

Sept. 12, 1950

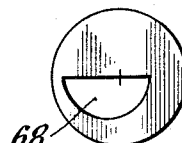
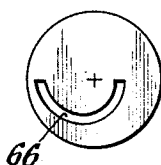
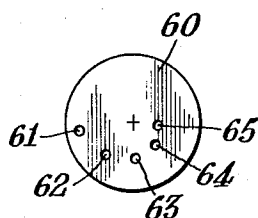
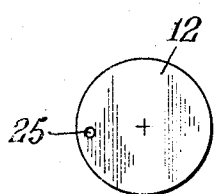
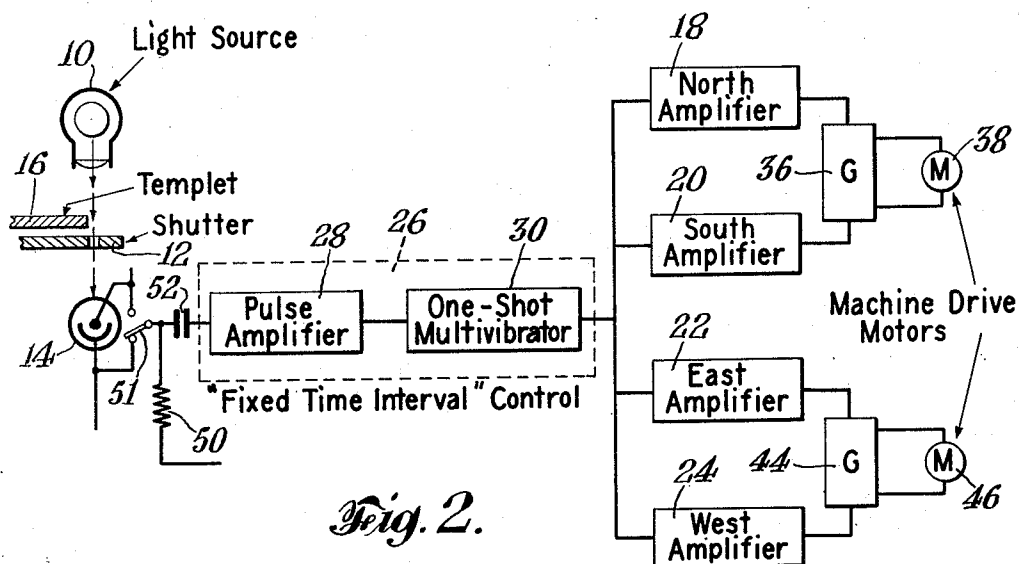
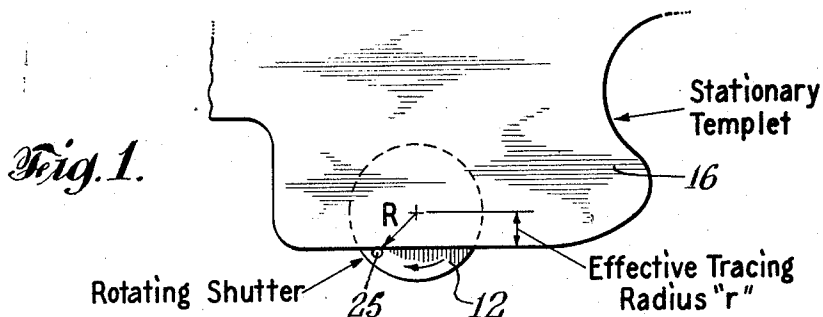
E. RATHJE

2,521,946

FIXED TIME INTERVAL LINE TRACKER CONTROL

Filed Aug. 30, 1949

2 Sheets-Sheet 1



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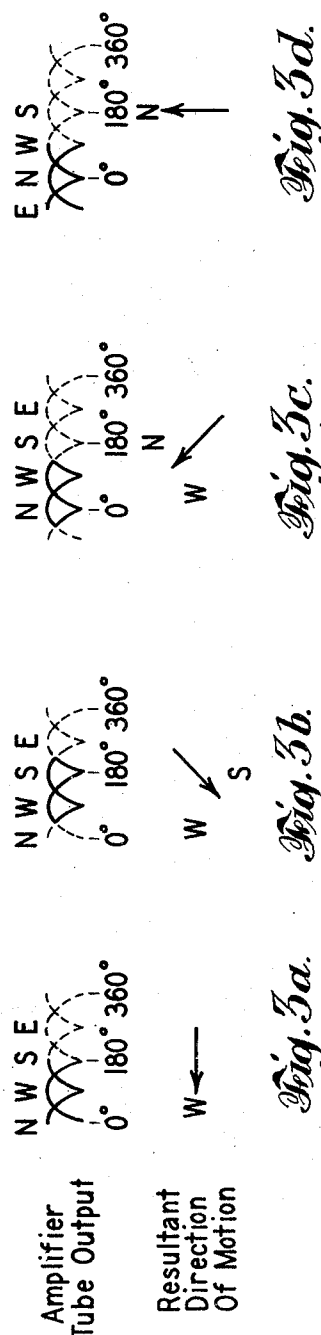
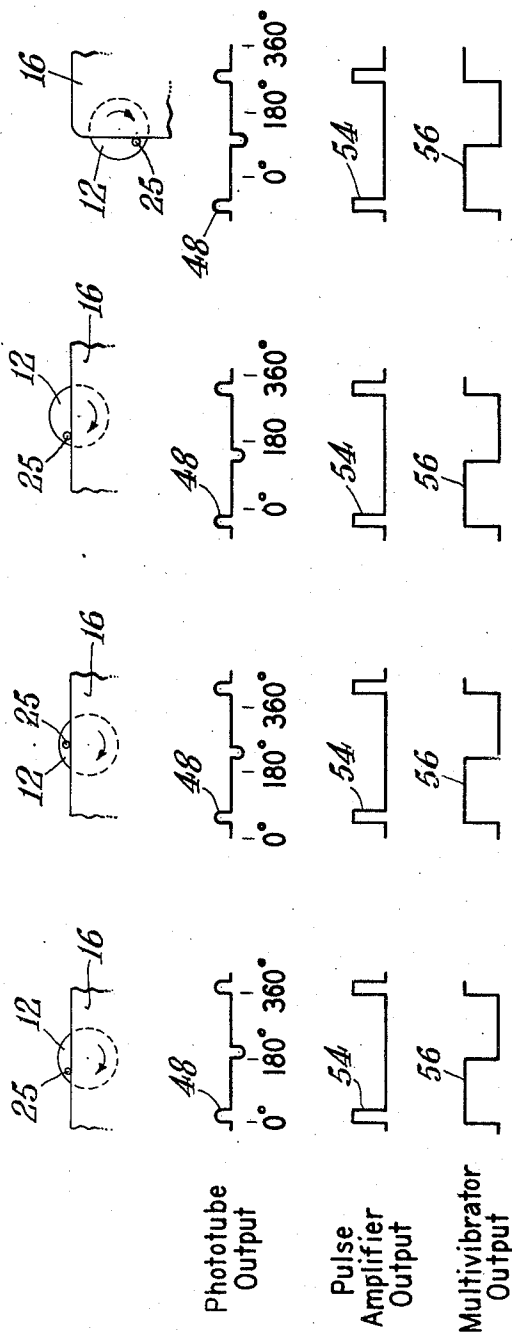
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FIXED TIME INTERVAL LINE TRACKER CONTROL

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2 Sheets-Sheet 2



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2,521,946

FIXED TIME INTERVAL LINE TRACKER
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Application August 30, 1949, Serial No. 113,168

5 Claims. (Cl. 250-202)

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This invention relates to line tracker controls for contour reproduction of the type disclosed in Fowle and Kennedy Patents 2,397,933 and 2,430,924.

In the Fowle and Kennedy system impulses from a photocell are directly transmitted to quadrature phase spaced power amplifier tubes in such a way that one correcting tube current changes at a greater rate than the opposite correcting tube current, which adversely affects the sensitivity of the device. Furthermore, the direct-coupling between the photocell and the power amplifier tubes is not entirely stable. It also limits the amplification factor. Another disadvantage is that tracing is limited to the inside of the templet, i. e., when light is applied to the photocell. Also a non-uniform light pattern at every point around the tracing circle has an adverse effect on the operation of the tracer.

The main object of this invention is to provide an improved line tracker control in a contour reproducer of the type disclosed in such Fowle and Kennedy patents. Other objects are to provide a line tracker control which is more sensitive, can accommodate a variety of shutters with different operating characteristics, is more stable, capable of greater amplification, can be adjusted for tracing either the inside or outside of the templet, eliminates the adverse effects of a non-uniform light pattern on the operation of the tracer, and is simple and economical in its parts. Other objects will be clear to those skilled in the art from the following description.

According to the invention there is provided a contour reproducing device having a line tracker control including four amplifiers and a photocell, provided with a fixed time interval control circuit coupling such photocell and the four amplifiers, including a pulse amplifier and a one-shot multivibrator, which improves the operation of the device by limiting the amount of time the photocell impulses are transmitted to the amplifier tubes. More specific features and additional advantages of the invention are set forth below.

In the drawings:

Fig. 1 is a plan view of a templet and pin-hole shutter illustrating the operation of the invention;

Fig. 2 is a simplified block-diagram of a fixed time interval line tracker control embodying the invention;

Figs. 3a-3d are time-space diagrammatic representations further illustrating the operation of the improved control system; and

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Figs. 4a-4d are plan views of several different shutters which can be used with the new control.

As shown in Fig. 2 a source of light 10, a rotating shutter 12 and a photocell 14 are mounted in a tracing head so as to travel horizontally as a unit with respect to a stationary templet 16 which is disposed, for example, in a horizontal position between the light 10 and the shutter 12. The photocell 14 is coupled to quadrature phase spaced amplifiers 18, 20, 22 and 24 by a fixed time interval control circuit 26 comprising a pulse amplifier 28 and a one-shot multivibrator 30. The amplifiers 18 and 20 are connected to a generator 36 which energizes a north-south motor 38. The amplifiers 22 and 24 are connected to a generator 44 which energizes an east-west motor 46. The motors 38 and 46 drive the machine (not shown) which carries the unit containing light 10, shutter 12 and photocell 14.

For purposes of illustration, the operation of the system when using a pin-hole shutter, as shown in Figure 1, will be described first. The shutter 12 rotates at synchronous speed as in the patented method and thus provides means for timing the operation of the four amplifiers 18-24.

Referring to Figure 3a, when the shutter 12 rotates to the position shown, light falls through pin-hole 25 upon the phototube 14, and a voltage pulse 48 is developed across a load resistor 50 connected in series with the phototube by a switch 51. Such resistor is capacitively coupled at 52 to the pulse amplifier 28 which amplifies the pulse without changing the timing. The amplified pulse 54 is used to trigger the one-shot multivibrator 30. This is a well known component (see page 277, Industrial Electronics Reference Book) which gives a pulse output 56 of a fixed time duration, the beginning of such pulse 56 coinciding with the trigger pulse 54.

The square wave output 56 of the multivibrator 30 is applied to the grids of the four amplifier tubes 18-24, and from there the operation of the system is the same as that of the Fowle and Kennedy patents. With the timing shown in Figure 3a, the "West" tube 24 gives maximum output W, the "North" and "South" tubes 18 and 20 gives one half maximum output N and S which balances out in the "North-South" generator 36. The resultant motion of the machine is in the "West" direction.

Figure 3b shows how a correcting motion is obtained when the templet 16 is too far over the tracing head. In this case light hits the phototube 14 some 45 degrees later and the square

wave output 56 of the multivibrator 30 is applied to the grids of the power tubes forty-five degrees later, resulting in a decrease in the "North" current and an increase in the "South" current, thus providing a strong correcting drive to bring the templet 16 back to the nominal tracing radius.

Figure 3c shows how a correcting drive is obtained when the templet 16 is not far enough over the tracing head.

Figure 3d shows how a change in direction is obtained when the contour of the templet changes.

The sensitivity of the tracer can be varied by varying the radius R (Fig. 1) of the pin-hole 25, and the effective tracing radius r can be varied by changing the timing of the shutter by shifting the stator of the shutter driving motor a fraction of a revolution in either direction.

The operation of the present control system is not limited to use with a simple pin-hole shutter 12. In fact better control of the sensitivity and the tracing radius can be obtained by using a shutter 60 (Fig. 4b) with a series of pin-holes 61-65 at varying radii from the center of the shutter. Other modifications are the eccentric arcuate slot 66, and eccentric semi-circular opening 68 (Figs. 4c and 4d) which are very successful.

Some of the advantages of the present improved control are: increased sensitivity of the system, because one correcting tube current is increased while the opposite correcting tube current is decreased, whereas with the Fowle and Kennedy system one correcting tube current is increased or decreased at a greater rate than the other. Any one of a variety of types of shutters can be used, each with different operating characteristics. The A.-C. coupling between the phototube and the power tubes is much more stable and capable of greater amplification than a direct-coupling between the phototube and the power amplifier tubes. Tracing on either the inside or the outside of the templet for cutting male and female mating pieces is possible and can be accomplished by simply adjusting switch 51 so that the system can use either the pulse when light strikes the phototube, or the other (dark) pulse when light is cut off the phototube. The effects of a non-uniform light pattern on the operation of the tracer are eliminated. As long as there is sufficient light at every point around the tracing circle to trigger the multivibrator 30, any light variations above this minimum value will have no effect upon the timing of the four power output tubes.

What is claimed is:

1. In a line tracker control system comprising a photocell and quadrature phase spaced power amplifier tubes for reproducing contours, a fixed time interval control circuit comprising a pulse amplifier and a one-shot multivibrator coupled to said amplifier, said circuit being connected between such photocell and the quadrature phase spaced power amplifier tubes and acting to limit the amount of time each photocell impulse is transmitted to said amplifier tubes.

2. In a line tracker control, the combination with a phototube and quadrature phase spaced power amplifiers, of a time interval control circuit coupling said phototube to said amplifiers for the purpose of improving the operation of the control by limiting the amount of time each impulse from the phototube is transmitted to the power amplifier tubes.

3. In a contour reproducer comprising a line tracker control including quadrature phase spaced power amplifiers and a tracing head including a photocell responsive to light impulses transmitted through a shutter which rotates at a fixed speed, a fixed time interval control circuit comprising an impulse amplifier operatively associated with said photocell, and a one-shot multivibrator operatively associated with said impulse amplifier and said power amplifiers which applies an impulse of fixed duration to said power amplifiers in response to each triggering impulse from said photocell occurring when said multivibrator is not applying an impulse to the power amplifiers, whereby the operation of the contour reproducer is stabilized.

4. In a line tracker control system comprising quadrature phase spaced power amplifiers and a photocell for reproducing contours, a pulse amplifier, an alternating current coupling connecting said pulse amplifier to said photocell, and a multivibrator connected to said pulse amplifier and to said power amplifiers.

5. In a line tracker control system, as defined by claim 4, means for switching said photocell for response of the system to either light or dark impulses on the photocell.

EDWARD RATHJE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,397,933	Fowle et al.	Apr. 9, 1946
2,430,924	Fowle et al.	Nov. 18, 1947