator.

When the motor progresses any number of steps, the angular error between its real position and its theoretical position may reach several percent, even for well-made motors. The angular displacement of the rotor between two consecutive fixed positions may therefore not be exactly constant, even though the motor accomplishes the same number of steps each time. Such an angular error affecting the angular displacement is not compatible with a luminous projection

which, at a distance, amplifies the absolute value of this error by the effect of enlargement.

Experience shows however, that, when the same set of stator poles is active in order to fix a set of rotor poles each time the motor is stopped, this angular error becomes negligible. This result is obtained each time the rotor has progressed through $k \cdot p$ steps (k being an integer), that is to say when the p poles of each of the $2n$ stator sectors have been k times successively excited. This is due to the fact that, when the same poles of the stator are excited each time the motor stops, the distribution of the magnetic field in the stator is always the same and, when the rotor is made with high mechanical precision as regards its symmetry of rotation, its consecutive fixed positions are displaced by a fixed angle equal to $k \cdot p \cdot \alpha$, α being the elementary and theoretical angular step of the motor.

Then k is equal to $2n$, that is to say when the rotor progressing step-by-step accomplishes exactly one turn between two successive rest positions, the electromagnetic situation and the geometrical situation of the rotor in relation to the stator are exactly re-established and the angular error becomes negligible.

A motor of this kind driving an image supporting strip progresses by one step in a constant predetermined time. In order to produce progression of the strip by an amount equal to the pitch-spacing of the images, it is suitable to supply to one of the inputs of the motor a train of $m \times p$ pulses (m being the whole number multiplier corresponding to the progression of one complete image) separated by intervals of time at least equal to this constant time.

The strip having thus progressed, in one direction or the other, a distance equal to the pitch-spacing of the images, and the motor having stopped, immobilising the strip in position for reproduction of the associated image, a new train of pulses will permit the reproduction of the next image, and so on.

The speed of the pulse trains thus determines the rate of reproduction of the images. This speed may be instantaneously modified or reversed since, for this purpose, it suffices to vary the intervals between pulse trains or the order of arrival of these pulses at the electromagnetic poles. By varying the speed of the pulse trains as well as the direction of rotation of the step motor, it is possible to obtain special effects (retardations or accelerations), directly during projection using a film photographed at one of the conventional camera speeds, and to increase the duration of projection at any selected frame without wasting long lengths of film reproducing that same frame.

Reversal of the transport direction enables

back-tracking, especially for teaching purposes, for the detailed study of a scene or, owing to the instantaneous possibility of varying the film transport speed, for the breakdown of a movement into its successive phases.

In cinematographic projection by the optical method it is possible, in known manner, when film transport is arrested to project just one frame, to lower the luminous intensity so as not to deteriorate the film locally through overheating.

Owing to the possibility of varying the speed and instantaneously reversing the driving motor, it is also possible to give the strip a reciprocating movement, so that a certain number of images, from one to three by way of example, situated on opposite sides of the image on which it is desired to stop, can be substituted for the latter, at normal projection speed, by a reciprocating movement of the strip in the projector.

This reciprocating movement applies also in the case where the reproduction of the image is ensured by other than optical means.

In the case of optical projection, it is known that, when the speed of projection is slow, the flickering of the projected image may be difficult to endure. However, since the passage from one image to the other always takes place at the same high speed, flickering can be avoided, at the time of projection, by utilising a luminous source having a flash frequency greater than that which provokes the flickering effect. Moreover, the passage from one image to another may be effected during a period of extinction of the source, which dispenses with the need for a movable shutter during this passage from one image to the other.

The trains of pulses necessary for the energisation of the step motor may be generated in various ways. In particular, they can be recorded on a magnetic tape with the series of desired pulse spacings for the projection of a particular film, this tape carrying, in addition, the recording of special signals for controlling reversals of the direction of film transport.

For a projection in which the speed and the direction of transport must at each instant be controlled by the user, the pulses may be generated by a source of pulses associated with a counter device.

In one advantageous embodiment of the invention, for the advance of one image the advance of the motor is equal to p steps ($m=1$) and, a pulse source having been started for this advance, the pulse trains are stopped as soon as the first of the electromagnetic poles of each sector is fed again to hold the motor in this position. In this way the risk is avoided of parasitic pulses, interposed between the normal pulse trains gener-

ated for the progression of the strip, causing the strip to move more than p steps.

When the advance of the motor corresponds to mp steps, a counter of capacity m may be released for each return of the pulsating feed to the first electromagnetic pole, while the filling of the counter ensures the stoppage of the emission of pulses.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which

Figure 1 is a schematic end view of a step motor utilisable for the invention,

Figure 2 is a series of graphs relating to the supply to this motor,

Figure 3 is a circuit diagram of means for producing the supply illustrated in Figure 2,

Figure 4 is a logic circuit usable in the circuit according to Figure 3,

Figure 5 is a schematic view of an optical projector provided with a film feeding device according to the invention,

Figure 6 is a partial view of a modified embodiment of such a projector, and

Figure 7 is a circuit diagram of one embodiment of an electronic control for a projector such as that illustrated in Figure 5.

The step motor shown in Figure 1 comprises a toothed ferromagnetic rotor 1 having eight poles 2 and a rotatable shaft 3.

The stator ring 4 of the motor comprises twelve electromagnetic poles 5 each provided with a winding 6. Dividing the motor into four sectors ($n=2$) by the lines XX and YY, the stator thus comprises four sectors of three poles ($p=3$) and the rotor four sectors of two poles ($p-1=2$).

For the sake of clarity, Figure 1 only shows schematically the windings $6a \dots 6a_3$, corresponding to the first pole of each sector (first phase) and the two windings $6b$ and $6c$ corresponding to the two other poles of one of the sectors.

It will be noticed that the windings $6a_1$ and $6a_3$ have opposite winding directions compared with the windings $6a$ and $6a_2$, so that, when the current causes a north pole to appear, for example at $6a$ and $6a_2$, it causes a south pole to appear at $6a_1$ and $6a_3$, the magnetic flux always being closed by the rotor. In the situation shown, in which the windings $6a \dots 6a_3$ are excited, the rotor is locked in position by the attraction of the poles.

If the windings $6a$ cease to be excited and the winding $6b$ become excited, the rotor poles (or teeth) 2 nearest to the poles caused by the windings $6b$ will be attracted by the latter, so that the motor will turn in the direction of the arrow F through an angle equal to the difference of the angular spacing of the rotor and stator poles, namely

$$45^\circ - 30^\circ = 15^\circ.$$

Two new steps of 15° will be effected by exciting the windings 6c then, again, the windings 6a so that after an angular travel of

$$3 \times 15 = 45^\circ,$$

5 the rotor will have returned to the situation illustrated.

If the order of excitation of the windings is reversed, that is to say the order becomes 6c, 6b, 6a, the direction of rotation is reversed, which can be understood by considering the winding 6c, symmetrical with the winding 6b and the respective actions of these windings on the teeth 2₂ and 2₁ on each side of the tooth 2₀ situated opposite the winding 6a.

15 The pulses necessary for rotating the motor of Figure 1 through three steps are illustrated in Figure 2. In this Figure a first pulse of the train, shown at 9a, cuts off the feeding of the windings 6a . . . 6c, and triggers the formation of the pulse 9 having a duration which is twice that of the pulses 8, which is supplied to the windings 6b. The second pulse 8 generates the pulse 10 which follows immediately the pulse 9 and is supplied to the windings 6c. Finally, as shown at 11, the third pulse 8 re-establishes the excitation of the winding 6a, and the motor has progressed through three steps.

30 The duration of the pulses 9 and 10 is evidently chosen greater than the constant time necessary for the motor to effect one step.

35 These different pulses may be derived from the circuit illustrated in Figures 3 and 4. This circuit comprises essentially a logic element 12 (Figure 4) which is a known scale-of-three counter-decounter, followed by a decoder.

40 The trains of pulses 8 (the number of which may be limited to three by any suitable circuit, or in the manner described later in relation to Figure 7) are supplied to the input 14 of the logic element 12, while the two directions of counting are defined respectively by a "1" voltage (positive) or a "0" voltage applied to the input terminal 15.

45 The logic element 12 comprises two JK bistable elements which function synchronously when each pulse 8 arrives. These bistable elements define four binary states of which one is eliminated by the loop provided by conductors 13a and 13b.

50 The counting direction signal arriving at the terminal 15 is directly supplied to AND-gates E₁ and E₂ disposed respectively at one of the outputs of the two bistable elements and, through the intermediary of a NOR-gate N₁, to AND-gates E₂ and E₄ disposed on the other output of each of the two bistable elements.

60 The outputs of the AND-gates E₁ and E₂ are connected to a NOR-gate N₂ the output

of which is connected, by the conductor 13b, to one of the inputs of the bistable element B₂, whilst the output of a NOR-gate N₂, which receives the outputs of the gates E₃ and E₄, is connected by the conductor 13a to the input of the bistable element B₁, on the side opposite to that of the bistable element B₂ which is connected to the conductor 13b.

For decoding, one of the two outputs of each bistable element is connected to one of the two inputs of three NOR-gates, N_a, N_b, N_c the outputs of which constitute the terminals 17a, 17b, 17c, the fourth possible combination of the outputs of the two bistable elements being eliminated by the loop 13a, 13b which causes the automatic advance by one step of the successive states of the bistable elements.

Since the NOR-gates only supply a signal when they simultaneously receive two "0" signals, it will be understood that, depending on whether a "0" or "1" signal is at the input 15, one of the two sets of gates E₁, E₃ or E₂, E₄ will always supply a "0" signal to the gates N₂, N₃, whilst the other set will alternately furnish a "0" and a "1" signal.

According to the direction of functioning of the logic element 12, the first or the second pulse from the train of pulses 8 reverses the state of the bistable element B₂ with respect to that of the bistable element B₁. Thus the direction of transposition of the excitation is reversed at the outputs 17a, 17b, 17c. The pulse following the pulse which has reversed the relative state of the bistable elements B₁ and B₂, re-establishes the initial state via the conductor 13a.

The outputs 16a, 16b, 16c, corresponding respectively to the inputs of the same reference of the stator poles, are connected to the outputs 17a, 17b, 17c of the logic circuit by the two-stage amplifier 18.

In the embodiment illustrated, the circuit is star-connected by the diodes 19. These diodes protect the power transistors against the effects of self-induction of the motor windings.

In the projector schematically illustrated in Figure 5, the shaft of a step motor 20 is secured to a toothed feeding wheel which drives a film 22 frame by frame. This film comes from an unreeling spool 23 and is wound up on a receiving spool 24. These two spools are each under the control of a motor-couple. Preferably, the two motors are asynchronous motors fed under suitable voltage from the mains or local supply circuit. Advantageously, they are under the control, for their torque and their speed of rotation, of the step motor supply so as to avoid excessive variations in the state of tension of the film.

It is possible to drive the two spools 23 and 24, by their auxiliary motors, in the

direction which tends to wind the film on the spools, one of the motors, that which corresponds to the normal direction of travel of the film, having a greater power than the other. Thus, the perforations of the film are always in engagement with the same side of the teeth of the feeding wheels driven by the step motor and no longitudinal movement of the film is produced in the region where the movement of the latter is ensured by the step motor at the time of reversal of direction of advance of the film.

Two tension pulleys 25 and 26, mounted on the spring-loaded levers 27 and 28, maintain the film tension constant.

A known type of film gate (without driving claws) may be provided. Advantageously, however, it may be replaced by the pairs of nip rollers 29 and 30 situated on each side of the projection window 31.

The projector also comprises, in known manner, a lamp 32, a concave mirror 33, a condenser 34, an objective lens 35 and a focussing lens 36.

The illustrated embodiment corresponds to a twenty-four step motor, such as shown in Figure 1, which progresses each time by three steps, or 45° , and having an 8-tooth feeding wheel, each tooth corresponding to one frame of the film.

The shutter is not shown. It may be a reciprocating electromechanical shutter controlled by a rapid electromagnet, or else a rotary shutter also driven by a step motor. It may also be synchronised with the rotation of the step motor for driving the film.

The lamp 32 may be a discharge lamp synchronised to be extinguished when the step motor progresses, which dispenses with the need for a shutter.

If it is feared that the abrupt pull exerted on the film on the occasion of each movement of the motor may lead to breakages of the film, the number of feeding wheels can be increased, for example in the manner shown in Figure 6. In this Figure, the shaft of the step motor 20 is secured to the toothed wheel 21 and to a gear 38 which drives the similar gears 39, 40 and 41, a reversing pinion 45 being interposed between the gears 39 and 40. The gears 39, 40 and 41 are secured respectively to feeding wheels 42, 43 and 44 around which the film 22 also passes. The shafts of the four gear wheels 38—41 are disposed at the apices of an isosceles trapezium.

Thus, in the embodiment of Figure 6, the film, at each instant, is in engagement with at least four times the number of feeding wheel teeth compared with the embodiment of Figure 5. This embodiment is particularly suitable for normal or large size films.

A feeding device according to the invention may be controlled by a circuit such as that illustrated in Figure 7. In this circuit the

speed of the images is determined by a multi-vibrator 60 constituted by transistors 50 and 52, the base of each transistor being capacitively connected to the collector of the other transistor. The operating speed of the multi-vibrator is controlled by a potentiometer 53, situated within reach of the hand of the user, serving as a voltage divider between supply lines 54 and 55.

This potentiometer may be graduated in terms of speed of the images and it may have positions marked on its cursor for the normal speed, which permits the passage in particular of normal sound films. In this case, the projector illustrated in Figure 5 would have a pick-up head in the region where the unwinding of the film is made uniform by the tension pulleys and the coupled motors.

The signal of the multi-vibrator amplified by the transistor 51 is taken out at 59 from the collector of the latter. The regulation of the supply is ensured by a transistor 56 and the series connection of a zener diode 57 and a resistor 58 which feeds the base of this transistor.

The output 59 of the multi-vibrator circuit feeds, on the one hand, the shutter mechanism (for example, the circuit of the lamp 32) and, on the other hand, the generation of the control pulses for the step motor.

The shutter, which is maintained open by excitation of a winding 61, is closed by excitation of a winding 62, this excitation being obtained by rendering the transistor 63 conductive by the signal taken out at 59 and amplified by the cascade of transistors 64, owing to the fact that the transistor 63 short circuits the winding 61 and feeds the winding 62.

By a differentiating network 65, the leading edge of the signal appearing at the point 59 supplies a pulse which controls the change of state of a bistable element formed by transistors 66 and 67. The output signal of transistor 67 amplified by a transistor 68 is applied to the base of a unijunction transistor 69, which, with a variable resistor 70 and a condenser 71, constitutes a pulse generating oscillator. The speed of the pulses depends on the time constant of the RC-network 70—71.

The pulses thus generated are transmitted to the input 14 of the logic element 12 (Figure 4) in order to be transformed into control pulses for the step motor.

As soon as the first winding of each sector of the motor is supplied with voltage again, a voltage appears at the point 16a. This voltage which is shaped by the RC-network 72 and then sent by the conductor 73, restores the bistable element 67 to its initial state, which stops the emission of pulses by the oscillator 70—71.

Thus, without it being necessary to count

the pulses, the emission of the latter is stopped as soon as the current is returned to the first pole of each sector of the stator.

5. Finally, via a transistor 74 and an output 75, the excitation of the first electromagnetic stator poles is maintained by the locking of the motor until the emission of a following train of pulses.

10 When the motor must accomplish $m \times p$ steps before being stopped, the connection 73 may comprise an m -stage counter which postpones, by a number corresponding to cycles of p pulses, the sending of the stop pulse to the base of the transistor 67. The remainder of the circuit need not be modified.

15 It is to be noticed that since the feeding device according to the invention does not have any reciprocating member, its sound level is very low.

20 The invention can be applied to all devices for recording or reproducing images carried by supports in the form of strips and especially to amateur cinematographic projection and to audio-visual arrangements.

WHAT WE CLAIM IS:—

1. A feeding device for a strip-formed support bearing a series of images or patterns comprising a driving wheel for driving said strip by contact therewith and driving means for intermittently rotating said wheel by imparting thereto consecutive angular displacements to ensure the lengthwise progression of the strip image-by-image or pattern-by-pattern, wherein said driving means comprises a step motor having a rotor mechanically coupled to said driving wheel and a stator coaxial with said rotor and provided with a multiplicity of electromagnetic poles, and comprises energizing means comprising a generator for providing consecutive sequences of pulses, each sequence comprising a given number of successive pulses for successively exciting the stator poles of the step motor to cause the step motor to accomplish a number of steps equal to said number of pulses and necessary to ensure the lengthwise progression of the strip by one image or pattern, said number of pulses being chosen so that each time the motor stops, following a lengthwise progression of the strip by one image or pattern, a same set of stator poles remains excited.

2. A device according to claim 1 wherein said step motor is a variable reluctance motor and stator of which is formed of $2n$ sectors, each provided with p poles, and the rotor of which is ferromagnetic and is also formed of $2n$ sectors each provided with $p-1$ poles, the stator poles of each stator sector having windings connected to said energizing means to be excited individually and in succession by said successive pulses, and the windings of correspondingly posi-

tioned stator poles of two adjoining stator sectors having opposite winding directions. 65

3. A device according to claim 2 wherein said energizing means comprises a generator of consecutive sequences of kp pulses (k being an integer) so that a same set of stator poles is excited at the end of each pulse sequence, said set of stator poles remaining excited for an extended time interval during which said rotor and said driving wheel are temporarily arrested. 70 75

4. A device according to claim 3 wherein $k=2n$.

5. A device according to any of the preceding claims wherein said generator is provided with adjustment means for varying the recurrent frequency of said pulse sequences and thereby varying the speed of progression of the strip measured in images or patterns per unit of time. 80

6. A device according to any of the preceding claims wherein means is provided for reversing the sense of rotation of said rotor by modifying the order of excitation of said stator poles. 85

7. A device according to claim 3 wherein said energizing means comprises a logic network having p outputs energized in immediate succession by successive pulses from said generator. 90

8. A device according to claim 7 wherein said generator comprises timing means provided with a feedback connection connected to the windings of said set of stator poles for terminating each pulse sequence in response to the excitation of said set of stator poles. 95 100

9. A device according to claim 8 wherein said feedback connection includes a plural-stage pulse counter.

10. A device according to claim 8 wherein said timing means comprises a multivibrator, a bistable element settable by said multivibrator, a bistable element settable by said multivibrator and resettable by said logic network via said feedback connection and wherein said generator comprises an oscillator controlled by said bistable element, said oscillator delivering successive pulses in the set condition of said bistable element and being blocked in the reset condition of said bistable element. 105 110 115

11. A device according to claim 10 wherein said timing means comprises a potentiometer connected to said multivibrator for varying the switchover period thereof. 120

12. A device according to claim 10 wherein said logic network is connected to said oscillator and includes a binary frequency divider and gating means selectively biasable to invert the order of energization of the outputs of said logic network. 125

13. A device according to any of the preceding claims wherein said strip is regularly perforated with a pitch spacing equal to, or

the pulses, the emission of the latter is stopped as soon as the current is returned to the first pole of each sector of the stator.

5. Finally, via a transistor 74 and an output 75, the excitation of the first electromagnetic stator poles is maintained by the locking of the motor until the emission of a following train of pulses.

When the motor must accomplish $m \times p$ steps before being stopped, the connection 73 may comprise an m -stage counter which postpones, by a number corresponding to cycles of p pulses, the sending of the stop pulse to the base of the transistor 67. The remainder of the circuit need not be modified.

It is to be noticed that since the feeding device according to the invention does not have any reciprocating member, its sound level is very low.

The invention can be applied to all devices for recording or reproducing images carried by supports in the form of strips and especially to amateur cinematographic projection and to audio-visual arrangements.

WHAT WE CLAIM IS:—

1. A feeding device for a strip-formed support bearing a series of images or patterns comprising a driving wheel for driving said strip by contact therewith and driving means for intermittently rotating said wheel by imparting thereto consecutive angular displacements to ensure the lengthwise progression of the strip image-by-image or pattern-by-pattern, wherein said driving means comprises a step motor having a rotor mechanically coupled to said driving wheel and a stator coaxial with said rotor and provided with a multiplicity of electromagnetic poles, and comprises energizing means comprising a generator for providing consecutive sequences of pulses, each sequence comprising a given number of successive pulses for successively exciting the stator poles of the step motor to cause the step motor to accomplish a number of steps equal to said number of pulses and necessary to ensure the lengthwise progression of the strip by one image or pattern, said number of pulses being chosen so that each time the motor stops, following a lengthwise progression of the strip by one image or pattern, a same set of stator poles remains excited.

2. A device according to claim 1 wherein said step motor is a variable reluctance motor and stator of which is formed of $2n$ sectors, each provided with p poles, and the rotor of which is ferromagnetic and is also formed of $2n$ sectors each provided with $p-1$ poles, the stator poles of each stator sector having windings connected to said energizing means to be excited individually and in succession by said successive pulses, and the windings of correspondingly posi-

tioned stator poles of two adjoining stator sectors having opposite winding directions.

3. A device according to claim 2 wherein said energizing means comprises a generator of consecutive sequences of kp pulses (k being an integer) so that a same set of stator poles is excited at the end of each pulse sequence, said set of stator poles remaining excited for an extended time interval during which said rotor and said driving wheel are temporarily arrested.

4. A device according to claim 3 wherein $k=2n$.

5. A device according to any of the preceding claims wherein said generator is provided with adjustment means for varying the recurrent frequency of said pulse sequences and thereby varying the speed of progression of the strip measured in images or patterns per unit of time.

6. A device according to any of the preceding claims wherein means is provided for reversing the sense of rotation of said rotor by modifying the order of excitation of said stator poles.

7. A device according to claim 3 wherein said energizing means comprises a logic network having p outputs energized in immediate succession by successive pulses from said generator.

8. A device according to claim 7 wherein said generator comprises timing means provided with a feedback connection connected to the windings of said set of stator poles for terminating each pulse sequence in response to the excitation of said set of stator poles.

9. A device according to claim 8 wherein said feedback connection includes a plural-stage pulse counter.

10. A device according to claim 8 wherein said timing means comprises a multivibrator, a bistable element settable by said multivibrator, a bistable element settable by said multivibrator and resettable by said logic network via said feedback connection and wherein said generator comprises an oscillator controlled by said bistable element, said oscillator delivering successive pulses in the set condition of said bistable element and being blocked in the reset condition of said bistable element.

11. A device according to claim 10 wherein said timing means comprises a potentiometer connected to said multivibrator for varying the switchover period thereof.

12. A device according to claim 10 wherein said logic network is connected to said oscillator and includes a binary frequency divider and gating means selectively biasable to invert the order of energization of the outputs of said logic network.

13. A device according to any of the preceding claims wherein said strip is regularly perforated with a pitch spacing equal to, or



- proportional to, that of the images or patterns which it carries, the driving wheel being toothed to engage in the perforations.
- 5 14. A device according to any of the preceding claims wherein the movement of the strip, outside the region where its movement is controlled by the step motor, is effected by at least one auxiliary motor which is under the control of the step motor supply.
- 10 15. A cinematographic projector comprising a device according to any of the preceding claims for intermittently feeding a film therethrough.
- 15 16. A projector according to claim 15 when dependent on claim 8 wherein the luminous source of the projector is extinguished, under the control of said timing means, during the passage of each image of the film through the gate of the projector.
- 20 17. A projector according to claim 15, wherein the step motor drives in synchronism several toothed feeding wheels for the film, which wheels are disposed in a series one after the other along the course of the film.
- 25 18. A projector according to claim 17 wherein the shafts of said toothed wheels are disposed at the apices of an isosceles trapezium.
19. A projector according to claim 15 when dependent on claim 14 wherein the supply and takeup reels for the film are each driven by a motor couple.
20. A cinematographic projector according to claim 15, constructed and arranged substantially as herein described with reference to, and as illustrated in, Figure 5 or Figure 6 of the accompanying drawings.
21. A feeding device according to claim 1, constructed and arranged substantially as herein described with reference to, and as illustrated in, Figure 7 of the accompanying drawings.
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