

Dec. 29, 1936.

G. E. PERREAULT

2,065,907

TRANSLATING DEVICE

Filed April 27, 1934

2 Sheets-Sheet 1

FIG. 1

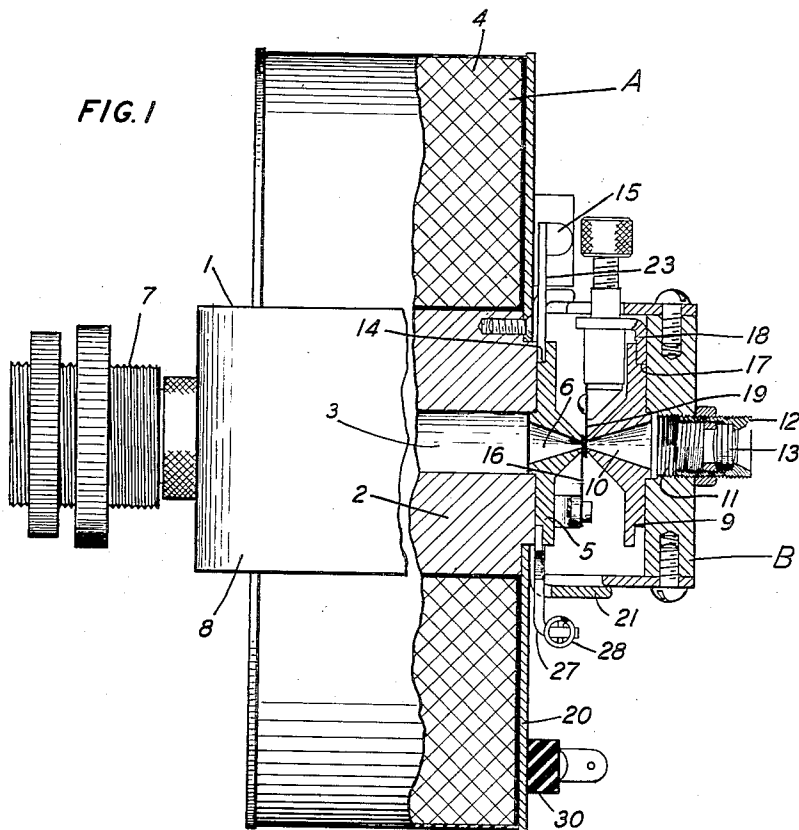
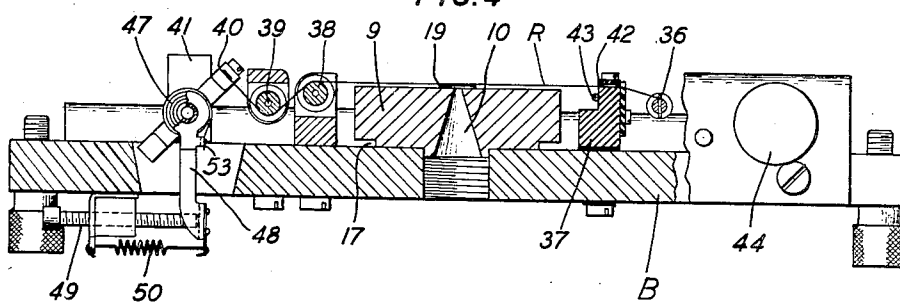


FIG. 4



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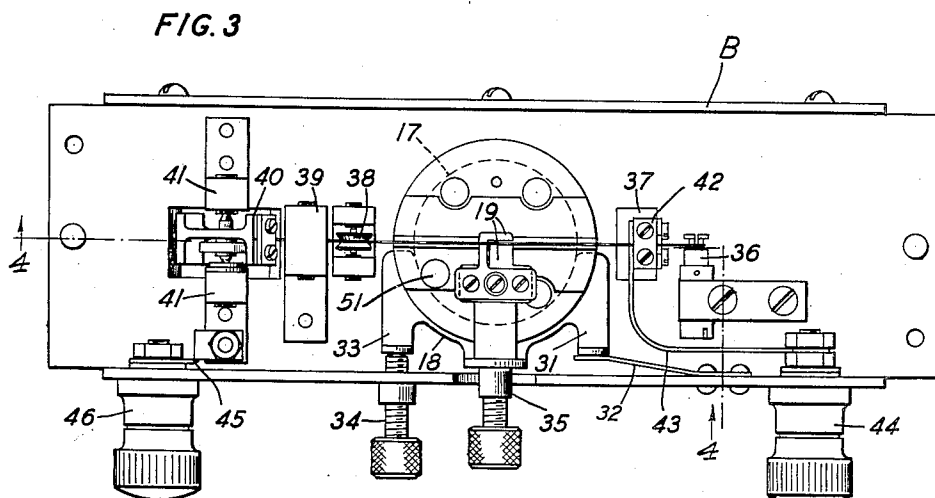
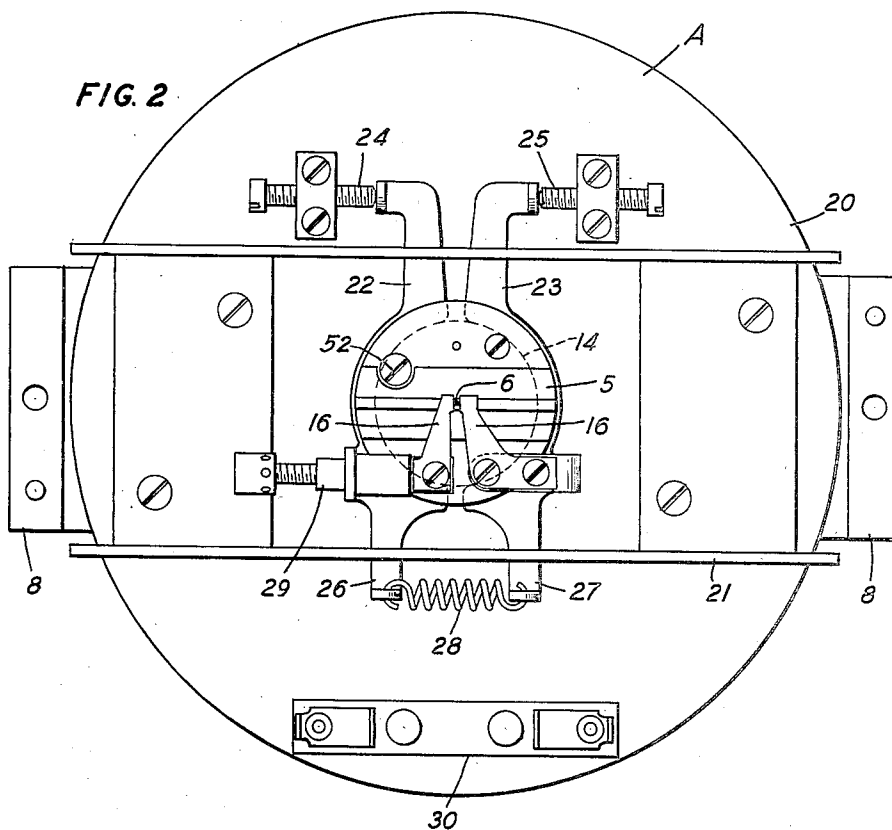
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2 Sheets-Sheet 2



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2,065,907

TRANSLATING DEVICE

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15 Claims. (Cl. 83—61)

This invention relates to translating devices or light valves and more particularly to structures adapted for use in the receiving or recording apparatus of picture transmitting systems.

According to one method of reproducing pictures, a light valve is operated by causing the received signals to flow through its conductive ribbon, which is thereby actuated to vary the amount of light applied on elementary portions of the light sensitive film to form light and dark areas similar to the elementary areas of the original subject. It is customary to mount the light sensitive film on a rotating drum, so that the entire area is exposed in a succession of helical traces, to provide a small spot of light of varying area having a fixed width for producing the trace or unit line, whereby the boundaries of the successive traces are continuously in contact with each other and hence line structure in the reproduced picture is prevented. This result may also be produced by providing a light spot of such shape that the successive traces overlap more or less. Again it is desirable to keep the tension applied to the light valve ribbon as low as possible, in order to provide a valve which is extremely sensitive to current variations flowing through the ribbon and to reduce to a minimum breakage of the ribbon during manufacture and use of the valve. On the other hand, the tension applied to the ribbon should be such that its natural rate of vibration does not tend to cause it to selectively respond to any of the signal components flowing through it, otherwise the reproduced picture will be distorted.

In one aspect, the present invention provides a light valve which may be advantageously used in picture reproducing apparatus operating in accordance with the method described above.

An object of the invention is to provide a light valve of high sensitivity.

Another object of the invention is to provide a light valve including means for controlling the size and shape of the light aperture as well as its position relatively to the ribbon.

Still another object is to provide a light valve having movable jaws which may be oriented to control the position of the light aperture with respect to the ribbon.

A further object is to provide a mounting and tensioning means for the ribbon which is adapted to maintain it in a fixed position within the valve structure, whereby the light aperture defining means may be accurately adjusted with respect to the ribbon.

A further object is to provide a ribbon ten-

sioning means which will maintain the tension substantially constant regardless of changes in the length of the ribbon caused by temperature changes.

An additional object is to provide tensioning means which will substantially compensate for differences in the expansion of the ribbon and that of the base, which carries the supports for the ribbon.

An auxiliary object is to provide freely movable elements, associated with the tensioning means, for supporting the conductor ribbon.

The invention will be hereinafter described as applied to a light valve consisting of two members, one of which comprises a W-shaped magnetic yoke, the central leg of which is provided with an orifice extending axially thereof, is surrounded by a field winding and carries a pole-piece also provided with an opening which registers with the orifice, the second member comprises a plate of magnetic material which is detachably secured to the outer legs of the yoke to complete the magnetic circuit and carries a pole-piece that is provided with an orifice adapted to register with that in the first member when the two members are assembled. Each pole-piece is provided with a reduced portion engaged by a yoke and each yoke carries a pair of thin opaque plates which extend inwardly to a point adjacent the center of the orifice to substantially cover it, but with the inner ends of the respective pairs of plates spaced apart to provide a slit and the two slits are superposed at an angle, whereby they cooperate to define an aperture through which light may be transmitted from a light source to the sensitive recording material. The yokes may be oscillated upon the pole-pieces concentrically of the axis of the orifice to cause the ends of the two sets of plates to respectively occupy different angular positions with respect to each other whereby the shape of the aperture may be varied, and one plate of one set may be adjusted to vary the distance between it and its associated plate, whereby the size of the aperture may be regulated.

The second member carries a mounting for the conductive ribbon comprising a take-up screw to which one end of the ribbon is secured and, after passing over a bridge support and being threaded through the space between the two pairs of light aperture defining plates, it passes over one pulley, under a second pulley and has its opposite end secured to a lever pivoted on a shaft. This shaft is connected to one end of a spring, which is wound spirally thereabout,

the other end of the spring being connected to a lever which may be adjusted to effect a refined adjustment of the spring and thereby control the position of the lever, as well as the tension applied to the ribbon. The spring is of such length and it is wound and flexed to apply tension to the ribbon in such manner that variations in its length, produced by changes in temperature, cause the lever to move by an amount substantially equal to and in an opposite direction to the movement of the end of the conductive ribbon caused by such changes in temperature; whereby the position of the ribbon with respect to the aperture determining plates is fixed, the tension applied to it is maintained constant and hence its rate of vibration, i. e., the frequency at which it resonates, is independent of temperature variations, and its response to the different frequency components of the picture band is determined solely by their amplitudes. This has the advantage over prior practice that, instead of tensioning the ribbon to resonate at a frequency which is high compared with the highest frequency of any signal component supplied to it, the conductive ribbon may be adjusted to vibrate at a frequency closely adjacent to the upper limiting frequency of the picture band, or even at this upper limiting frequency, provided its response is properly equalized electrically. Consequently, the ribbon is extremely sensitive to current variations and the tension applied to it may be reduced to a minimum, so that breakages during manufacture and in use are substantially eliminated.

A detail description of the invention follows and is shown in the attached drawings in which:

Fig. 1 is a side elevation of a light valve embodying the invention, partially broken away;

Fig. 2 is an interior face view of one member of the light valve;

Fig. 3 is an interior face view of the second member of the valve; and

Fig. 4 is a side view of the second member partially in section along the broken line 4-4 of Fig. 3.

Referring to Fig. 1, there is shown a side elevation of a light valve consisting of two members A and B, parts of which are in section. Member A consists of a W-shaped yoke 1 having a central leg 2 provided with an axial orifice 3, surrounded by a field winding 4 and carrying a pole-piece 5 provided with a conical opening 6, the larger dimension of which is adjacent the leg 2 and axially aligned with the orifice 3. The yoke 1 also carries a member 7 which encloses a lens system for directing light from a source of constant intensity through the orifice 3 and opening 6 and also serves as a means for securing the valve to a support. The two outer legs 8 of the yoke 1 extend beyond the winding 4, and the member B of magnetic material is secured to the free ends of these legs to complete the magnetic circuit. Member B carries a pole-piece 9 having a conical opening 10, the small end of which is directed toward the opening 6 in the pole-piece 5 and the larger end of which is directed to an aperture 11, in which is mounted an adjustable member 12 enclosing a lens system 13 for directing the light passing there-through to the sensitive recording surface.

Pole-piece 5 is provided with a reduced portion 14 surrounded by a yoke 15 which carries a pair of thin opaque plates 16. These plates are directed toward the center of the opening 6 but with their inner ends spaced apart, so that

they respectively occupy positions closely adjacent to but on opposite sides of the center of the opening 6, to provide a narrow slit. Pole-piece 9 is also provided with a reduced portion 17 adapted to accommodate a yoke 18 which carries a pair of opaque plates 19 directed toward the center of the opening 10. The inner ends of these plates are spaced apart and respectively occupy positions adjacent to but on opposite sides of the center of the opening 10 and thereby form a second slit at an angle to that provided by the plates 16.

Fig. 2 illustrates an interior face view of the member A with the member B removed.

The end plate 20 of the spool carrying the field winding 4 is provided with a flanged plate 21 adapted to guide and hold the member B in fixed position when it is secured to the outer legs 8 of the yoke 1.

The reduced portion 14 of the pole-piece 5 is surrounded by the substantially semicircular portions of two members 22 and 23 which cooperate to form the yoke 15. These members are provided with off-set portions respectively engaging set-screws 24 and 25 and also with extensions 26 and 27 engaged by a tension spring 28, which cooperates with the set-screws to maintain the yoke in yielding engagement with the bearing 14. By actuating the screws 24 and 25, the arms 22 and 23 may be adjusted with respect to each other to properly align the ends of plates 16 and by simultaneously adjusting the screws 24 and 25, the yoke 15 may be rotated about the bearing 14 and hence about the axis of the opening 6 in the pole-piece 5 as a center, whereby the plates 16 may be simultaneously moved to cause the slit, defined by their inner ends, to be accurately adjusted with respect to a vertical plane at right angles to the drawings and passing through the axis of the valve. The left-hand plate 16, carried by the member 22, may be adjusted toward and away from the right-hand plate 16 by a differential vernier adjusting device 29, whereby the space between the inner ends of these plates may be varied and hence the width of the slit regulated. The field winding is connected to a direct current source by means of contacts carried by terminal strip 30 mounted on the end plate 20.

Fig. 3 is an interior face view of the member B inverted, i. e. this member has been rotated about an axis longitudinally thereof, as will be apparent from an inspection of Fig. 1.

The reduced portion 17 of the pole-piece 9 is engaged by a substantial semicircular portion of the yoke 18 which is provided on one side with an arm 31 adapted to engage a spring 32 and on the other with an arm 33 adapted to engage a set-screw 34, whereby the yoke is held in yielding engagement with the bearing formed by the portion 17, but so that it may be rotated about this bearing and hence about the axis of the opening 10 of the pole-piece 9 as a center. The plates 19 are carried by the yoke 18 with their inner ends spaced apart, and respectively occupying positions on opposite sides of the center of the opening 10, to provide a slit. The plates 19 are connected to the yoke 18 by a differential vernier adjusting device 35. By actuating the screw 34, the yoke 18 may be rotated to cause the ends of plates 19 to occupy different angular positions with respect to a horizontal plane passing through the axis of the opening 10 and perpendicular to the drawings, and, by actuating the vernier adjusting device

35, these plates may be simultaneously adjusted so that their inner ends define a slit, the longitudinal axis of which occupies a position substantially at right angles to that of the slit provided by the inner ends of the plates 16. Since the openings 6 and 10 are accurately aligned and the two pairs of plates occupy positions closely adjacent the axis of these openings to provide slits which cross one another, the central portions of the slits cooperate to define an aperture through which light may be transmitted from the light source and through the lens system 13 to the light sensitive recording material. By varying the positions of the plates 16 and 19 with respect to each other and the valve structure, the position of the light aperture may be adjusted with respect to the aligned openings 6 and 10 and the ribbon R, whereby the size of the initial opening, corresponding to a dark elemental area of the picture, may be accurately determined.

Between the two pairs of plates 16 and 19 is a shutter consisting of a flat conductive ribbon R, as shown herein and as more clearly set forth in Fig. 4. One end of this ribbon is secured to a take-up screw 36 at one end of member B, passes over a saddle or bridge 37 of non-conductive material, is threaded through the space between the two pairs of plates 16 and 19, passes over a pulley 38, under a second pulley 39, and its opposite end is secured to one end of a spring controlled lever 40 pivoted in bearings 41 at the opposite end of the member B. The lower end of lever 40 is loaded or weighted, so that it is statically balanced and hence is not deflected by jarring or jolting of the valve. The saddle 37 is provided with a terminal contact 42 which is connected by conductor 43 to the binding post 44, and one of the bearings 41 is connected by a conductor 45 to a binding post 46. The pulleys 38 and 39 are freely rotatable in their bearings and are provided with grooves of substantially the same width as the conductive ribbon R.

The ribbon is mounted for operation as follows. After being placed in position as shown, i. e. extending parallel to and out of contact with the pole-pieces and so as to substantially cover the aperture formed by the plates 16 and 19, the take-up screw 36 is rotated to apply tension to the ribbon. When the proper tension has been applied, the contact 42 is secured in position to complete the electrical connection to the binding post 44, and a fret carried by the saddle 37 cooperates with the pulleys 38 and 39 to hold the ribbon in fixed position relatively to the valve structure. Application of tension to the ribbon causes the lever 40 to be rotated about its pivot to the position shown. The lever is secured to the inner end of a spiral spring 47 having its outer end secured at the point 53 to a lever 48 engaged by a set-screw 49, against which it is held by the spring 50. The set-screw 49 and spring 50 are provided to permit adjustment of the spring 47 to effect an accurate regulation of the tension applied to the ribbon. Adjustment of the lever 40, from its neutral position to that shown, causes the spring 47 to be unwound; whereby a definite tension is applied to the ribbon.

According to prior practice the ribbon was maintained in parallelism with the pole-pieces and out of contact therewith by two supports or bridges, similar to saddle 37. When tension was applied to the ribbon, considerable friction

developed between the ribbon and the surfaces of the supports engaged by it, with the result that the ribbon was not free to move longitudinally under the action of the tensioning means, but was caused to move in jerks. In other words, due to the friction developed between the ribbon and its supports, any variation in the length of the ribbon caused, for example, by changes in temperature, could not be readily taken up by the tensioning means and hence the tension applied to the ribbon was subject to serious fluctuations which detrimentally affected its resonance period and hence its response to the current variations, thereby introducing distortion in the picture recorded.

The pulleys 38 and 39 not only serve to maintain the ribbon in fixed position with respect to the light aperture defined by the plates 16 and 19 but, due to their rotary motion, operate to permit free longitudinal movement of the ribbon, and hence permit lever 40 to rotate in either direction under control of the spring 47 to thereby maintain a constant tension applied to the ribbon.

The conductive element is a duralumin ribbon which is mounted on supports carried by the member B, consisting of iron, and hence the coefficient of expansion of the ribbon due to variations in temperature is twice that of its mount. These temperature variations are caused by current flow through the field winding 4 and the ribbon R, as well as by heat from the light source. Since the ribbon and the member B are subject to substantially the same changes in temperature, the length of the ribbon will vary by an amount twice that of the supporting structure. The spring 47 is of phosphor-bronze and is subjected to the same temperature changes as the valve structure and ribbon. The ends of the spring are secured to elements which are spaced apart a fixed distance, but one end, being connected to the shaft carrying lever 40, is free to move relatively to that secured to the lever 40.

With the take-up screw operated to apply tension to the ribbon and with the regulating means, comprising set-screw 49 and spring 50, actuated to accurately adjust the tension to the desired value, the spring will be unwound. When the length of the spring increases, due to a rise in temperature, a thrust is applied to the shaft thereby tending to move lever 40 in a counterclockwise direction and hence in a direction to increase the tension applied to the ribbon. However, at the same time, the change in temperature causes the ribbon to increase in length, and this increase is greater than the increase in length produced in the supporting member B by an amount sufficient to permit the outer end of lever 40 to move through such an angle that the tension applied to the ribbon is maintained substantially constant. With a decrease in temperature, the length of the spring will be decreased and the length of the element will also decrease, relatively to that of the supporting member B, by an amount sufficient to permit the outer end of the lever 40 to move to a position such that the tension applied to the ribbon is not changed.

In other words, as the length of the ribbon varies and tends to change the tension applied thereto, the length of the spring will vary to move the lever in a direction to change the tension applied to the ribbon in the opposite sense. Thus, variations in the length of the spring are effective to compensate for differences in the expansion and contraction of the ribbon with

respect to the supporting member B. The conductive ribbon is thereby maintained at all times in a plane parallel to but out of contact with the pole-pieces and the aperture defining plates 16 and 19 and at right angles to the steady magnetic field produced by the winding 4, which is supplied with direct current.

The pole-faces are accurately spaced a definite distance apart by virtue of the engagement of member B with the guide plate 21 and the engagement of a non-magnetic stud 51, carried by the member B, with the extended head 52 of one of the screws, which are used to secure the pole-piece 5 to the core 2. The stud 51 is adjustable with respect to member B and extends about fifteen one-thousandths of an inch beyond the face of pole-piece 9. The screw 52 and stud 51 serve to prevent member B from being bent by the magnetic pull of the field produced by winding 4. The openings 6 and 10 in the pole-pieces are axially aligned and the two pairs of plates 16 and 19 may be accurately adjusted to definite positions with respect to the axes of these openings and each other, to define a light aperture.

With any given set of operating conditions, the tension applied to the ribbon may be only slightly greater than that necessary to cause its natural period of vibration to correspond to that of the current component of maximum frequency present in the picture band. In other words, the tension applied to the ribbon may be reduced to substantially the minimum possible under the prescribed operating conditions, to provide a light valve of extremely high sensitivity. Again by using electrical compensation, as disclosed in U. S. Patent 1,324,054, December 9, 1919 to Irwin, the tension may be reduced to a value such that it is just sufficient to cause the natural period of vibration of the ribbon to correspond to that of the current component of maximum frequency present in the picture band.

While in the preceding description the plates 16 and 19 cooperate to provide a light aperture which is substantially rectangular, the ends of the plates 16 may be so designed and mounted that they occupy a position at any angle to the reference plane passing through the axis of the openings in the pole-pieces, and hence so as to cooperate with plates 16 to define an aperture which is rhomboidal. In this case, a substantially triangular portion of each trace overlaps a similar triangular portion of the preceding and following traces, with the result that no line structure is visible in the reproduced picture. The angular position of the plates 16 and hence the amount of overlap may be varied, within limits, by varying the position of plates 16 with respect to plates 19.

In operation the incoming picture current is supplied through the binding posts 44 and 46 to the conductive ribbon R, which is thereby caused to vibrate transversely in a fixed horizontal plane.

In one design of light valve used for recording a picture of a remotely scanned subject, the plates 16 and 19 were adjusted to provide a light aperture having a width of the order of two one-hundredths of an inch and a height of seven one-thousandths of an inch, and the ribbon was initially adjusted to provide an aperture, the height of which was seven ten-thousandths of an inch. In other words, with no signal current passing through the ribbon, the latter cooperated with the plates 16 and 19 to provide a light aperture two one-hundredths

of an inch wide by seven ten-thousandths of an inch high, representing a dark elemental area, and when picture current passes through the ribbon and the latter was caused to vibrate, the width of the light aperture remains fixed, but its height varied from seven ten-thousandths of an inch to a maximum of seven one-thousandths of an inch. The latter represents a white elemental area. Associated with the aperture is an optical system which reduces the size of the light spot applied to the film to one-half that given above. Thus, for initial adjustment the light spot at the film is one one-hundredth of an inch wide and three and one-half ten-thousandths high, and for maximum opening the light spot is one one-hundredth of an inch wide and three and one-half thousandths high.

The length of the ribbon between the saddle 37 and the upper end of lever 40, i. e. the portion of the ribbon which is free to expand and contract, because of changes in temperature, was approximately three inches, and the length of the coiled spring 47 was substantially the same. The tension applied to the ribbon was such that its natural period of vibration did not cause it to selectively respond to any frequency component within the picture band, which extends from zero to approximately 1200 cycles, its tension was so regulated, by the tension control means, that its resonance period was maintained substantially constant at 1200 cycles, and its response was electrically compensated for that particular frequency in the manner disclosed in the above mentioned Irwin patent and hence the lateral position of the ribbon with respect to the aperture was directly proportional to the amplitude of the picture current flowing through it at any given instant of time. Consequently, its position varied from instant to instant in accordance with the variations in the amplitudes of the picture current.

In case the change of tension due to change of temperature does not need to be taken into consideration in the design of a particular valve, it becomes immaterial whether the tension on the ribbon is produced by winding or unwinding the spring from its neutral position.

From the preceding description it will be apparent that the present invention provides a light valve having means for controlling the tension applied to the ribbon, including elements that enable the ribbon to move freely in a longitudinal direction, and which is so designed that it operates to compensate the effect of differences in the expansions and contractions of the ribbon and its supporting base, whereby any tendency to cause a variation in the length of the ribbon, and hence in the tension applied to it, may be compensated; with the result that the ribbon is always maintained in a fixed plane parallel to and out of contact with the juxtaposed faces of the pole-pieces.

It is to be understood that, for a square or rectangular light aperture, the ends of the plates 16 and 19 are at right angles to each other and for a rhomboidal aperture, these ends will occupy positions other than at right angles to each other. Throughout the detailed description, reference planes have been referred to as vertical and horizontal. These designations only apply when the valve is mounted in the position shown in the drawings and hence the description must be interpreted accordingly. Should the mounting of the valve be changed, the respective refer-

ence planes will occupy positions other than vertical and horizontal.

What is claimed is:

1. A light valve comprising a plurality of pole-pieces for setting up a constant magnetic field, each pole-piece having an axial opening and a reduced portion constituting a bearing, a conductor supplied with signal current suspended between said pole-pieces, a support engaging the respective bearings and each provided with a plurality of opaque elements having their ends spaced apart, and means for adjusting said supports to bring the ends of said elements in register for defining a light aperture.

2. A light valve comprising a plurality of pole-pieces for setting up a constant magnetic field, each pole-piece having an axial opening and a reduced portion constituting a bearing, a conductor supplied with signal current suspended between said pole-pieces, a support engaging the respective bearings and each provided with a plurality of opaque elements having their ends spaced apart, and means for adjusting said supports to bring the ends of said elements in register for defining a light aperture and for controlling said supports to effect relative adjustment of said registering elements to vary the shape of said light aperture.

3. A light valve as described in claim 2 having means for adjusting at least one of said elements for varying one dimension of said light aperture.

4. A light valve as described in claim 2 including means for adjusting one plurality of elements with respect to the other for controlling the position of said light aperture with respect to said conductor.

5. A light valve comprising a plurality of oppositely disposed pole-pieces having aligned openings, a support on each pole-piece carrying a plurality of movable elements, means for adjusting said supports operable externally of the valve, and means carried by said supports for moving said elements with respect to said aligned openings to provide a light aperture of variable shape and size.

6. A light valve comprising a plurality of oppositely disposed pole-pieces for setting up a constant magnetic field and having aligned openings, a conductor having one terminal fixed, a support having movable elements engaging an intermediate portion of said conductor, and a movable member connected to the other terminal of said conductor for holding it in a plane parallel to the faces of said pole-pieces to constitute a shutter for said aligned openings, and means controlling said member and inversely responsive to conditions affecting said conductor, for maintaining a uniform tension applied to said conductor.

7. A light valve comprising a plurality of oppositely disposed pole-pieces for setting up a constant magnetic field and having aligned openings, a conductive ribbon, means for supporting said ribbon in a plane parallel to said pole-pieces to constitute a shutter for said aligned openings, comprising a fixed support to which one of its terminals is connected, a plurality of supports having movable elements engaging an intermediate portion of said ribbon and a movable member to which the other terminal of said ribbon is connected, and a spiral spring, responsive to temperature changes, for controlling said member to compensate variations in the length of said conductor.

8. A light valve comprising a plurality of op-

positely disposed pole-pieces for setting up a constant magnetic field and having aligned openings, a conductive ribbon, means for supporting said ribbon in a plane parallel to said pole-pieces to constitute a shutter for said aligned openings, comprising a fixed support to which one of its terminals is connected, a plurality of supports having movable elements engaging an intermediate portion of said ribbon and a movable member to which the other terminal of said ribbon is connected, and a spiral spring having one end secured to said member and its other end secured to a lever and responsive to temperature changes, for oscillating said member to thereby compensate variations in the length of said conductor due to changes in temperature.

9. A light valve comprising a linear vibratable element having an appreciable temperature coefficient of expansion, a base support, stationary means for holding one end of said element stationary on said base support, and means for placing said element under tension and maintaining said tension substantially constant irrespective of temperature changes comprising a lever pivoted on said base support having one arm many times as long as the other and having its long arm attached to the end of said element remote from said stationary holding means, a spirally coiled spring having one end attached to the short arm of said lever, and adjustable means attached to said base support for holding the other end of said spring stationary, whereby changes in temperature of said element have little effect upon the force exerted by said spring on said element through said lever.

10. A light valve comprising a linear vibratable element having an appreciable temperature coefficient of expansion, a base support, stationary means for holding one end of said element stationary on said base support, and means for placing said element under tension and maintaining said tension substantially constant irrespective of temperature changes comprising a lever pivoted on said base support having one arm many times as long as the other and having its long arm attached to the end of said element remote from said stationary holding means, a spirally coiled spring having one end attached to the short arm of said lever, and adjustable means for holding the other end of the spring stationary on said base support in such position that the spring is normally unwound from its neutral position, whereby when said element increases in length due to a rise in its temperature the force exerted by the spring tends to decrease due to a tendency of the spring to weaken but tends to increase due to an increase in its length, and whereby, aside from changes in length of the spring with temperature, a change in length of said element with a change of its temperature has little effect upon the force exerted by said spring on said element through said lever.

11. A light valve comprising a linear vibratable element having an appreciable temperature coefficient of expansion, a base support, stationary means for holding one end of said element stationary on said base support, and means for maintaining said element under tension comprising a lever pivoted on said base support having one arm many times as long as the other and having its long arm attached to the end of said element remote from said stationary holding means, a coiled spring having one end attached to the short arm of the lever, said spring

measured along its coils being substantially as long as said element, and means attached to said base support for holding the other end of said spring in adjustable fixed position relative to said base support.

12. A light valve comprising a linear vibratable element having an appreciable temperature coefficient of expansion, a base support, stationary means for holding one end of said element stationary on said base support, and means for placing said element under tension and maintaining said tension substantially constant irrespective of temperature changes comprising a lever pivoted on said base support having one arm many times as long as the other and having its long arm attached to the end of said element remote from said stationary holding means, a coiled spring having one end attached to the short arm of the lever, said spring measured along its coils being substantially as long as said element, and adjustable means for holding the other end of said spring stationary on said base support in such position that an increase in length of said element due to an increase in its temperature would tend to weaken said spring if the temperature of the latter were kept constant while that of said element increases.

13. A light valve comprising a linear vibratable element having an appreciable temperature coefficient of expansion, a base support, stationary means for holding one end of said element stationary on said base support, and means for placing said element under tension and maintaining said tension substantially constant irrespective of temperature changes comprising a spiral spring, a rotatable shaft to which the inner end of said spring is fixedly attached, an arm rigidly supported on said shaft and having its end attached to the end of said element remote from the stationary end thereof, the length of said spring being substantially the

same as that of said element, and adjustable means for holding the outer end of said spring stationary on said base support, whereby changes in length of said element with changes of its temperature have little effect upon the force exerted by said spring upon said element through said lever.

14. A light valve comprising a linear vibratable element, a base support, stationary means for holding one end of said element stationary on said support, means for placing said element under tension comprising a spiral spring, adjustable means for holding the outer end of said spring stationary on said base support, a rotatable shaft on said base support to which the inner end of said spring is fixedly attached, an arm fixed to said shaft, said vibratable element being attached to the other end of said arm, bridge means on said base support across which said vibratable element is held by the tension of said spring, the portion of said bridge means contacting said vibratable element being freely movable in the direction of the length of said element as said element expands and contracts as its temperature changes, and means for passing an electric current through said vibratable element and said spring in series.

15. A light valve comprising a base support, a vibratable element extending longitudinally of said support, stationary means carried by said base to which one end of said element is secured, means carried by said base and secured to the opposite end of said element for regulating the tension applied thereto, and, adjacent said tension regulating means, a bridge for said element comprising a plurality of rotary members the axes of which lie in different planes, said element engaging the upper peripheral surface and then the lower peripheral surface of the respective members.

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