July 2, 1929. A. G. COOLEY 1,719,392

PHOTOTELEGRAPHY

Filed Oct. 9, 1925 2 Sheets-Sheet 1

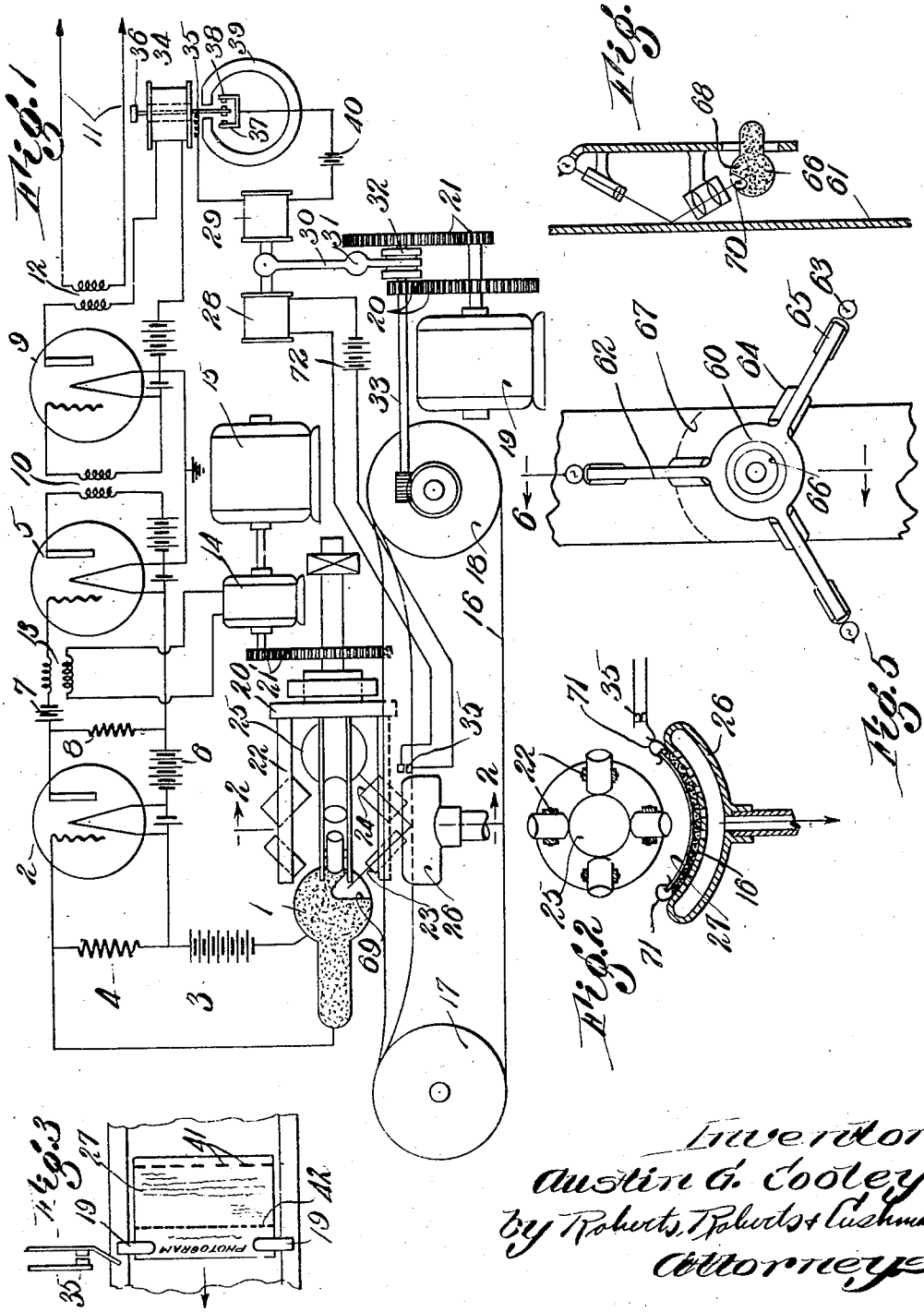


Fig. 1

Fig. 6

Fig. 5

Fig. 2

Fig. 3

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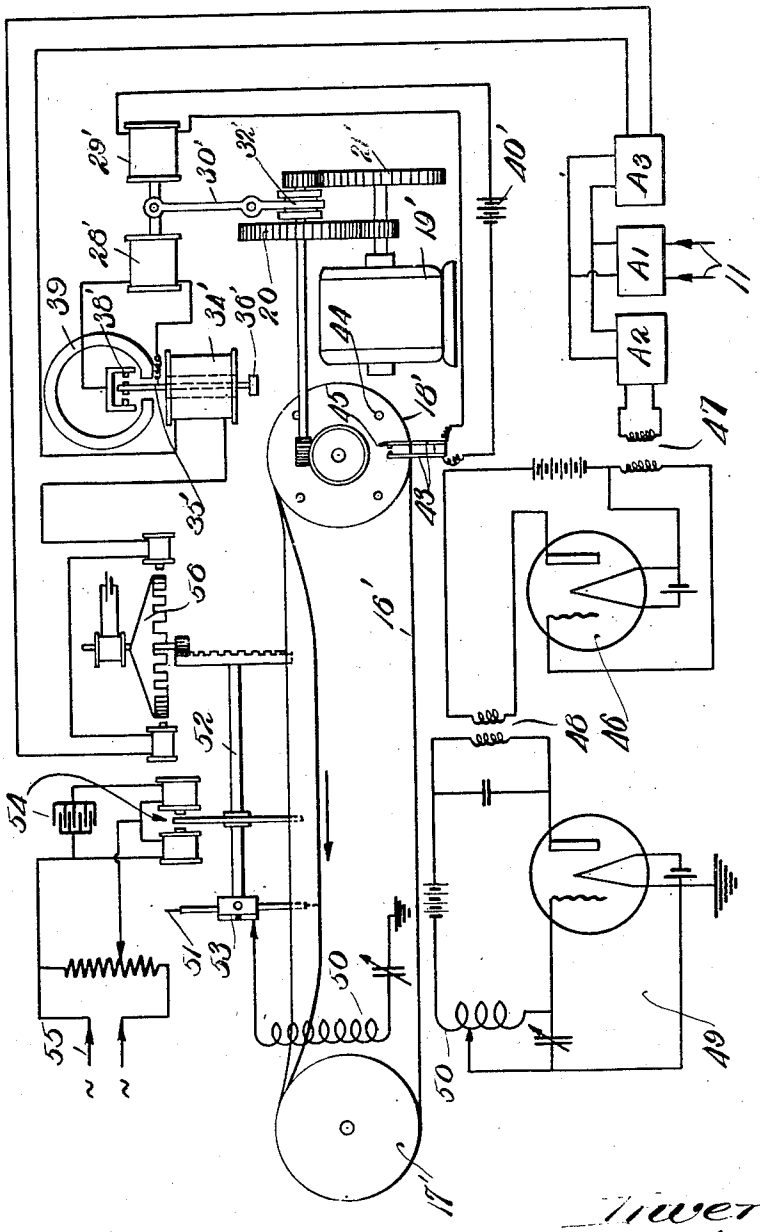


Fig. 4

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Patented July 2, 1929. 1,719,392

UNITED STATES PATENT OFFICE.

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PHOTOTELEGRAPHY.

Application filed October 9, 1925. Serial No. 61,441.

This invention relates to the art of phototelegraphy, and various parts of the subject-matter herein disclosed are claimed in my prior applications Serial Nos. 755,336 and 755,339, filed on December 11, 1924, and my prior Patent No. 1,593,651, granted July 27, 1926.

The principal objects of the invention are to provide a phototelegraphic system in which a series of printed messages, pictures or other subjects-matter may be transmitted successively and automatically, and received in similar manner, preferably by producing relative movement between parts of the sender and receiver respectively in two dimensions and synchronizing the sender and receiver movements in one dimension only.

Other objects of the invention will be apparent from the following description and claims, read in connection with the illustrative embodiments shown in the accompanying drawings, in which:

Fig. 1 is a diagrammatic representation of the mechanism at the sending station;

Fig. 2 is a section on line 2–2 of Fig. 1;

Fig. 3 is a plan view of a detail of the system shown in Fig. 1;

Fig. 4 is a diagrammatic representation of an illustrative form of receiving system;

Fig. 5 is a plan view of a modification; and

Fig. 6 is a side view of the modification shown in Fig. 5.

Referring to Fig. 1, 1 represents a photo-electric cell connected to an amplifier 2 through a source of current 3 and in parallel with a resistance 4, 5 a second amplifier connected to the output circuit of the amplifier 2 through batteries 6 and 7 and in parallel with a resistance 8, 9 a third amplifier connected to the output side of amplifier 5 through a transformer 10, and 11 a line coupled to the amplifier 9 through transformer 12 and extending to the receiving station shown in Fig. 4. It will be understood that as many amplifiers as desired may be used at the transmitting station and that the transmitter may be adapted either for line transmission or radio transmission. Connected to the aforesaid circuit by transformer 13 is a source of alternating current 14 driven by motor 15 at predetermined speed. Variation of the resistance of the photo-electric cell 1 in accordance with the subject-matter to be transmitted superimposes upon the grid of audion 5 potential variations which control the amplitude of the alternating current signals in line 11 originating at generator 14, thereby causing the receiving apparatus to reproduce the subject-matter all as described more fully in aforesaid Patent No. 1,593,651.

According to this invention the subjects-matter to be transmitted may for example be mounted upon a conveyor belt 16 travelling over guide rollers 17 and 18 and driven by a motor 19 through either of two sets of gears 20 and 21. When transmitting telegrams for example, the printed telegrams are attached to the conveyor 16 and fed in succession past optical tracing or scanning means which moves transversely of the path of the conveyor and focuses light from a small spot of the subject-matter on the photo-electric cell. The telegrams may be attached to the belt by means of clips 71 fast to the conveyor at opposite sides thereof, opposite sides of the telegram being slipped under these clips so that the telegram lies flat upon the conveyor.

The scanning or tracing means may take any one of many forms but in the particular embodiment shown in Fig. 1 this means comprises a carrier 20 rotating about an axis extending along the longitudinal center of the photo-electric cell 1. This carrier may be driven from motor 15 through gears 21′ in synchronism with the impulses transmitted to the line through transformer 13 from generator 14. The rotary carrier has four longitudinal arms 22 distributed 90° apart around the axis of rotation and each arm carries two lenses 23 and 24. Light source 25 is mounted within the arms so that light from the source is condensed by one of the lenses 24 upon the subject-matter on the conveyor and the illuminated spot is focused on the photo-electric cell by one of the lenses 23. When the carrier 20 is rotated in the normal operation of the apparatus the spot of light traces or scans the subject-matter transversely from side to side of the belt, the angular distance between the successive sets of lenses 23 and 24 being so determined that when the spot of light from one condenser lens 24 passes off the subject-matter at one

side a spot of light from the next succeeding condenser lens 24 comes on the subject-matter from the opposite side of the conveyor. Inasmuch as the conveyor is moving slowly at approximately right-angles to the path of the light spot the lines traced by succeeding spots of light are substantially parallel and may be as close together as desired, depending upon the speed of rotation of the optical system and the rate of travel of the conveyor.

In order to hold the subject-matter in focus a support 26 is provided beneath the upper stretch of the conveyor belt, this support being curved transversely to position the subject-matter concentric with the axis of rotation of the optical system, the conveyor belt being sufficiently slack to conform to the curved support. In order to insure the subject-matter and conveyor sliding snugly along the support, the support may be hollow as shown in Fig. 2 and perforated on its upper surface so that by pumping air from the interior of the support as indicated by the arrow in Fig. 2 the belt 16 and subject-matter 27 are held in desired position as shown in Fig. 2, the belt being reticular when made of fabric for example. When using four sets of lenses as illustrated in Figs. 1 and 2, the curved subject-matter should subtend an arc of approximately 90° as shown in Fig. 2.

In order to increase the capacity of the apparatus I prefer to provide means for increasing the speed of the conveyor between successive subjects-matter. That is, after each subject-matter has been completely transmitted the conveyor travels at increased speed until the next succeeding subject-matter comes into position to be transmitted. While various means may be employed to change the speed of the conveyor, Figs. 1 and 4 illustrate two ways as examples. The means for varying the speed illustrated in Fig. 1 comprises two electromagnets 28 and 29 connected to an arm 30 pivoted at 31 and engaging a clutch 32 keyed to shaft 33 which drives the conveyor belt. When magnet 28 is energized the clutch 32 is thrown to the right to connect the conveyor to motor 19 through gears 21 to drive the conveyor slowly. When magnet 29 is energized the clutch 32 is thrown to the left thereby causing the conveyor to be driven rapidly through gears 20. The magnet 28 is connected in a circuit comprising battery 72 and a switch 35 which is closed momentarily as the clip 19, which holds the subject-matter on the conveyor passes the switch as shown in Fig. 2. By positioning the subject-matter in predetermined relation to the clips lengthwise of the conveyor this switch may be closed at any point along the length of the telegram or other subject-matter. Ordinarily the message or picture is so positioned that the switch is not closed until the body portion of the message is about to be traced by the optical system, although in the case of telegrams having headings they may be positioned so that the heading is transmitted as well as the body portion. In any event the subject-matter is so positioned relative to the clips that the switch 35 is closed before the portion of the subject-matter which is to be transmitted reaches the transversely travelling spot of light.

The means illustrated in Fig. 1 for actuating electromagnet 29 to increase the speed of the conveyor at the end of each message comprises a tuned relay 34 connected in series with the output circuit of amplifier 9. The tuned reed 35 of this relay is fixedly mounted at 36 and vibrates between contacts 37 and 38 under the influence of permanent magnet 39. As is well known, a tuned relay of this kind is only responsive to impulses of current transmitted to it at a predetermined frequency, at which time the reed vibrates, closing the circuit of electromagnet 29 through battery 40. The particular means illustrated in Figs. 1 and 3 for transmitting impulses of this predetermined frequency at the end of each message comprises a series of marks 41 (Fig. 3) extending transversely of the conveyor at the end of the subject-matter to be transmitted. These marks are so spaced that when scanned by the optical system strong alternating current signal impulses are sent in groups of such group frequency as to actuate the relay 34. These impulses are also transmitted over the line 11 to the receiving system to operate a similar mechanism at the receiving station as will be described hereinafter. Obviously a tuned circuit might be employed instead of the tuned relay 34.

The receiving apparatus illustrated diagrammatically in Fig. 4 comprises a travelling conveyor and means for driving it at different rates, this apparatus being similar to the corresponding apparatus at the transmitting station and the corresponding parts being similarly designated. As illustrated, the means for increasing the speed of the conveyor at the end of each message may be like that shown in Fig. 1, the relay 34′ receiving the same impulses as the relay 34 in Fig. 1. However, the means for reducing the speed of the receiving conveyor 16′ at the beginning of each successive transmission comprises a switch 43 adapted to be closed at recurrent intervals by pins 44 mounted on the belt roller 18′ at predetermined intervals, these pins recurrently closing the switch 43 by wiping over the projecting end 45 of one of the switch contacts. The motors 19 and 19′ at the transmitting and receiving stations respectively are adapted to drive the belts at the two stations at approximately the same speed. While they may be synchronized by any suitable

synchronizing means (not shown) they need not be synchronized precisely inasmuch as variations in their relative speeds merely cause the subject-matter to be condensed or extended lengthwise of the conveyor a small amount depending upon the difference in speeds. The pins 44 on the roller 18′ are spaced in accordance with the spacing of the successive messages on the conveyor at the transmitting station, the spacing between the pins 44 preferably being somewhat greater than the spacing between the messages at the transmitting station. Obviously the mechanism for varying the speed of the conveyor at the receiving station may be omitted entirely so that the receiving conveyor will either run continuously or be stopped and started at the beginning and end of each message, as for example by two relays responsive to rows of dashes, such as 42 at the beginning and 41 end of each message (Fig. 3).

The reproducing mechanism shown in Fig. 4 is similar to that disclosed in my copending applications Serial Nos. 755,336 and 755,339. This mechanism comprises an amplifier A^1 connected to a line 11 leading from the transmitting station (or in the case of radio to the detector circuit), another amplifier A^2 connected to the output circuit of A^1, an amplifier comprising an audion 46 connected to the amplifier A^2 through transformer 47, the output circuit of 46 being connected through transformer 48 to an oscillating circuit 49 which, as illustrated, may be of the well-known Hartley type. This oscillating circuit is connected through a Tesla transformer 50 to the reproducer, which comprises contact points movable over the surface mounted on conveyer belt 16′ upon which the subject-matter is to be reproduced. This reproduction is preferably effected by a corona discharge as disclosed in my prior application Serial No. 755,339. For this purpose four discharge needles or points 51 are mounted 90° apart on a rotating shaft 52 so that the needles pass in close juxtaposition to the reproducing surface mounted on the belt 16′, the belt being curved transversely as described in connection with Figs. 1 and 2. A commutator 53 is mounted on the end of the shaft 52 so that the high frequency current through the Tesla transformer 50 passes to the needle 51 which is moving across the belt. The reproducing surface may be in the form of photographic paper or film attached to the belt 16′ in any suitable manner, and inasmuch as the action of the discharge on the photographic emulsion is largely if not entirely electronic, the photographic emulsion may be enclosed within an envelope so that the apparatus may be used in the light.

The synchronous apparatus for rotating the needles 51 in synchronism with the rotating optical trains of Fig. 1 may be of any suitable type, the type illustrated in my prior application Serial No. 755,336 being shown in Fig. 4 by way of illustration. As described in the prior application, this mechanism comprises an eddy-current motor 54 driven at approximately the speed of the rotating optical systems of Fig. 1 by a suitable source of alternating current indicated at 55. Also connected to the shaft 52 is the synchronizing motor 56 of the type disclosed in the aforesaid application, this motor being connected to the line 11 through amplifiers A^1 and A^3 as in the prior application. In this way the synchronizing motor 56 supplies advancing or retarding impulses derived from the generator 14 at the transmitting station, to assist or oppose the eddy-current motor 54 dependng upon whether the shaft 52 tends to run slower or faster than the rotating carrier 20 at the transmitting station.

The modification in Figs. 5 and 6 is intended to be used with a conveyor which need not be curved transversely as in Figs. 1, 2 and 3. In this modification the carrier 60 rotates about an axis perpendicular to the belt 61 and carries its optical systems upon arms 62, each optical system comprising a light source 63 at the end of each arm and lenses 64 and 65 corresponding to 23 and 24 in Fig. 1. The carrier 60 rotates around the photo-electric cell 66 and the parts are so adjusted that the light from the sources 63 traces the subject-matter on belt 61 in arcuate paths 67 concentric with the rotating carrier 60. This arc subtends approximately 120° when three optical systems are employed whereas if it only subtends 90° four optical systems will be required as in Fig. 1. If the path of the belt is such that the light crosses the belt on both sides of the photo-electric cell, the path along which the light travels on one side may be covered as illustrated at 68 so that the subject-matter will be placed on one side of the cell. It will of course be understood that suitable means will be provided to prevent variation of light being transmitted to the photo-electric cell except by the particular optical system which is tracing the subject-matter, and only while that particular system is crossing the belt, suitable means for screening the photo-electric cell from the undesirable light may comprise opaque coatings on the photo-electric cells having windows 69 and 70, (Figs. 1 and 6 respectively).

From the foregoing it will be evident that the operation of the system is as follows: The subjects-matter to be transmitted are clipped to the belt 16 somewhere between the roller 17 and table 26 and are unclipped and removed after passing the table. So far as this invention is concerned any suitable means may be employed to attach and de-

tach the subjects-matter, either manual or automatic. The paper or film upon which the subjects-matter are to be reproduced at the receiving station are attached to the belt 16′ to the left of the path traced by the needles 51 and removed at points to the right of this path. The surfaces upon which the subjects-matter are to be reproduced may be separate or joined together as a continuous sheet in which case the paper or film may be unrolled from roller 17′ and rolled upon roller 18′ without using a belt. The motors 19 and 19′ at the transmitting and receiving stations are adjusted to drive the conveyors at approximately the same rate and the needles 51 are synchronized with the optical systems 23—24, in accordance with the frequency of the impulses transmitted to the line by the generator 14 as above described. The amplitude of these impulses is varied in accordance with the subject-matter to be transmitted by varying the potential of the grid of audion 5 under the control of the photo-electric cell as more fully described in my prior application Serial No. 755,336. These impulses of varying amplitude control the intensity of the discharge from needles 51 to reproduce the subject-matter. At the end of each message the two relays 34 and 34′ increase the speed in response to the row of marks 41 (Fig. 3) of the subject-matter. At the beginning of the next subject-matter the speed of the conveyer at the transmitting station is again reduced by the automatic closing of switch 35. At the receiving station the speed of the conveyer is reduced at the same time as the transmitting conveyer, or somewhat sooner, by the automatic closing of switch 43. Thus a series of messages, pictures or other subjects-matter may be transmitted continually and automatically without synchronizing the conveyer at the transmitting and receiving stations respectively, although of course it will be understood that these conveyers may be synchronized if desired. When using a continuous reproducing sheet at the receiving station, as for instance photographing paper or film, the receiving conveyer is perfectly stopped between messages. Suitable mechanism for this purpose may for example comprise magnets 28′ and 29′ controlled by tuned relays to respond to definite frequencies respectively and the messages to be transmitted having marks of different spacing at the beginning and end so that the relay controlling 29′ will respond only to the marks at the beginning of the message, while the relay 28′ responds only to the marks at the end of the message as above described. Where the conveyer is to be stopped between messages the gears 21′ would of course be omitted. In the illustrated embodiment the messages are preferably reproduced on separate sheets and spaced along the receiving conveyer the same as the subjects-matter to be transmitted are distributed along the transmitting conveyer.

From the foregoing it will be evident that the relative movement in two dimensions between parts of the sender and receiver respectively is synchronized in one dimension only, the rotary movement of the optical systems at the transmitting station being synchronized with the rotary movement of the recording points at the receiving station without synchronizing the movements of the conveyers at the two stations, thereby simplifying the system without substantially affecting its effectiveness.

I claim:

1. In a phototelegraphic system, sending means responsive to the subject-matter to be transimtted, conveyor means for continuously feeding spaced subject-matter into operative association with said sending means, and means for automatically increasing the speed of the conveyor while the spaces between predetermined parts of the subject-matter are passing the sending means.

2. A phototelegraphic system comprising a sender including point-by-point tracing means for tracing the subject-matter along substantially parallel paths with an optical system focused upon a photo-electric cell, and automatic means for successively bringing recurrent subjects-matter into the path of said tracing means, whereby successive subjects may be transmitted continually and automatically.

3. A phototelegraphic system comprising a sender including point-by-point tracing means for tracing the subject-matter along substantially parallel paths with an optical system focused upon a photo-electric cell, and a conveyor for continually feeding subjects-matter into the path of said tracing means with said parallel paths extending transversely of the conveyor.

4. In a phototelegraphic system, a sender including means for tracing the subject-matter along substantially parallel paths with a beam of light, a conveyor for continually feeding subjects-matter in spaced relation into the path of said tracing beam, and means for automatically increasing the speed of the conveyor while the spaces between the subjects-matter are passing the tracing beam.

5. In a phototelegraphic system, means for continuously feeding subject-matter along a predetermined path, and point-by-point tracing means for continually tracing the subject-matter from side to side with light rays swinging through an arc and a light-sensitive cell responsive to said light rays.

6. In a phototelegraphic system, means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side with an

optical system swinging transversely through an arc, and means for increasing the speed of the feeding means while the spaces between said subjects-matter pass the light rays.

7. In a phototelegraphic system, transmitting means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side by means swinging transversely through an arc, receiving means continually movable along a predetermined path for recording the transmitted subjects-matter, and means for varying the speed of said transmitting and receiving means between successive subjects-matter.

8. In a phototelegraphic system, transmitting means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side by means swinging transversely through an arc, receiving means continually movable along a predetermined path for recording the transmitted subjects-matter, and means controlled by the transmitting means for varying the speed of said transmitting and receiving means between successive subjects-matter.

9. In a phototelegraphic system, transmitting means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side by means swinging transversely through an arc, receiving means continually movable along a predetermined path for recording the transmitted subjects-matter, means controlled by the transmitting means for increasing the speed of said transmitting and receiving means at the end of each subject-matter, and means controlled by the transmitting means for decreasing the speed of the transmitting means before the transmission of the next subject-matter.

10. In a phototelegraphic system, transmitting means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side by means swinging transversely through an arc, receiving means continually movable along a predetermined path for recording the transmitted subjects-matter, means controlled by the transmitting means for increasing the speed of said transmitting and receiving means at the end of each subject-matter, and means controlled by the receiving means for decreasing the speed of the receiving means before the transmission of the next subject-matter.

11. In a phototelegraphic system, sending means responsive to the subject-matter to be transmitted, conveyor means for continuously feeding spaced subjects-matter into operative association with said sending means, and means responsive to movement of the conveyor for automatically increasing the speed of the conveyor while the spaces between the subjects-matter are passing the sending means.

12. In a phototelegraphic system, a sender including means for tracing the subject-matter along substantially parallel paths with a beam of light, a conveyor for continually feeding subjects-matter in spaced relation into the path of said tracing beam, and means responsive to movement of the conveyor for automatically increasing the speed of the conveyor while the spaces between the subjects-matter are passing the tracing beam.

13. In a phototelegraphic system, means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side with an optical system swinging transversely through an arc, and means responsive to movement of the conveyor for increasing the speed of the feeding means while the spaces between said subjects-matter pass the light rays.

14. In a phototelegraphic system, a sender including means for tracing the subject-matter along substantially parallel paths, a conveyor for continually feeding subjects-matter in spaced relation into the path of the trace, and means for automatically increasing the speed of the conveyor while the spaces betwen the subjects-matter are passing the trace.

15. In a phototelegraphic system, means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side with means swinging transversely through an arc, and means for increasing the speed of the feeding means while the spaces between said subjects-matter pass the tracing means.

16. In a phototelegraphic system, sending means responsive to the subject-matter to be transmitted, conveyor means for continuously feeding spaced subjects-matter into operative association with said sending means, and means responsive to marks on the subjects-matter for varying the speed of the conveyor while the spaces between the subjects-matter are passing the sending means.

17. In a phototelegraphic system, a sender including means for tracing the subject-matter along substantially parallel paths, a conveyor for continually feeding subjects-matter in spaced relation into the path of the trace, and means responsive to marks on the subjects-matter for varying the speed

of the conveyor while the spaces between the subjects-matter are passing the tracing means.

18. In a phototelegraphic system, means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side with means swinging transversely through an arc, and means responsive to marks on the subjects-matter for varying the speed of the conveyor while the spaces between the subjects-matter are passing the tracing means.

19. In a phototelegraphic system, transmitting means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side by means swinging transversely through an arc, receiving means continually movable along a predetermined path for recording the transmitted subjects-matter, and means responsive to marks on the subjects-matter for varying the speed of said transmitting and receiving means between successive subjects-matter.

20. In a phototelegraphic system, transmitting means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side by means swinging transversely through an arc, receiving means continually movable along a predetermined path for recording the transmitted subjects-matter, and means responsive to marks on the subjects-matter for varying the speed of said transmitting and receiving means between successive subjects-matter.

21. In a phototelegraphic system, transmitting means for continuously feeding along a predetermined path subjects-matter spaced longitudinally of the path, means for continually tracing the subject-matter from side to side by means swinging transversely through an arc, receiving means continually movable along a predetermined path for recording the transmitted subjects-matter, means responsive to marks on the subjects-matter for increasing the speed of said transmitting and receiving means at the end of each subject-matter, and means controlled by the transmitting means for decreasing the speed of the transmitting means before the transmission of the next subject-matter.

Signed by me at Rutherford, New Jersey, this sixth day of October, 1925.

AUSTIN G. COOLEY.