No. 844,086. PATENTED FEB. 12, 1907.

E. & M. BELIN.

TELEGRAPHIC PICTURE TRANSMITTING MECHANISM.

APPLICATION FILED DEC. 6, 1904.

3 SHEETS—SHEET 1.

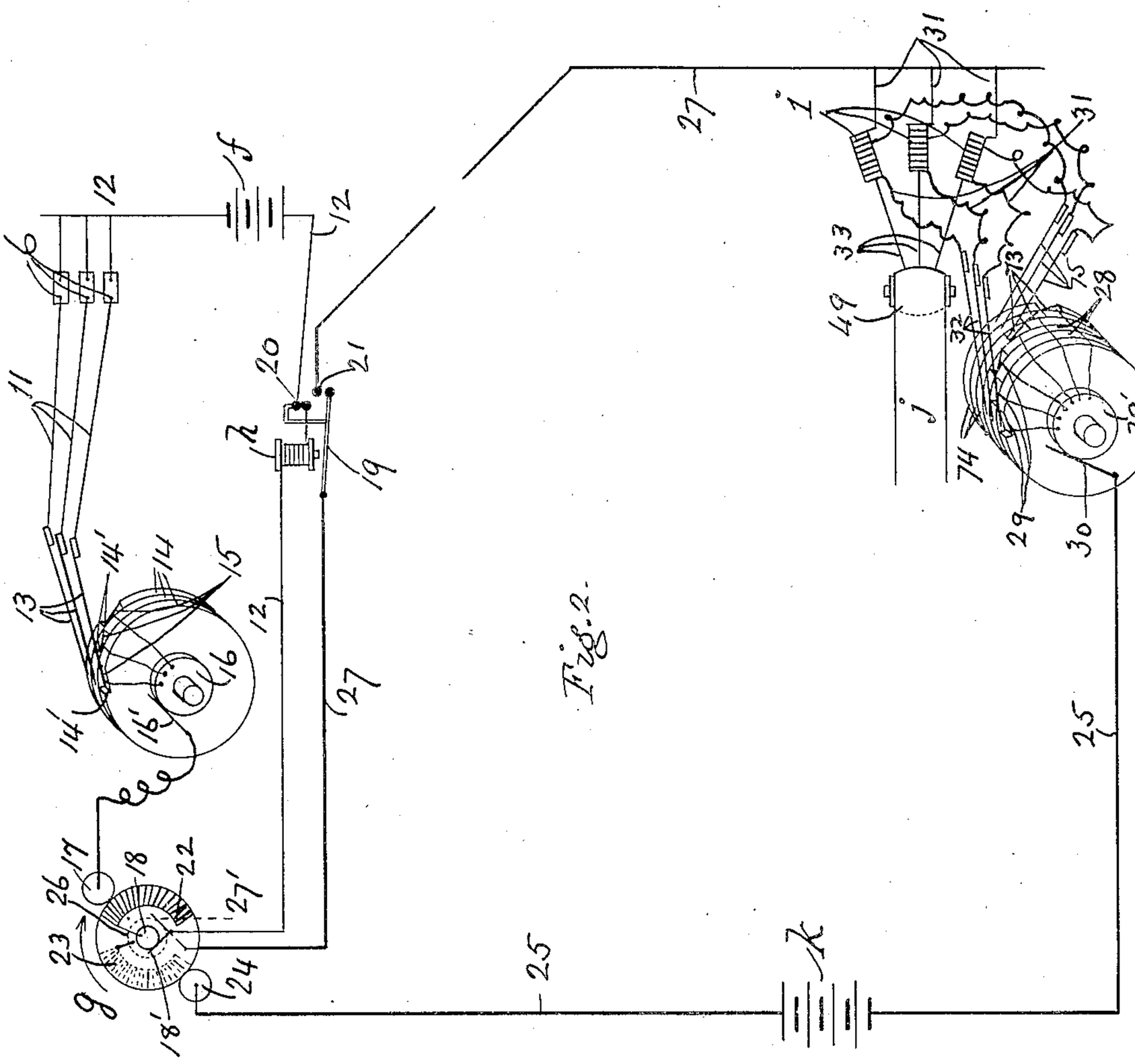

Fig. 2.

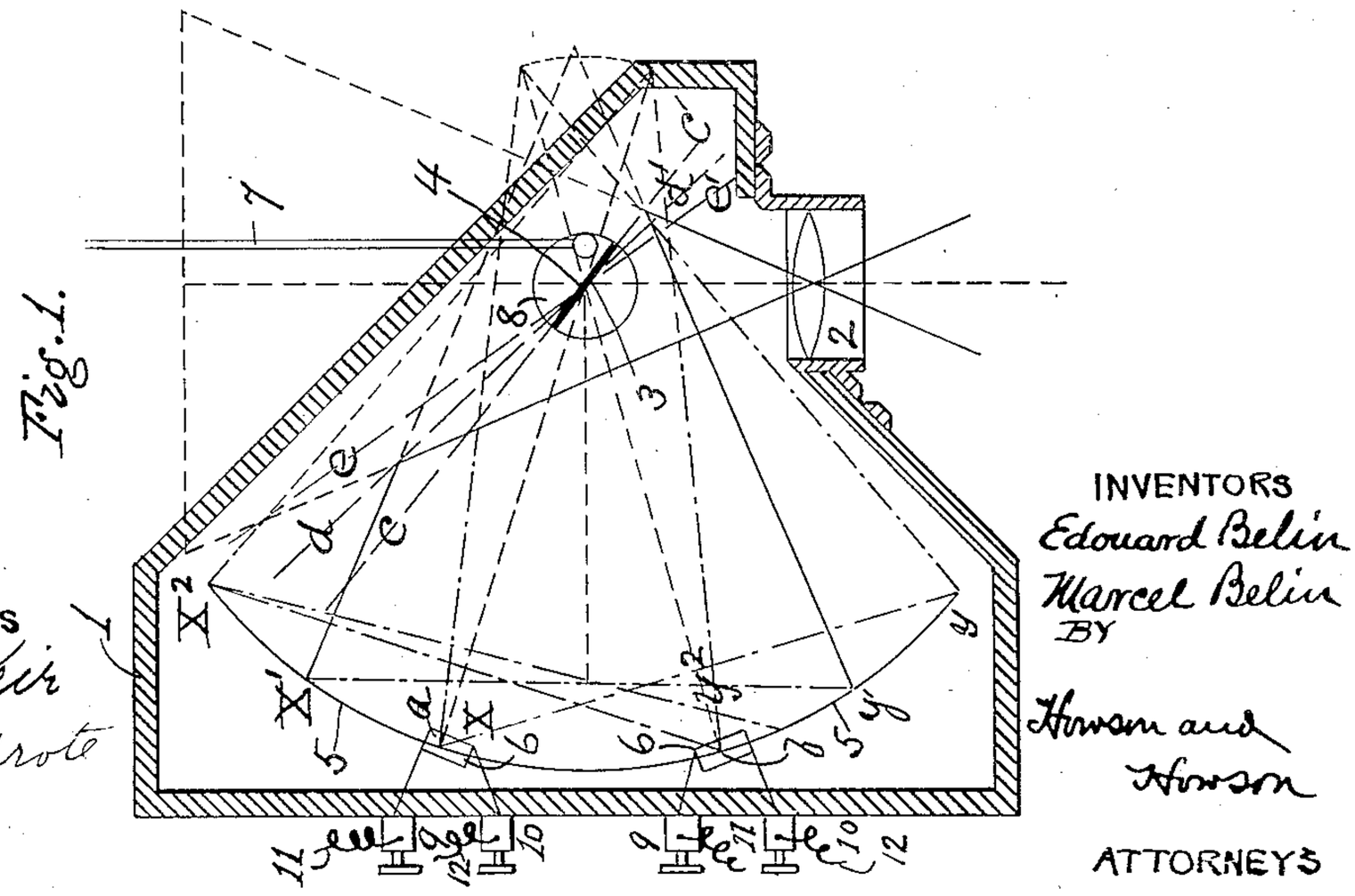

Fig. 1.

WITNESSES

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Fig. 3.

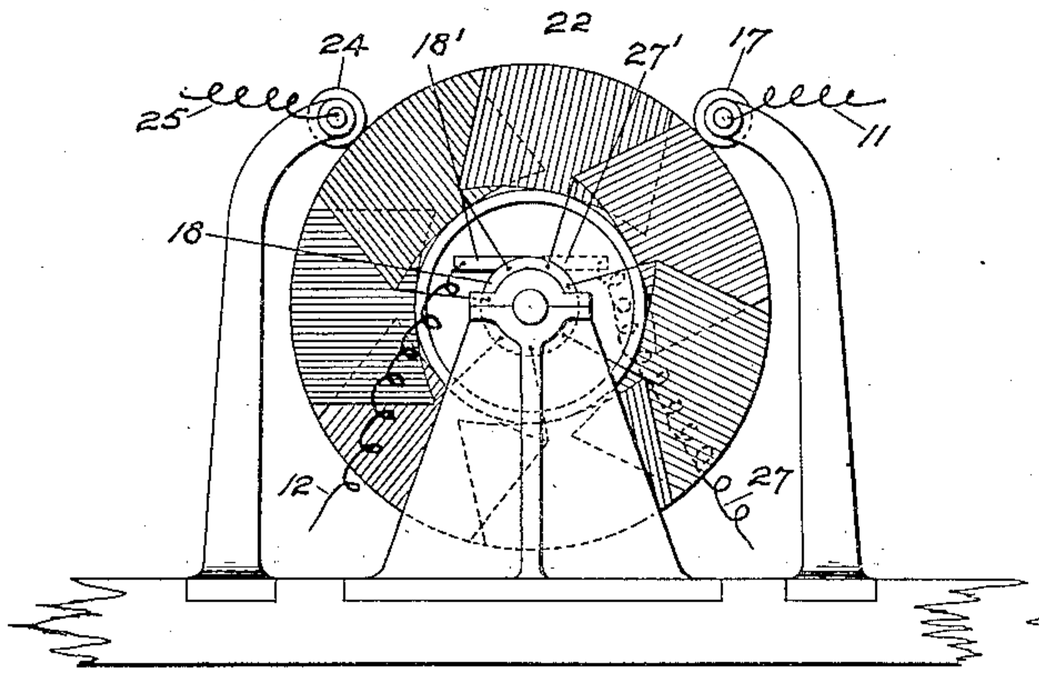


Fig. 4.

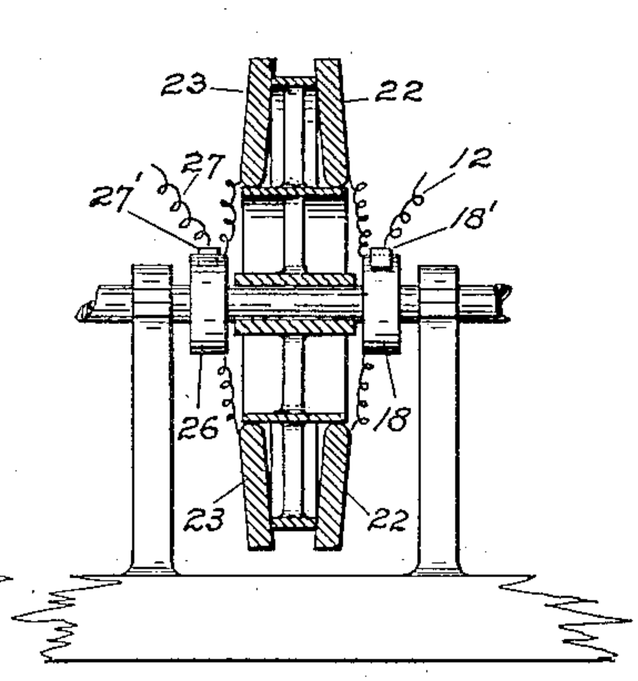


Fig. 5.

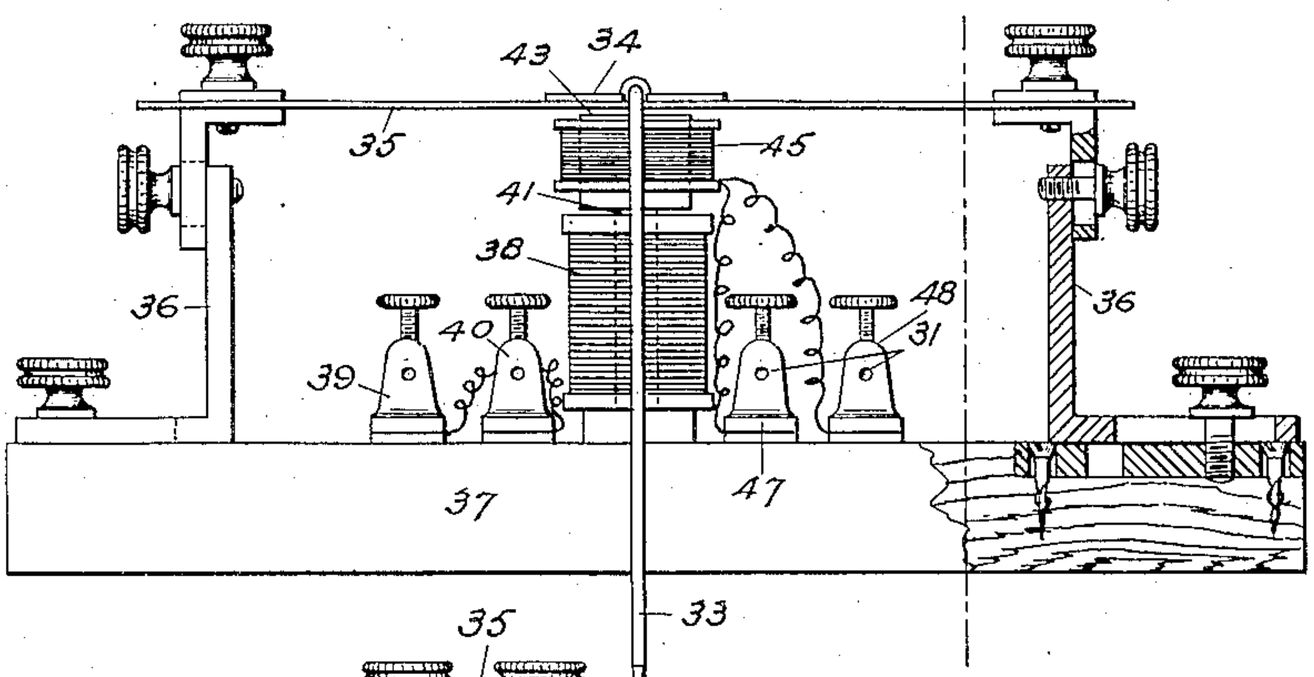
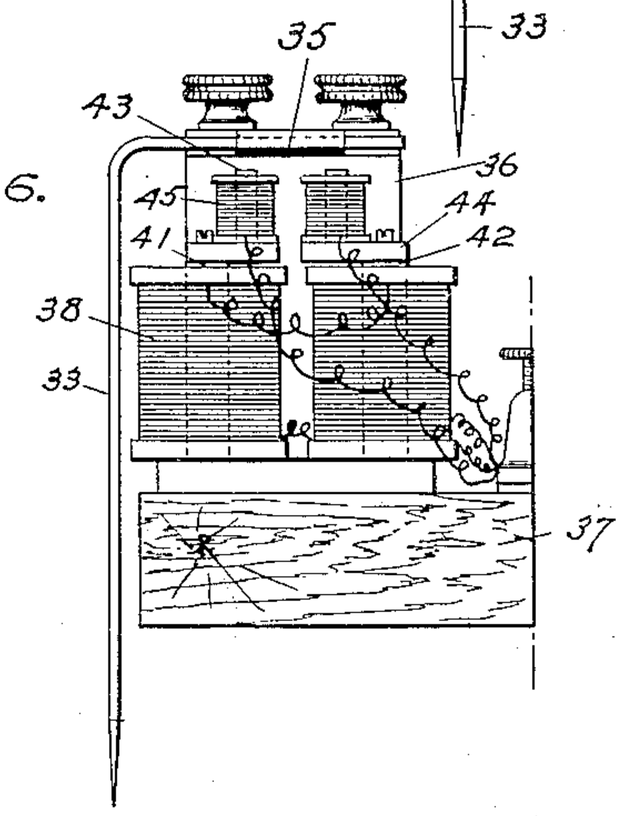


Fig. 6.



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3 SHEETS—SHEET 3.

Fig. 7.

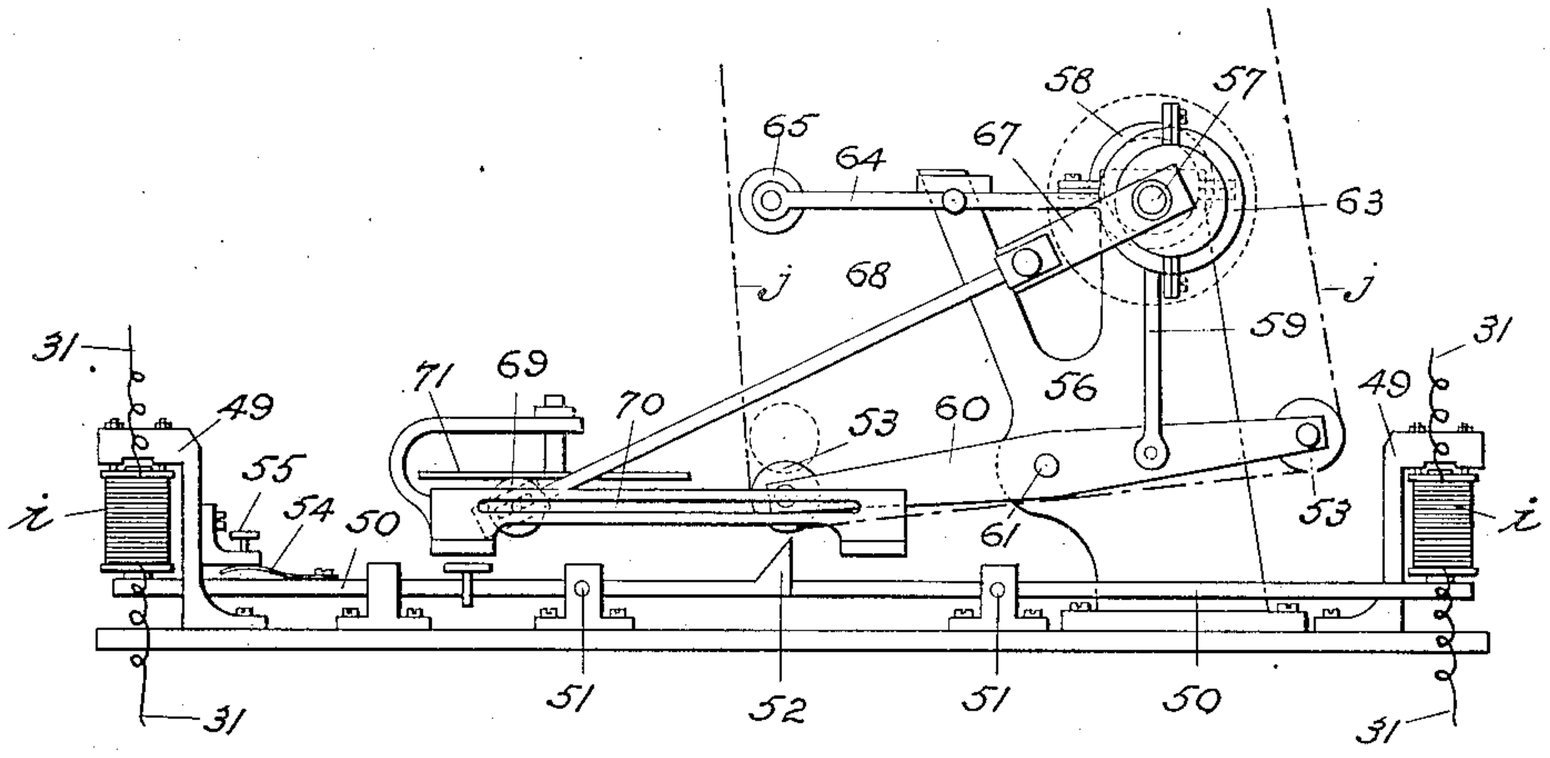
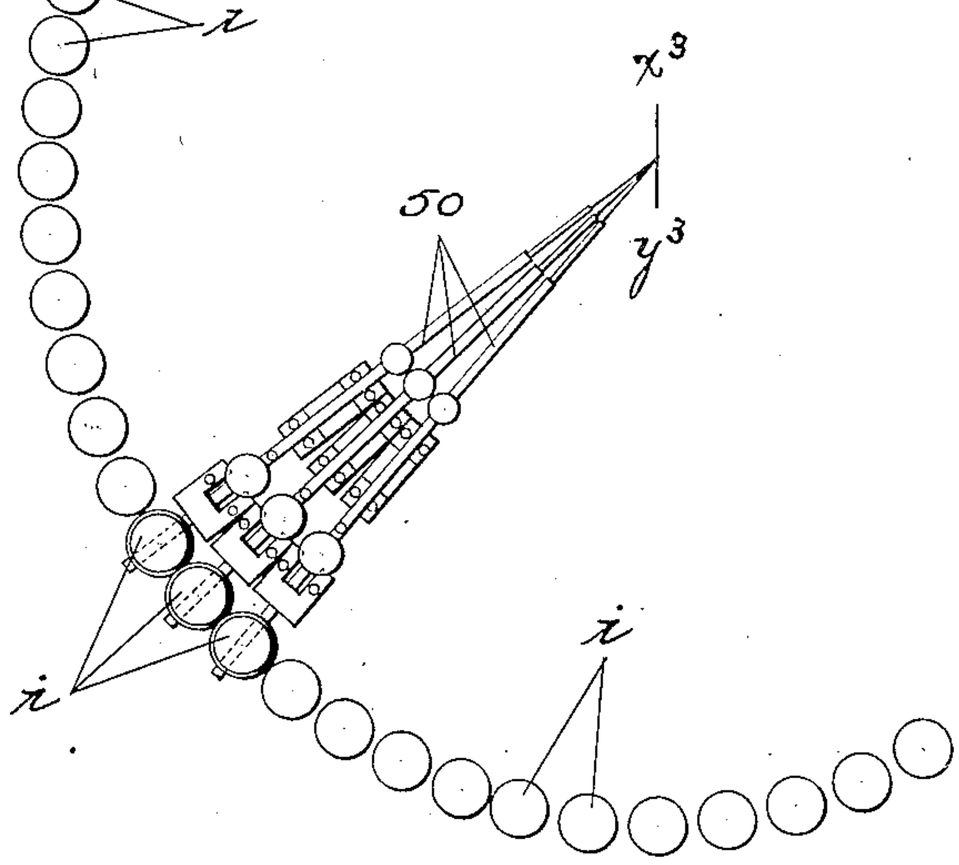


Fig. 8.



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UNITED STATES PATENT OFFICE.

EDOUARD BELIN AND MARCEL BELIN, OF PARIS, FRANCE.

TELEGRAPHIC PICTURE-TRANSMITTING MECHANISM.

No. 844,086. Specification of Letters Patent. Patented Feb. 12, 1907.

Application filed December 6, 1904. Serial No. 235,749.

To all whom it may concern:

Be it known that we, EDOUARD BELIN and MARCEL BELIN, citizens of the Republic of France, residing at Paris, in the Republic of France, engineers, (whose full postal address is 60 Boulevard de Clichy, Paris, aforesaid,) have invented certain new and useful Improvements in Telegraphic Picture-Transmitting Mechanism, of which the following is a specification.

This invention has for its object a method enabling real optical images to be transmitted to a distance in a negligible space of time and also of apparatus for practically carrying out this method.

The properties which selenium possesses of varying its conductivity according to the illuminating power of the luminous rays which strike it are utilized. It is thus possible to obtain images where each color is rendered with an intensity proportionate to its optic brilliance—that is to say, the perfect realization of orthochromatism.

According to this improved method sensitive elements are provided, as will be hereinafter explained, formed in such a way that being switched into an electric circuit they cause the needle or pointer of a galvanometer to undergo oscillations varying with the color and intensity of the luminous rays which strike them. These elements are arranged in a photographic chamber, (transmitting apparatus,) where they receive the luminous rays refracted by the objective. Each sensitive element switched into a local electric circuit modified by means of a special relay the intensity of a line-current which acts at a distance (receiver apparatus) on an electromagnetic apparatus operating either a perforating-point or a printing-point, so as to obtain on a suitable surface perforated or printed dots, the dimension of which vary with the intensity of the current traversing the apparatus. As the number of these points does not vary per unit of surface, the effect of shade and light are thus obtained by the differences in their size exactly as is produced in so-called "simili-gravure" reproductions.

The sensitive elements, of which mention has hereinbefore been made, are preferably formed by winding a very fine copper wire over an insulating plane support and casting pure selenium in the intervals of the helices thus formed on one side of the support only. The sensitive elements are also obtained by substituting metallic selenids for selenium. Finally these selenids or pure selenium may be run into thimbles, cells, or alveoles the walls of which are of conducting metal.

The element at the extremity of each of the copper wires corresponds to one of the poles of an electric circuit.

The apparatus intended to put in practice the method hereinbefore described is shown in the accompanying drawings, in which—

Figure 1 is a horizontal section of the dark chamber receiving the sensitive elements. Fig. 2 is a diagrammatic view showing the electric arrangement of the whole of the system. Fig. 3 is a front view of the special relay. Fig. 4 is a vertical section through the axis of Fig. 3. Figs. 5 and 6 are a front and side views in detail of the mechanism for operating the perforating-points. Fig. 7 shows the application of the system with a printing-point. Fig. 8 is a diagrammatic plan view corresponding to Fig. 7.

In the practical method of carrying out the invention, the description of which will now be given, the electric arrangement is such that the connection between the transmitting apparatus and the receiving apparatus only necessitates the use of a single wire, which allows of the existing telegraphic and telephonic lines to be utilized, if need be, for transmission.

The transmitter and the receiver each possess their own movement, determined by an independent force. The perfect synchronism of the two stations is insured by an electric clockwork arrangement, utilizing as conductor the line itself. It appears preferable to employ for the motive force an electric accumulator.

Transmitter.—The transmitting apparatus comprises a dark chamber 1, Fig. 1, analogous to photographic chambers and provided with an objective 2.

Between the nodal point of emergence of the objective and the focal plane a mirror 3 is arranged, reflecting the emerging luminous group of rays in such a variable direction that the reflected axis is normal, or nearly so, to the principal axis. The motion of the movable mirror 3 should be such that the axis of the totality of the luminous rays reflected shall be perpendicular, or nearly so, to the axis of the objective principal axis. In other words, the mirror 3 is at an angle of forty-five degrees with relation to the principal axis, or nearly so.

The mirror 3, which is movable on an upright 4 perpendicular to the principal axis, projects the real image reflected onto a cylindrical surface 5. The angle of displacement of the mirror is selected, so that two generating-lines *a b* of the surface 5 are each necessarily and successively illuminated by all the points of the half-image.

The sensitive elements 6, of which mention has hereinbefore been made, are fixed on the said generating-lines *a b*. The use of this double row is justified, first, by the inertia of the selenium itself and the obligation to explore the whole of the image in as short a time as possible; second, by the impossibility of causing a luminous group of rays of sufficient angle to turn opposite a single row of elements without the reflected group overlapping the incident group.

In course of working the emergent luminous group falls on the mirror 3, occupying the position *c c'*—that is to say, forming with the principal incident axis an angle superior to forty-five degrees. The image is thus reflected at *x y*, and the two rows *a b* of sensitive elements are situated one at the end, the other at the middle, of this image.

By the intermediary of a rod 7 and crank-plate 8, operated by the general motor of the apparatus, the mirror 3 is caused to pivot on the axis 4. Of course the image is displaced with it. When it occupies the position *x' y'*, the mirror is at *d d'*, (angle of forty-five degrees.) Finally when it occupies the limit position at x^2 y^2 the mirror is at *e e'*, (angle inferior to forty-five degrees.) At this moment the exploration is terminated. The succeeding operation is obtained immediately after the return of the mirror 3 to its primitive position.

On one of the external faces of the chamber 1 terminals 9 and 10 are arranged, two of these terminals corresponding to one of the sensitive elements 6 and each receiving one of the ends of the copper wire forming part of the element.

From the terminals 9 and 10 wires 11 and 12 start, which close the circuit of each element passing through the source of electricity *f*, as shown in Fig. 2. In all these circuits or in shunt on these circuits a flexible metallic strip 13 is connected, intended to act in combination with a disk 14, of insulating material, having a notch 14' and provided with a contact-piece 15. The disks 14 are juxtaposed and displaced angularly the one relatively to the other. All the parts 15 are in electric communication with a ring 16, itself connected by a brush 16' and a wire to a roller 17 of the special relay *g*. The current entering at 17 into this part of said relay emerges, as will be shown hereinafter, by means of a brush 18' in contact with the ring 18.

There exist as many disks 14 as there are selenium elements 6. These disks 14 serve to successively introduce the said elements 6 into the local circuit of the transmitter. Into this circuit is introduced at the same time as the element 6 a resistance 22 by the relay *g*.

The parts 13 to 15 remain in contact during all the time that the resistance 22 is displaced under the wheel 17. If the relay *g* has only one resistance 22, as Fig. 2 shows, it being assumed that this resistance should be put successively with each element 6 it operates, it follows that for a turn of the shaft carrying the disks 14 the relays *g* will make a number of turns equal to the number of the elements 6, and consequently to the disks 14. If the relays, on the contrary, have seven resistances 22, as shown in Fig. 3, it will turn seven times less quickly than in the example, Fig. 2.

As to the mirror 3, it is quite difficult to establish a relation between its movement and that either of the relay *g* or of the disks 14. In fact, the disk 14 makes a complete revolution to successively put at once into action all the elements 6, which include the rows *a* and *b* of the dark chamber.

We have seen that the relays *g* turn more or less quickly, according to the number of resistances 22 actuated in its revolution.

As to the mirror 3, it will have an extremely slow displacement, since it will go from the position *c c' a* to the position *e e'*, while the rows of selenium *a* and *b* will be put as many times into action as the reproduction of each operation of the image transmitted will necessitate rows of printed or perforated points.

On the return-conductor an electromagnet *h* is arranged, calculated for only producing a useful effect with a given intensity of current and the armature 19 of which governs two contacts 20 and 21, the first arranged on the circuit of the sensitive elements, the second on the line-circuit.

The relay *g*, Figs. 3 and 4, thus formed of two series of wire windings or resistance-coils 22 23, single or multiple, arranged in parallel, but in inverse direction, and so as to present an external cylindrical surface on which a contact-roller bears, the roller 17 aforesaid is opposite the winding 22, a similar roller 24 being arranged on the winding 23. The ends of the windings are respectively connected with rings 18 and 26. The second line's wire 27 is connected with a brush 27', bearing on the ring 26. After having passed over the switch 21 it is directed, with the other wire 25, toward the receiving-station. K indicates the source of electrical energy.

It will be evident that the said relay *g* is switched automatically into the circuit of the sensitive elements and into the line-circuit proportionate although variable resistances by reason of the displacement of the coils 22 and 25 relative to the rollers 17 and 24.

Suppose the luminous rays, white, strike

the element 6. When that is intercalated in the local circuit of the transmitter, it does not offer resistance to the passage of the current, and from the moment of contact of the wheel 17 with the wire 22 the electromagnet *h* operates, closing the line-circuit. At this moment, first, there is in this local circuit all the resistance R of the coil 22. There then passes a current of the intensity *i* R. Second, the coil 23 is not included, by reason of the construction of the relay *g*. There flows, on the contrary, a current of the intensity I. If we suppose now that this selenium element 6 corresponds to the obscure point of the image and the point block that it is intercalated in the local circuit of the transmitter, the intensity of the current of this circuit is no more than *i*–L–R, (L represents the resistance of the selenium-cell,) and in order that this current may operate the electromagnet *h* it is then necessary that the wheel 17 shall have free the greatest part of the resistance 22 (R) and that this last shall have been illuminated from the quantity $n-a-L$, so that the total value of the resistance intercalated in the circuit shall be equal to $R-n+L=R$. At this moment, first, in the local circuit the current is still an intensity *i* R and the electromagnet *h* operates. Second, in the line-current, by reason of the position of the wheel 34, which is intercalated little by little into this circuit, the resistance 23 (R,) in proportion of the elimination of the resistance R in the local circuit of the transmitter, there flows in the contrary direction a current of the intensity I R.

From what precedes it follows that for a light point—smallest resistance, for example, of the selenium—the intensity of the line-current equals I, and therefore a black point: maximum resistance L of the selenium the line current equals I R. It will therefore be understood that according to the degree of light of the selenium-cell between black and white its resistance varies between O and L, the corresponding line-current will oscillate inversely between I and I R, the exact value of this intensity depending necessarily upon the position of the wheel 24 on the resistance 22, a position which corresponds to that of the wheel 17 on the resistance 22 at the moment of the operation of the electromagnet *h*, which can only be actuated when the total resistance intercalated in the local circuit of the transmitter corresponds to $R-n-L=R$.

Receiver.—The receiving apparatus comprises a commutator formed of recessed or hollowed disks 28, similar to those hereinbefore described, arranged in the same way and each provided with a contact-piece 29, which is connected by a wire with a ring 29′, while a brush 30 places the ring 29′ and the line-wire 25 in connection. Between the disks 28 and the wire 27 recording devices operated by differential electromagnets *i* are interpolated in independent circuits. On each connecting-wire 31 an electromagnet is arranged, and its extremity is fixed on a flexible metallic strip 32, intended to act in combination with one of the disks 28.

Each electromagnet *i* commands a point 33, which punches in a receiving-band *j*, of paper or other suitable material, holes of proportionate or inversely proportionate diameter at will to the luminous intensities of the corresponding points of the optical image or picture. The perforating-point 33, (see Figs. 5 and 6,) mounted on a small soft-iron plate 34, is firmly attached in any suitable manner to a flexible strip 35, preferably metallic, stretched between supports 36, arranged on an insulating-plate or sole-piece 37.

The supports 36 are combined so as to allow of a variation, and consequently a suitable regulation, of, first, the point of attachment of the ends of the strip 35; second, its degree of tension; third, the distance which separates this strip from the electromagnetic apparatus. According to the drawings this result is obtained by means of various pieces constituting supports 36, provided with slides adapted to be displaced relative to one another and firmly connected by means of screws; but it is evident that the same object may be attained by utilizing any other suitable arrangements.

On the bed-plate 37 and opposite the strip 35 there is fixed an electromagnet 38, fed by a local current of any suitable kind conveyed to the terminals 39 and 40. The cores 41 and 42 of this electromagnet are prolonged by means of pieces of soft iron 43 and 44, retained by screws or otherwise and on each of which a winding of wire is mounted in such a way as to form two coils constituting a sort of second electromagnet 45, intended to modify the attractive force of the first electromagnet 38 and the feed-wires of which start from two terminals 47 and 48, which are interpolated into one of the electric circuits 31, hereinbefore mentioned.

Of course the apparatus is regulated in such a way that the needle 33, the point of which is of any desired and determined conicity, shall be suitably displaced by the action of the electromagnetic apparatus onto the plate 34 and perforates more or less the receiving-band *j*, which is adjusted opposite it.

As shown in Fig. 2 of the drawings, the needles 33 are directed, according to the radii, round a center, and the film passes over a roller 49, having a surface convex to the same center.

The system when in action operates as follows: The coils 22 23 and the disks 14 of the transmitter revolve at a given speed and the disks 28 of the receiver revolve synchronously with the disks of the transmitter. The contact 21 is closed. One of the strips 13 dropping into the notch of its disk 14 comes in contact with a piece 15. At this movement

the roller 17 presses on the outgoing wire (maximum of resistance) of the resistance-coil 22 at the same time as the roller 24 bears, on the contrary, on the opposite point (minimum of resistance) of the coil 23. In proportion as the relay *g* turns the rollers approach, respectively, the admission and discharge of their respective coils. The resistances therefore vary automatically. Immediately the intensity of the current which passes through the wires 11 and 12 is sufficient to set in action the electromagnet *h* the armature 19 closes the line-circuit and a current, variable according to the position of the roller 24 on the coils 23, is discharged into the receiving apparatus. The disk 28 of this apparatus, however, which is in engagement with a strip 32 is the same by reason of the synchronous action as the disk 14 working in the transmitter, and the result is that the line-current acts on the electric apparatus which operates the corresponding needle 33. The line-current passing into the electromagnet 45, the local current is sent immediately afterward by a particular commutation into the electromagnet 38, the plate 34 is attracted, and the point 33 perforates the recording-band.

On the shaft of the commutator 28 are fixed disks 74 equal in number to the disks 28 and also furnished with notches 73; but these latter are slightly behind the notches 29, so that the spring 75 falls immediately after the corresponding spring 32. On falling thus it throws an auxiliary current into the wire of the post 39, Fig. 5, the electromagnet 38 becomes active, and the current goes out at post 40. The resulting attraction of the double electromagnet on the plates 34 will be of varying intensities, according to the resistances interposed in the line-circuit at the given moment, which will determine the different amplitudes of the swing of the needle 33, and therefore the formation of larger or smaller holes.

It will be noticed that the working of the armature 19 by determining the closing of the line-circuit breaks the circuit of the selenium elements by opening the commutator at the contact-point 20. Immediately the local circuit of the transmitter is broken the electromagnet *h* no longer works, and the armature 19 resumes its initial position, while the line-circuit is in its turn broken, and the commutator at the contact-point 20 being simultaneously reclosed is consequently in the position which is occupied at the commencement of the operation, and similarly the perforating needle or point of the receiver is returned to a position of repose.

The coils 22 and 23 of the relay *g* continuing to revolve, the rollers 17 and 24 after having traversed the resistance-coil stand again facing the one the entrance and the other the discharge of the same coil or of a similar juxtaposed coil. It is at this moment that in consequence of the rotation of the disks 14 the strip 13 in question is separated from its point of contact 15 and another strip 13 interpolates a fresh sensitive element into the local circuit of the transmitter. The operations hereinbefore mentioned are renewed, another needle 33 perforates the band *j* in the receiving apparatus, &c.

There is provided in the transmitting apparatus two rows of sensitive elements *a* and *b*, which of course can be interpolated alternately in the local circuit of the transmitter.

It is evident that the construction of the various principal parts hereinbefore described, more particularly the relay *g* and the disks 14 or 28, may vary and have a larger or smaller number of constituent parts. As the case may be, the grouping of the elements, the relative speeds of the parts may be changed without thereby modifying the principle of the invention, the latter always consisting in successively interpolating in a circuit the intensity of which varies automatically with the striking luminous intensity of the sensitive elements themselves influenced successively and in recording at a distance the result of this influence on a suitable support or band.

As regards the perforating-point 33, if the line-current flowing through the electromagnet 45 opposes the attractive force of the magnet 38 it is evident that the strip 34, and consequently the point 33, will be displaced in a manner inversely proportionate to the luminous intensity acting on the corresponding sensitive element of the transmitting apparatus—that is to say, that the attraction of the piece 34 will be the less energetic as the line-current is stronger, and consequently the luminous intensity hereinbefore specified greater. Thus a recording-band will be obtained in which the smallest perforations correspond to the most brilliant points of the image or picture, and vice versa.

By reversing the direction of the line-current, the force of the electromagnet 45 being added to that of the electromagnet 38, the point will be displaced proportionately to the luminous intensity of the points of the image or picture, and the recording-band will receive perforations which are larger according as the corresponding points are less brilliant, and vice versa.

The point 33 is shown in the accompanying drawings in a preferred form; but it is obvious that this is capable of numerous variations without departing from the invention.

Although the perforated bands are of a kind adapted for printing, printing-points might nevertheless be substituted for the perforating-points 33. In this case it would be preferable to employ in the receiving apparatus the arrangement shown in Figs. 7 and 8 of the drawings.

The differential electromagnets *i*, operating the printing appliances, are mounted in a suitable curve on the arm or standards 49. The armature of these electromagnets is at the extremity of the longer arm of a lever 50, pivoted at 51, and the other extremity of which carries an india-rubber point or a printing-cone 52. All the cones are placed in a straight line at the center of the apparatus. In a normal condition they face the surface to be printed—for instance, a film *j*, passing over rollers 53, the axis of one of which is in the vertical plane of the said cones. The position of the levers 50 is insured by a spring 54, adapted to be regulated by means of a screw 55.

Above the plane of the levers 50 and perpendicularly to the large axis of the curve in which the electromagnets *i* are arranged a horizontal shaft 57 turns in a suitable frame 56, and carried at each of its ends and operates, first, an eccentric 58, having a vertical rod 59, operating a balancer 60, pivoted at 61 and provided at its ends with two rollers 53 for guiding the film *j*; second, an eccentric 63, having a horizontal rod 64, provided with stretching-rollers 65 for insuring the tautness of the film during the movements of the balancer 60; third, a crank-plate or a crank 67, actuating a rod 68, which pushes and pulls an inking-roller 69, guided in a slide 70, which roller rubs against the printing-cones 52 at one of the ends of its course and an inking-plate 71 at the other end.

The operation of the mechanism is readily understood. A motion more or less accentuated, according to the intensity of the current which passes through the electromagnets *i*, is imparted thereby to the lever 50, bearing the printing-cones 52. The latter consequently strikes the band *j* with greater or less force, leaving a dot thereon, which is heavy or light, according to the strength of the stroke. A succession of these dots forms a row x^3 y^3 across the band *j*, and a succession of these rows x^3 y^3, which follow one another as the band is uniformly displaced during the printing, form the image, the ensemble of dots of varying size having much the same appearance as an engravure.

The use of a differential electromagnet of special construction for operating the recording-points has been hereinbefore described; but satisfactory results may be obtained by utilizing simple electromagnets and more particularly when the picture is obtained by perforations proportionate to the luminous intensities.

We claim as our invention—

1. Apparatus for transmitting to a distance optical images, and comprising a transmitter and a receiver, the transmitter having a dark chamber with elements of a selenium basis and means for successively switching them into a local circuit, a relay and system of contacts to cause a line-circuit to act on the receiver in varying proportions, the receiver having a system of contacts moving synchronously with those in the relay-circuit.

2. An apparatus for transmitting optical images, comprising a dark chamber provided with an objective and a movable mirror, and containing plurality of rows of sensitive elements intended to receive the luminous rays reflected by the movable mirror on which fall the emergent rays of the objective, each row of elements corresponding to a proportional part of the image.

3. In an apparatus for transmitting optical images having a dark chamber with sensitive receiving elements therein, a local current connected therewith and a line-current, in combination with a relay comprising two series of rotating resistant windings, arranged inversely and on each of which is applied a roller, one of said windings being switched into the local current of the transmitter and the other into the line-current so as to cause the latter to vary proportionately with the variations of the local current influenced by the sensitive elements.

4. In an apparatus for transmitting optical images a contact arrangement for switching the elements successively into an electric circuit, comprising rotatable notched disks, flexible strips intended to form a connection with contact-pieces carried by the notched disks, the latter being juxtaposed and displaced angularly relatively to one another.

5. An apparatus for transmitting optical images, having a transmitting apparatus comprising a dark chamber, an objective, a movable mirror and sensitive elements, in combination with a system of switches having disks and strips successively switching these elements into a local circuit, a relay in said circuit intended to influence the line-current, and an electromagnet operating a double switch opening the local circuit of the transmitter when the line-circuit is closed, and vice versa.

6. An apparatus for the transmission of optical images, having a transmitter with sensitive elements therein, in combination with means corresponding to the sensitive elements of the transmitter for recording the real optical image on a suitable support, as a band of paper or the like, by means of circular perforations of variable diameters proportionate or inversely proportionate to the luminous intensity of the rays striking the sensitive elements, said points being operated by a suitable electromagnetic apparatus subjected to the variable line-current.

7. An apparatus for the transmission of optical images or pictures, having a receiver and recording-points therein, an electromagnetic apparatus operating each of the recording-points, and comprising an electro-

magnet with two distinct windings, the one traversed by a local current and the other by the variable line-current and modifying more or less at will, the local current.

8. An apparatus for the transmission of optical images having a transmitting apparatus with disks and strips and a receiving apparatus connected in a variable line-circuit, such receiving apparatus comprising recording means and a series of differential electromagnets operating the recording means, in combination with a contact system having disks and strips working synchronously with those of the transmitting apparatus, and successively switching the electromagnets into the variable line-circuit.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

EDOUARD BELIN.
MARCEL BELIN.

Witnesses:
ANTONIN MONTEILHET,
JOHN BAKER.