gether with the gold. It is further possible, even with a comparatively high proportion of silver in the anodes, to use a current density above 10 amperes per square decimeter, with sufficiently strong circulation.

In refining silver by the Moebius process the silver is deposited in form of crystals on the cathodes. When scraped off, the silver drops on the inclined bottom *f* and collects in the flask *fc*.

The insoluble anode slime, consisting principally of gold, falls into the reservoir *r* and accumulates in the flask *fa*. The electrolyte is returned after filtration to the cathodic compartment.

In the Dietzel process for refining copper-silver-gold alloys the cathodes are made of copper and the cathodic deposit consists of copper. Silver, copper, and some impurities pass from the anodes into the electrolyte, while gold and other insoluble constituents drop into the flask *fa*. The electrolyte running from the anode compartment of the tanks contains silver nitrate and copper nitrate. Outside of the tank the silver is almost completely precipitated on copper. The electrolyte is then passed into the cathode compartment of the tank where the copper is alone deposited.

The apparatus described above is particularly suitable for this process and permits the treatment of alloys of such variable composition as between 50 and 90 per cent silver and between 0 and 28 per cent gold, yielding silver of 99.9 per cent purity, gold of 100 per cent and copper of 99.8 per cent.

Serious difficulties had to be met in the construction and installation of this apparatus, but they have been successfully overcome and various electrolyzers of this type, which are patented in all the principal countries, have been in regular operation for about two years.

USINE DE DÉGROSSISSAGE D'OR.

Geneva, Switzerland.

THE PROBLEM OF TELE-VISION.

A PARTIAL SOLUTION.

BY DR. MAX DIECKMANN.

THE transmission of a photograph by Korn's method occupies from 5 to 10 minutes. As the persistence of retinal images is limited to about 1/10 second it would be necessary to multiply the rapidity of the process by 3,000 in order to obtain vision at a distance by this method.

In order to transmit in 1/10 second a picture meas-

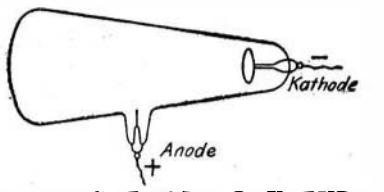


FIG. 1.—CATHODE RAY TUBE.

uring 3½ by 5 inches, which in transmission is drawn out into a strip 1/75 inch wide and more than 100 feet long, it would be necessary to send nearly one million electrical impulses per second from the transmitting to the receiving station. Such a speed of transmission

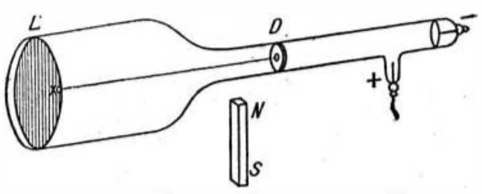


FIG. 2.—BRAUN'S CATHODE RAY TUBE.

is far beyond the capability of the conductor, as well as that of the receiver of the present apparatus. The frequency of the impulses that can be transmitted through a long conductor is limited by the electrostatic capacity of the wire, and every receiver yet invented, even Korn's very light relay, possesses far too much inertia to respond to the demands of vision at a distance.

Hence it appears proper to recall the attention of the inventors who are working on this problem to a

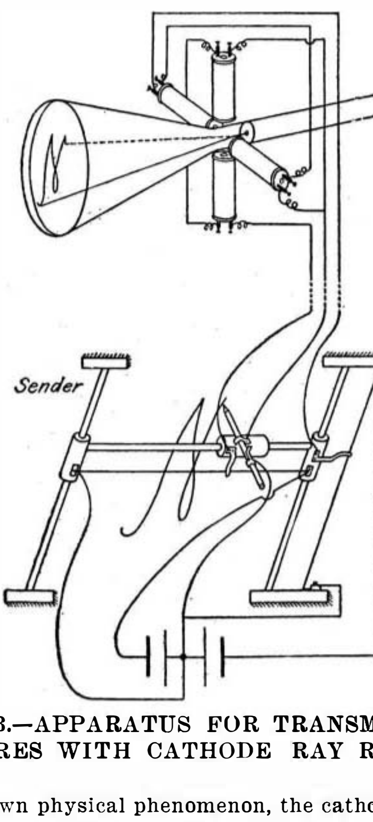


FIG. 3.—APPARATUS FOR TRANSMITTING PICTURES WITH CATHODE RAY RECEIVER.

well-known physical phenomenon, the cathode ray, and to certain experiments made by Dr. Glage and the writer two years ago.

Cathode rays were discovered by Hittorf in 1869. As the air is gradually removed from a glass vessel (Fig. 1) containing electrodes connected with the poles of an influence machine or an induction coil, the colored glow, which at low degrees of rarefaction fills the entire space between the electrodes, recedes from the cathode, leaving a dark space which becomes longer as the rarefaction increases, until it fills the vessel. The glass wall of the vessel, opposite the cathode, then begins to glow with a yellowish green light. This glow is due to fluorescence excited in the glass by invisible rays, the cathode rays, which the cathode emits at right angles to its surface. A screen interposed in the path of these rays casts a distinct shadow on the fluorescent glass. The cathode rays cause various salts and minerals to fluoresce even

FIG. 4.—WRITING TRANSMITTED BY APPARATUS OF FIG. 3.

more brightly than glass. According to recent theories the cathode rays are streams of electrons, or particles of negative electricity, each electron being equivalent to a change of 3.4×10^{-10} electrostatic units of negative electricity. Under the influence of an electromotive force of many thousand volts the electrons move with from 1/10 to 8/10 of the velocity of light, and they move in straight lines unless they are deflected by some extraneous force. Wehnelt has shown that slower cathode rays can be produced with a comparatively small electromotive force, if the cathode is coated with certain oxides and is kept hot. The cathode rays are strongly deflected by magnetic and electrostatic forces.

In studying these effects Braun employed a long and highly exhausted tube with an enlarged portion at one end (Fig. 2) and the cathode at the other, while

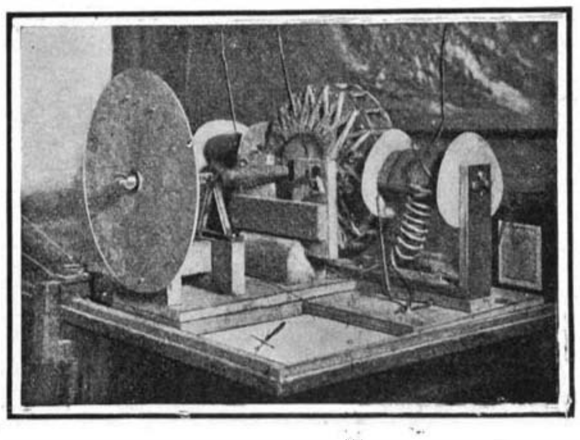


FIG. 5.—DYNAMO OF RECEIVING STATION FOR VISION AT A DISTANCE.

the anode was fused into a branch tube not far from the cathode. A perforated diaphragm at *D* allowed only a narrow pencil of cathode rays to enter the wide part of the tube and strike the opposite end of it, *L*, consisting of a plate of mica coated with a fluorescent substance, where the point of incidence of the pencil was revealed by a blue-green luminous spot.

As the pencil of cathode rays is composed of swiftly moving particles of electricity it is deflected by a magnet as a movable conductor bearing an electric current would be deflected. In the case represented in Fig. 2, the pencil is deflected toward the right by the north pole of the magnet *N S* placed vertically under the tube.

Now the important point is that the cathode rays obey the deflecting force instantaneously in consequence of their infinitesimal inertia. For this reason Braun employed cathode rays in investigating the curves of variation of rapidly alternating currents,

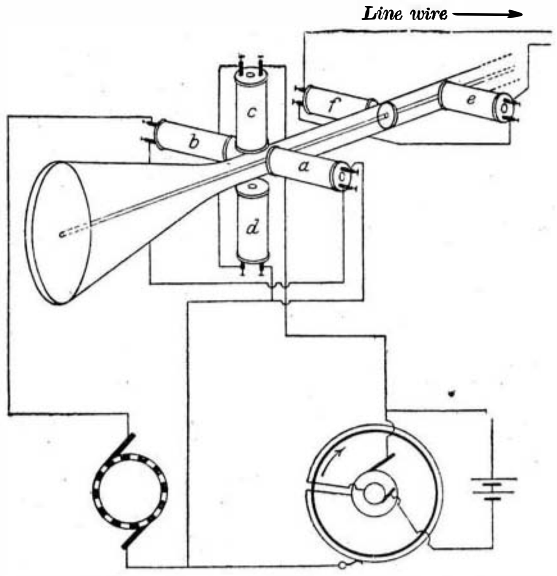


FIG. 6.—RECEIVING STATION FOR VISION AT A DISTANCE.

which he caused to act on the rays by means of electromagnetic coils traversed by those currents. Although other investigators also obtained valuable results with the Braun tube, the apparatus has not been properly appreciated and developed by inventors.

Fig. 3 illustrates the method by which we directly transmitted and reproduced writing and drawings by means of the Braun tube and three live wires. The tracing point at the transmitting station (Fig. 3, below) was attached to a sliding piece, the guide bar of which was borne by two pieces sliding on bars perpendicular to the first bar. Every movement of the tracing point was thus mechanically resolved into two mutually perpendicular components. The movements of the sliders, by causing variations in resistance, produced corresponding fluctuations in two currents which passed through the live wires to the receiving station. The receiver (Fig. 3, above) was a Braun tube surrounded by two vertical and two horizontal electromagnets. One of the currents from the transmitting station traversed the vertical coils and its fluctuations caused horizontal displacements of the cathode rays and the fluorescent spot produced by them. The other current energized the horizontal coils and moved the spot vertically. The combination of these horizontal and vertical movements caused the lumi-

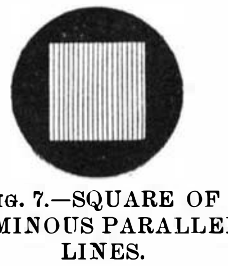


FIG. 7.—SQUARE OF LUMINOUS PARALLEL LINES.

FIG. 8.—COPY OF PATTERN PROJECTED ON LUMINOUS SQUARE.

nous spot to trace an exact copy of the design followed by the point at the transmitting station. In this way we found no difficulty in transmitting drawings and written words in a few seconds (Fig. 4).

Many instances of transmitting and receiving apparatus capable of accomplishing similar results have been invented, but the following experiment has probably not been performed by any other method.

We constructed a small dynamo (Fig. 5) which furnished current to the four deflecting magnets *a*, *b*, *c*, *d* of the receiver (Fig. 6). The machine was designed and operated in such a manner that the spot of light traced a succession of parallel and equidistant lines, with which it filled a small square (Fig. 7) in exactly 1/10 second, and then recommenced the process. In consequence of the closeness of the lines and the persistence of images on the retina, an eye placed opposite the large end of the Braun tube saw a rectangular luminous patch about 1¼ inches square. Behind the four coils and the diaphragm were two horizontal coils *e*, *f*, the function of which will appear.

At the transmitting station a fine metal brush moved synchronously with the luminous spot at the receiving station, covering an area 1¼ inches square with invisible lines in exactly 1/10 second. A sheet metal pattern was applied to this area. When the moving brush touched the metal an electric current was sent through the live wire to the receiving station and through the coils *e*, *f*. The magnetic field thus produced deflected the cathode rays vertically to such an extent that none passed through the hole in the diaphragm. During the passage of the brush over the pattern, therefore, no rays reached the fluorescent screen and no luminous spot was formed. The result was the obliteration of those parts of the luminous square which correspond to the area of the metal pattern or, in other words, the production of an exact copy of the pattern in black on a luminous field (Fig. 8). As the entire copy was produced in 1/10 second it followed every movement impressed on the pattern.

This experiment shows that the cathode ray is well worth the attention of inventors in search of apparatus destitute of inertia. But the retarding effect of the electrostatic capacity of a long conductor cannot be overcome by the employment of cathode ray tubes as receivers. Hence wireless telegraphy appears to offer the best promise of a solution of the problem of vision at a distance. The writer is now engaged in experiments in this field.—Adapted for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

THE VOYAGE OF "ZEPPELIN II."

THE OFFICIAL REPORT.

IN the Berlin Imperial Gazette of the 21st instant Count Zeppelin gives a very lucid account of his famous 38 hours' voyage in "Zeppelin II," which resulted in semi-disaster, attributed to the careless steering of the helmsman. Count Zeppelin commences by stating that his object was to prove that the new airship, constructed with funds supplied by public subscription to replace its predecessor, which was destroyed at Echterdingen, possessed all the qualities which he attributed to it. The crew, he says, consisted of eight men, and gasoline and oil sufficient to keep the two motors working for thirty-four hours was taken on board. He selected the direction of Berlin in order to show that he was in a position to travel that distance at any time, and also because in the event of his having to land he could reckon on the assistance of the Balloon Battalion. He kept his project secret so that in the case of failure it might not seem that the enterprise was unsuccessful, and also in order to avoid disappointing the people who might be awaiting his arrival. Rain was falling when he made his preliminary ascent on May 28th, and he maneuvered over Lake Constance for three-quarters of an hour, where it fell heaviest, to ascertain the effect on the gasholder. The water ultimately penetrated the covering and fell into the cars and increased the weight to such an extent that ballast had to be thrown out.

When he started for his long trip on the evening of May 29th rain was again falling, and unfortunately the astronomical instruments required for the journey had not arrived. The loss of weight resulting from the use of gasoline in the motors and the effect of the sun's rays on the gas made it desirable to obtain a fresh supply of water ballast by letting buckets down into the Deutzendteich, near Nuremberg, but so many boats were on the water that this could not be accomplished. Between Leipzig and Bitterfeld it was considered advisable to return in order to obviate the necessity for landing for a fresh supply of gasoline. Berlin could not in any case have been reached until late at night. After telegrams had been dropped at Bitterfeld and the return voyage commenced, darkness prevented Count Zeppelin from ascertaining his position, and with one motor working he traveled slowly in wide circles for five hours.

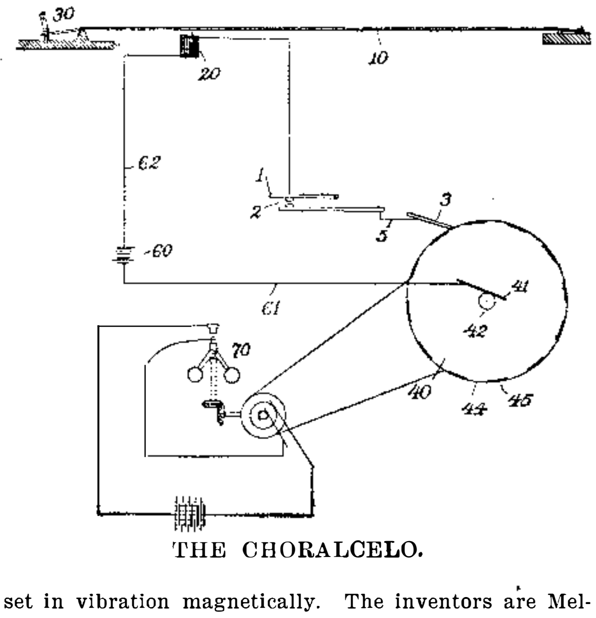
At daybreak he discovered that the airship was over Schweinfurt, and a course over Würzburg, Heilbronn, Stuttgart, Ulm, and Friedrichshafen was decided upon. He chose this route because he knew of several places on the way where, if necessary, he could land to obtain fresh supplies of gasoline and oil. It seemed probable that home could be reached with both motors working, but on the other side of Stuttgart such a strong head wind was encountered that it was decided to renew the stock of gasoline and oil at Göppingen. In attempting to reach a very favorable landing place on a flat piece of ground the steersman, who was attempting to describe a large curve, allowed the airship to be driven into a valley, and, instead of turning round and leaving the valley where he entered it, he directed the airship over a hill. Owing to the circumstance that the airship was traveling against the wind it could not be raised sufficiently high quickly enough, and being, moreover, caught over the hillside in a downward current of air it could not be prevented from running into a tree. The rigid framework of the balloon saved the crew and the machinery from the effects of the collision, but it was bent as far as the first car, the cover was torn off, and the front gas cells were destroyed.

When the mishap occurred the balloon had been in the air for thirty-nine hours and had not lost a cubic meter of gas or a liter of water ballast; so that if gasoline and oil had been obtained at Göppingen the "Zeppelin II" would have been ready to start afresh on an equally long voyage. The airship was provisionally repaired, but, owing to the fact that several gas cells were wanting, its carrying power was reduced. The front motor was therefore removed, and the engineer, Herr Duerr, who now assumed command, could take only four men with him.

Against a head wind, which at times was rather strong, with a blunt bow and with only one motor, the airship proceeded slowly. It was permitted to rise as the sun's rays affected it. When it reached the height of 4,000 feet much gas was lost, and a second landing became imperative at half-past eight, when the air became considerably cooler. Everything of weight that could possibly be dispensed with was thrown out, and fresh gasoline and oil for the motors having been obtained from motor cars the voyage to Friedrichshafen was completed without a new supply of gas.—Flight.

THE "CHORALCELO." A NEW MUSICAL INSTRUMENT.

A MUSICAL instrument known as the "choralcelo" was recently exhibited in Boston which produces musical notes not by mechanical means, such as striking a tense string with a hammer or drawing a bow across the string, but by electrical means, the string being



THE CHORALCELO.

set in vibration magnetically. The inventors are Melvin L. Severy and George B. Sinclair.

When a piano string is brought into the field of an electromagnet having a definitely timed number of electric pulsations conveyed thereto, and the string is gradually tuned up to vibrate in accord with the pulsations, the instant they are in exact accord the string will respond with a markedly pronounced maximum loudness, while if tuned but slightly sharp or flat, the resonance will at once fall off and become much weaker. Furthermore, as the string departs in the slightest degree from the number of vibrations per unit of time given by the electromagnet, not only does its volume decrease, but the quality of the tone changes as well. Hence, by providing a standard set of electromagnets and pulsating devices for the piano strings, and then gradually tightening each wire until its magnet fails to increase its loudness of vibrations further, the operator can know that the spring is in exact tune. Or if he tightens the wire a trifle too much, as evidenced by its diminution in loudness, he loosens up thereon until again the maximum volume is reached. When the operator becomes more experienced, he can also detect the exact point by noting the change in quality of sound produced.

In carrying the invention into effect for merely tuning ordinary pianos all that is needed in the way of apparatus is a single electromagnet, and a device for imparting thereto any desired number of standard pulsations. This magnet being supported in close proximity to any one of the strings, and the electric pulsations appropriate to the string communicated to the magnet, all that the tuner needs to do is to tighten up or loosen the wire until its maximum loudness and proper quality are reached. Then the magnet can be shifted to the next string; the pulsations changed in accordance therewith, and the tuning done as before. The process is, however, especially designed for electric pianos wherein the strings are vibrated by electromagnets permanently in place. Hitherto the method of tuning the strings was that of the old-time piano tuner—to turn the tuning-hammer and strike the note until the latter reached the standard set by the tuning fork; striving to reach the point where the beats, which showed a near approximation, should wholly cease. As different tuners' ears vary in their capacity to detect the exact vanishing point of these beats, it is impossible to tune all pianos precisely alike, even with the same standard. This, however, is a comparatively insignificant matter in comparison with the inability of even the same tuner to get identical temperaments on two or more pianos, or to duplicate the temperament in the same instrument when it is retuned; for the reason that the question of temperament is one of individual judgment, of compromise with exact chords.

Formerly the only known method of tuning electrically actuated pianos was first to change the tension upon each string until it suited the tuner's ear, and then to time the pulsation-producing mechanism until it accorded with the vibrations of the strings. In other words, the pulsation-producing device of each string is planned to deliver the proper number of impulses per unit of time to equal the theoretical number of its strings' vibrations. Then the strings are tuned in the usual manner, and the pulsation-producing motor speeded up or down until the periodicities thereof approximate the strings' vibrations. This is never satisfactory, however, inasmuch as no man can accurately temper the scale of the piano twice alike, and much less can two professional tuners make two different instruments with their scales exactly the same, so that the strings are never brought to the precise pitch for which their pulsation-producing mechanism is planned. This renders the piano irregular and uneven in tone and unreliable and uncertain in timbre. By means of the new process, however, the inventors are enabled to produce an instrument wherein not only are the strings tuned into exact accord with the standard established for every note in the entire scale, but wherein the strings vibrate with a maximum volume with a minimum expenditure of current, and which can be kept in perfect tune by any person who will follow the simple directions laid down.

Referring to the drawings, which show a means for carrying the process into effect, the reference numeral 10 designates a piano string having a tuning pin 30, and an electromagnet 20 in close proximity thereto. The rotating disk 40 having its periphery divided into alternate sections of conducting and non-conducting material 44, 45, acts in connection with the brush 3, wire 5, source of electricity 60, lead-wires 61, 62, and brush 41, to impart to said magnet the desired electric pulsations. 1 and 2 represent a key and contact by which the pulsations are turned off and on to the magnet. By turning the pin 30, the string is tightened or loosened in the usual manner. In tuning said string, the electric pulsations produced by the current-breaker 40 and exactly timed by a governing device 70, are continuously maintained in the electromagnet 20 while the string is being tightened. As the string approaches an octave below the set standard, it will increase in loudness, and then diminish as the tuning is continued past, but the quality of the note produced will make it evident that the string has not reached the true pitch for which it is designed. So the tight-