Jan. 13, 1931. F. W. REYNOLDS 1,788,472

LIGHT VALVE ADJUSTING MEANS

Filed July 7, 1928

FIG. 1.

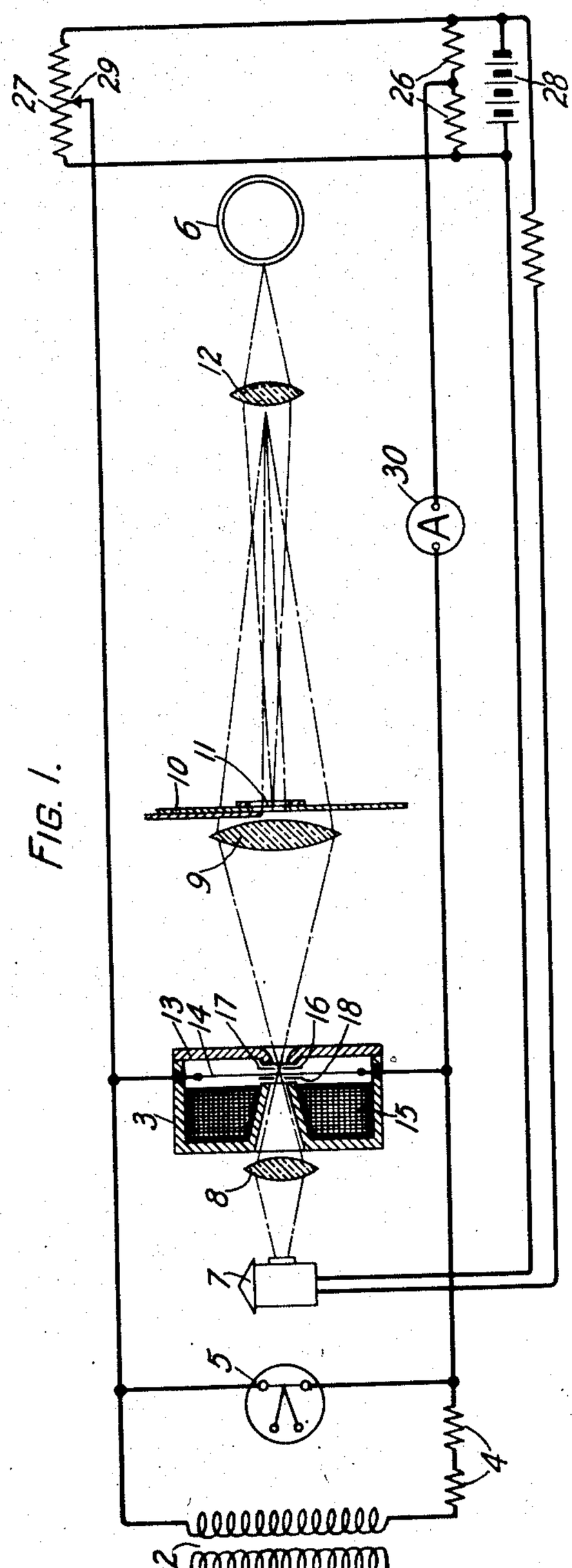
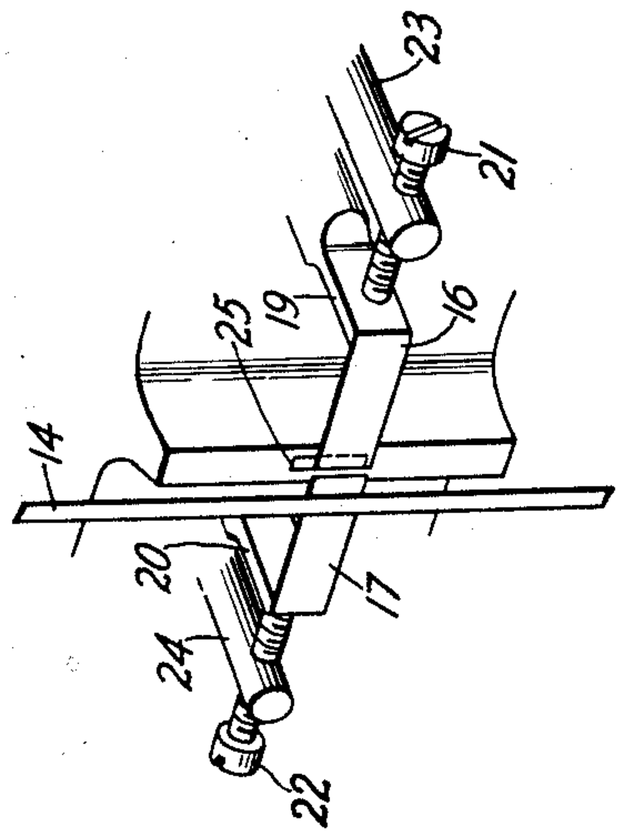


FIG. 2.



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UNITED STATES PATENT OFFICE

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LIGHT-VALVE-ADJUSTING MEANS

Application filed July 7, 1928. Serial No. 291,025.

This invention relates to light valves and particularly to means for obtaining an accurate adjustment of the light valve ribbon or conductor of an electromagnetic light valve to give it a desired position or initial bias with respect to the light aperture.

An object of the invention is the provision of means, which can be simply and cheaply constructed, for quickly and accurately adjusting the initial position of the vibrating element of a light valve with respect to the aperture.

In its preferred embodiment the invention is particularly applicable to an electromagnetic light valve of the type disclosed in U. S. Patent to H. E. Ives, No. 1,667,805, granted May 1, 1928. In this form of light valve adjustable jaws are provided for forming the sides of the light aperture and the conductor is in the form of a ribbon suspended in front of the light jaws in a magnetic field. Incoming modulated current passes through the vibrating conductor and reacts with the magnetic field to cause the aperture to be uncovered to permit light to pass in accordance with the modulations of the current. The invention in its preferred form comprises a source of potential in the form of a potentiometer connected across the vibrating ribbon in parallel to the incoming lines. The ribbon may then be quickly centered or otherwise positioned with respect to the light jaws by manual manipulation of the potentiometer. Heretofore light valves of this type have been adjusted by mechanical adjustment of the jaws forming the light aperture and considerable time has been required to make the adjustment.

The invention will be better understood from the following detailed description of the present preferred embodiment of the invention and accompanying drawings in which

Figure 1 is a diagrammatic showing of a telephotographic receiving circuit containing a light valve and circuits for adjusting the bias of the ribbon and also showing the light valve optical system, and

Fig. 2 is a fragmentary perspective view of a portion of the light valve, greatly enlarged, including the ribbon and the aperture forming jaws.

Referring to Fig. 1, which is based upon apparatus and circuits employed in one form of a commercial picture transmission system now in use, the picture currents reach transformer 2 over circuit 1, and, after transformation, pass to light valve 3 through damping resistance 4. A thermocouple 5 indicates the voltage applied to the terminals of the light valve. The incoming picture current is in the form of a modulated alternating current, the amplitude of which varies in accordance with the tone values of elemental areas of the picture. Suitable apparatus and circuits for producing, transmitting and receiving this type of current are disclosed in Patent 1,606,227 to J. W. Horton, H. E. Ives and M. B. Long, November 9, 1926. The light valve is of the type disclosed in this patent and is described in greater detail in H. E. Ives Patent 1,667,805, May 1, 1928. It comprises a string or ribbon which is caused to vibrate at the frequency of the modulated current and to pass more or less light according to the amplitude of its movement. The picture at the transmitting station is in the form of a transparency wrapped about a rotating drum which is progressively moved axially. The picture is reproduced at the receiving station upon a light sensitive film wrapped about the drum 6 which moves synchronously with the drum at the transmitting station. Light from the lamp 7 passes through lens 8 and the light valve aperture to lens 9 and thence through aperture 11 of baffle plate 10. The illumination in aperture 11 varies with the size of the light valve opening. An objective lens 12 located near the image of the ribbon 14 formed by lens 9 forms an image of aperture 11 upon the picture drum 6. The latter image varies in brightness as the light valve opens or closes and so forms a trace of varying density but uniform width upon the film upon drum 6.

The light valve comprises a single ribbon 14 (Figs. 1 and 2) of duralumin 0.00675 of an inch thick and approximately 0.01 of an inch wide. It is suspended in a strong mag-

netic field produced by field winding 15 and vibrates laterally in the plane of its flat surface, the length of the vibratable portion being approximately 1.25 inches. The tension of the string or ribbon 14 is such that the natural period of vibration is about 2500 cycles per second. The field coil 15 is supplied with current of constant strength (from a source not shown) to produce a flux density of approximately 35,000 gauss in the air gap between the pole pieces. The ribbon normally covers an aperture between jaws 16 and 17 carried by arms 19, 20 and adjustable by screws 21, 22 carried by supports 23, 24. The front plate 13 has an aperture 25 therein in line with the ribbon and opening between the jaws 16 and 17. The height of the effective opening through the light valve is controlled by plate 18 having a horizontal slot therein. This plate is positioned on the side of the ribbon opposite the front plate 13. A set of plates having slots of different widths are supplied with the light valve.

To maintain the proper exposure through the light valve it has been necessary occasionally to adjust the aperture jaws since a bias of the ribbon occasionally occurs and this can only be corrected by adjustment of the jaws. These adjustments are exceedingly minute since the total width of the string 14 is approximately 1/100 of an inch. They are made with the usual alternating current input to the light valve corresponding to minimum light conditions at the sending machine. In one form of commercial apparatus now in use the input to the valve for this condition is about 14 TU less than 30 milliamperes as measured in the thermocouple 5. The image of the jaws is viewed on a screen temporarily placed over the face of objective lens 12 in Fig. 1. Each jaw is moved to the right or left until the openings produced at the two sides of the ribbon as it vibrates are of equal width or brightness. Due to the necessity for separately adjusting both jaws while maintaining a correct distance between them and due to the minuteness of the adjustment, it frequently requires half an hour to make it.

In accordance with the present invention the centering of the ribbon may be very quickly and accurately obtained without adjustment of the jaws. This is accomplished by shunting across the light valve ribbon terminals a source of direct current whose value can be quickly and accurately adjusted and whose polarity can be quickly changed. Referring to Fig. 1 resistances 26 and 27 are bridged across battery 28 which supplies current to the lamp 7. One terminal of the light valve ribbon is connected by a lead to the mid-point of resistance 26 and the other terminal is connected by a lead to a sliding contact 29 on resistance 27. In one commercial embodiment of apparatus, each half of resistance 26 is 300 ohms and resistance 27 is 750 ohms. Battery 28 is of 24 volts. The impedance of the light valve circuit as measured at the ribbon terminals is less than two ohms and therefore the bridged circuit does not have any appreciable effect upon the characteristics of operation of the light valve, such as its damping coefficient, etc. The direct current which flows through the light valve ribbon as a result of this connection reacts with the contant field of coil 15 to give the ribbon a constant bias to the right or left. The desired amount of bias is obtained by moving adjustable contact 29 to the right or left upon resistance 27. The constants of the bridged circuit permit a variation in the bias current from 0 to +40 and 0 to −40 milliamperes. Ordinary variations in ribbon bias will not require more than 20 milliamperes for accurately centering the ribbon. If, due to unusual conditions, such as breakage of the light valve ribbon, more than 40 milliamperes are required, it is preferable to check the mounting of the ribbon and approximately recenter it mechanically with no direct current therethrough. The amount of bias current is indicated by the milliammeter 30.

The centering of the ribbon using this method is very simple and rapid. It is made with the usual alternating current input to the light valve corresponding to minimum light conditions and visual inspection of the ribbon image is made while contact 29 is moved until the openings at both sides of the ribbon are the same.

The light output of the valve is about 4% for minimum current at the sending machine, which corresponds to an alternating current input to the light valve of about 20% of that for maximum current at the sending machine, to obtain negatives suitable for commercial printing, when a certain standard light sensitive film is employed. If, however, the light valve ribbon is given a certain definite bias to one side of the center of the aperture, the light output may be increased. For example, if the ribbon is given a bias produced by 45 milliamperes the light output for minimum picture current is raised to about 11%. This will yield a flat negative from an average picture used at the sending machine. Thus it is possible to alter considerably the effective input-output characteristic of the light valve by known amounts using a measured value of direct current bias as indicated by the milliammeter 30. Within limits this will give the same result as substituting a film having a different emulsion contrast characteristic. Therefore the invention is useful not only to center the ribbon but to obtain a desired adjustment off-center.

While the non-mechanical ribbon centering or adjusting means of this invention have been described above as applied to a specific

form of light valve, it is obvious that it is applicable to other forms of the type in which reaction occurs between a current carrying ribbon and a stationary field of force.

What is claimed is:

1. Light valve apparatus comprising a vibratable straight conductor through which received current flows, means for setting up a field of force which reacts with the current in said conductor, means for forming a light aperture in line with said conductor and a source of light, and means for accurately centering said conductor with respect to said aperture comprising a Wheatstone bridge circuit having a source of direct potential across two conjugate points thereof and said conductor directly across the other two conjugate points thereof, whereby said circuit is in shunt to said conductor with respect to said received current, the impedance of said bridge circuit to said received current being high compared with that of said conductor.

2. Light valve apparatus comprising a straight vibratable conductor through which received current flows, means for setting up a field of force which reacts with the current in said conductor, means for forming a light aperture having its center approximately in line with the longitudinal axis of said conductor and a source of light, and means for accurately centering said conductor with respect to said aperture and light source comprising a circuit in shunt to the terminals of said conductor, a source of direct potential in said circuit, means in said circuit for preventing an appreciable amount of said received current from flowing therein, and means in said circuit for accurately adjusting the amount of direct potential applied to said conductor.

In testimony whereof, I have signed my name to this specification this 6th day of July, 1928.

FREDERICK W. REYNOLDS.