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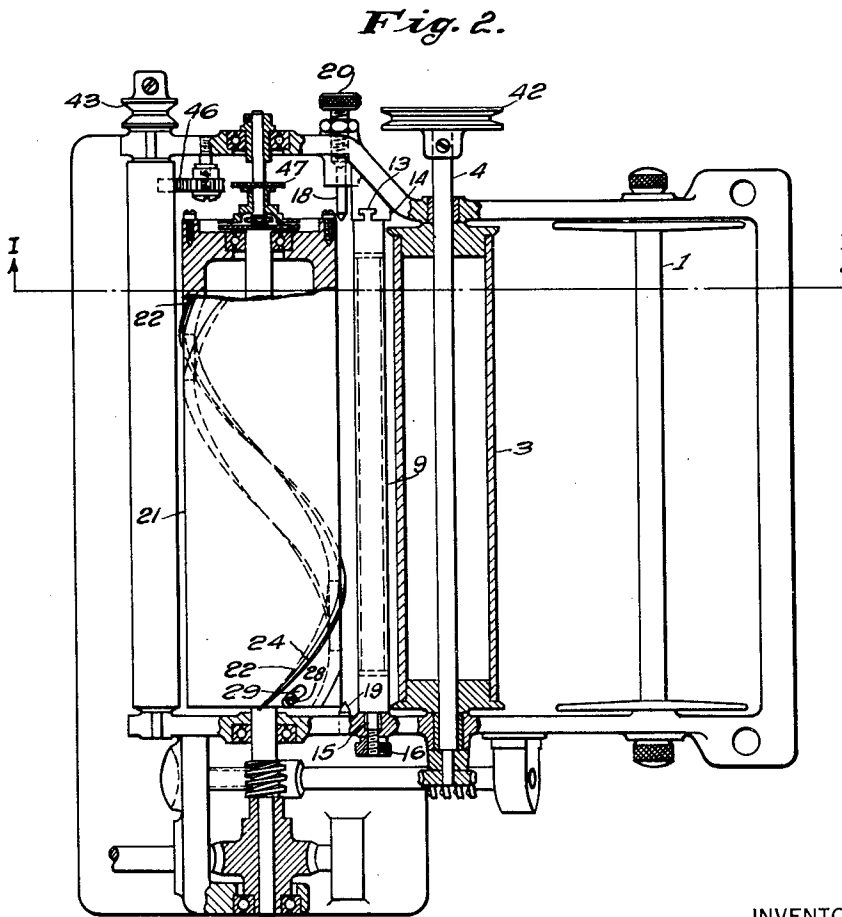
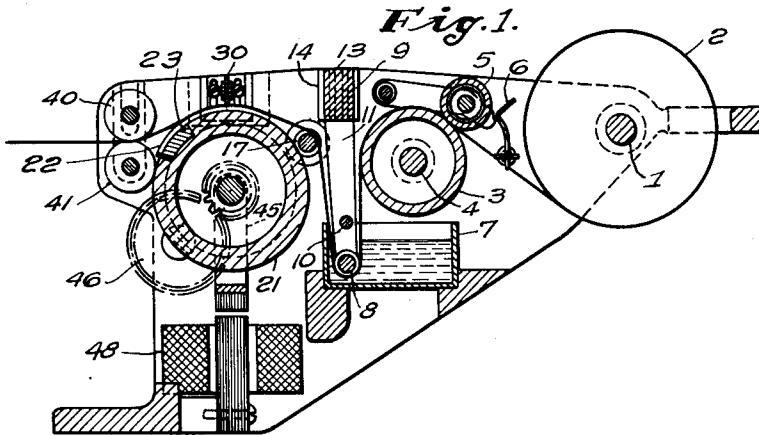
V. K. ZWORYKIN ET AL

1,909,142

FACSIMILE RECEIVER

Filed Jan. 20, 1930

2 Sheets-Sheet 1



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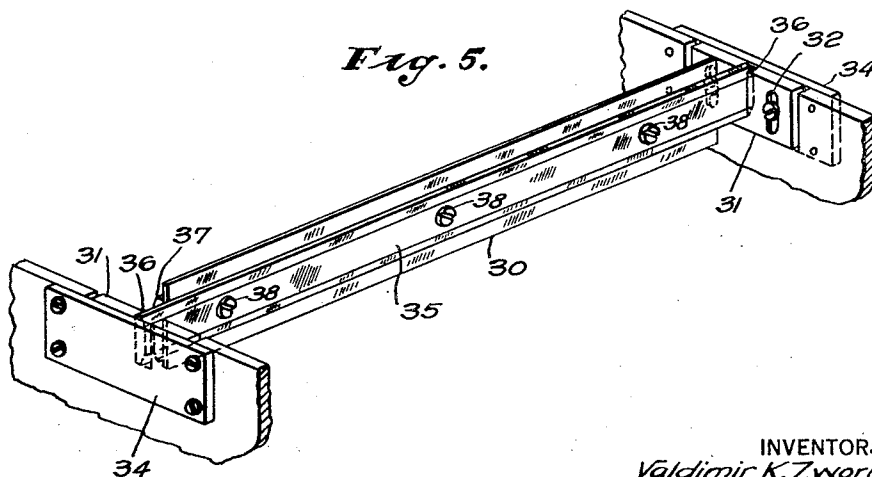
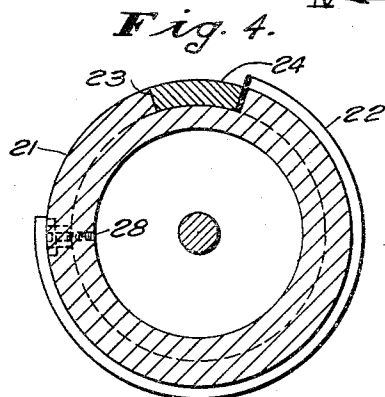
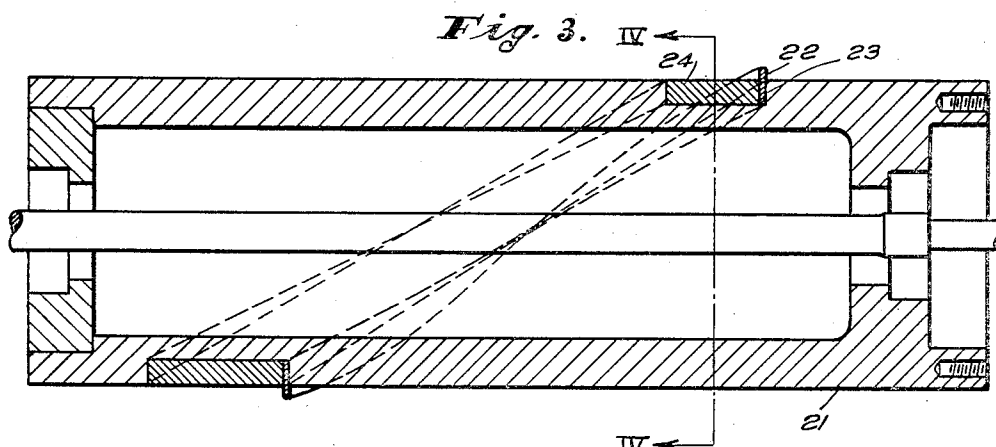
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FACSIMILE RECEIVER

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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

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## FACSIMILE RECEIVER

Application filed January 20, 1930. Serial No. 421,965.

Our invention relates to facsimile transmission and particularly to the reproduction, at the receiving station, of drawings, pictures or other messages by electrolytic means.

It has been proposed to reproduce pictures by impregnating paper with a substance which will be discolored under the influence of an electric current and to apply this current at single small areas of the paper at a time, causing said area to progress systematically over the paper and so varying the current that, at each position of said area, it shall be proportional to the degree of darkening necessary to reproduce the picture.

This method has heretofore presented the disadvantage that the paper must be manipulated in a wet condition. It has not proved feasible to operate upon continuous bands of paper because of this condition.

It is an object of our invention to provide a picture-reproducing machine in which a continuous band of paper can be used. The band is to be dry during the greater part of its travel through the machine and is to be wet just previous to its passage between the electrodes.

It is a further object of our invention to provide a combination of electrodes, one helical and the other straight, between which the paper passes and to so arrange them that the abrasion of the paper by the electrodes shall be reduced to a minimum.

It is a further object of our invention to provide such a pair of electrodes in which the electrode from which metal is removed by the electrolytic action may be conveniently replaced.

Other objects of our invention will be apparent from the following detailed description and the accompanying drawings in which:

Figure 1 is a sectional view, showing the course of the paper through the machine, taken along a line corresponding to the line I—I in Fig. 2;

Fig. 2 is a top plan view of the machine, certain parts being shown in section and the paper being omitted;

Fig. 3 is a longitudinal central section of the roller carrying an electrode;

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 3;

In Fig. 5 is a detail perspective view showing the construction and the mounting of the straight electrode.

A spool 1, carrying a roll of paper 2, is mounted in the upper part of the machine at one end thereof. A drive roller 3 is mounted upon a shaft 4, suitably spaced from the shaft 1 to afford effective delivery of the paper thereto. A friction roller 5 is pressed, by a spring 6, into engagement with the paper as it passes over the roller 3. A continuous and positive tension is thus exerted upon the paper.

Below the roller 3, a tank 7 is provided which contains a guide roller 8. The guide roller is mounted at the lower part of a removable frame comprising an upper bar 9, a lower tie rod 10 and side members 11. The bars for the roller 8 are mounted in the lower ends of the side members which extend below the tie rod 10 and reach near to the bottom of the tank 7. At one end of the cross bar 9, the frame is provided with a lug 13 which extends into a dove-tail groove in a boss 14 on the side wall of the machine. At the other end, the cross bar 9 is provided with a tenon 15 which extends into a vertical groove in the other side wall of the machine. A set screw 16, by engaging the end of the tenon 15, will retain the frame and, therefore, the roller 8 at the selected height.

A guide roller 17 is located on the other side of the frame from the roller 3 and, somewhat higher, this guide roller is supported between the pointed pivots 18 and 19, one of which is adjustable in order to insure the correct connection to the bars and to provide for removal of the roller, when necessary. This adjustment is effected by the screw 20.

Adjacent to the guide roller 17, is mounted a roller 21 which carries a helical electrode 22. The electrode 22 is preferably of flexible metal. It may, before being inserted into place, be a ring of a diameter which will fit the groove in the cylinder 21 but

split at one point. By pulling the ends apart, in a direction at right angles to the plan of the ring, it may be deformed into a helix and inserted in the groove 23, which extends helically around the cylinder 21. The pitch of the helix is such that the electrode extends substantially from one end of the cylinder to the other.

The groove 23 is not of uniform width but tapers, narrowing gradually from one end of the cylinder to the other. A helical strip 24 tapers so that it will fit this groove. When the strip 24 is placed in the groove 23 by a screw movement, it will restrain the electrode 22, compelling it to conform to one wall of the groove. The electrode is thus brought to a true helical shape, even though, as originally produced from the ring, it is only approximately helical.

When the filler 24 has been screwed into the groove 23 so far that it presses the electrode 22 firmly into place, it is secured by a set screw 28. An elongated opening 29 is provided near one end of the filler 24 for the accommodation of the head of this screw during the tightening movement of the filler.

A straight electrode 30 is adjustably supported above the cylinder 21. The adjustment is provided for by plates 31, one at each side wall of the machine. The plates are provided with vertical slots 32 which cooperate with set screws extending into exterior plates 34. The exterior plates are secured to the outer faces of the side walls of the machine, and the side walls are recessed to provide space for the plates 31.

The electrode 30, being of thin metal and, therefore, too flexible to maintain itself in a straight line across the machine, is stiffened by a bar 35 which extends beyond the electrode 30 at each end and is received into notches 36 in the plates 31. A second reinforcing bar 37 extends along the other face of the electrode, and screws 38, at spaced intervals along the electrode, fasten the bars 35 and 37 together. A plurality of holes are provided in the electrode in position to register with the screws to enable them to draw the bars together. Tightening the screws thereby produces a rigid structure, the lower edge of which is the projecting edge of the electrode. The upper edge of the electrode may project above the upper edges of the bars 35 and 37. The whole structure may then be reversed end for end to bring the upper edge of the electrode into the lower position.

Guide rolls 40 and 41, at the delivery side of the cylinder 21, serve to put the necessary tension on the paper to insure its motion past the cylinder 21. Each of the rollers 3, 21, 40 and 41 is driven by gearing on the outer side of the side walls of the machine. It is unnecessary to describe this gearing in detail. It includes a pulley 42 by which

the roller 3 is driven, and a pulley 43 by which the roller 40 is driven. In order to insure the necessary small slipping movement between the paper and the roller 21, a brake is provided for controlling the speed of the roller 21. The necessary slippage between the pulleys 42 and 43 and the belts which drive them is regulated by the action of the brake.

The brake includes a pressing member 45 to cooperate with a gear wheel 46 which meshes with a gear wheel 47 upon the shaft of the cylinder 21. The pressure of the member 45 against the face of the gear wheel 46 is regulated by a magnet 48 which may be controlled in any suitable manner.

In the operation of the device, a roll of paper 2 is mounted upon the spool 1, threaded between the rollers 3 and 5, led into the tank 7 and then over the guide roll 17, past the upper surface of the cylinder 21 and between the rollers 40 and 41. The frame, including the cross bar 9 and carrying the roller 8, is then put in place by slipping the dove-tail lug into the slot 13 and the other lug into the slot in the opposite wall. The height of the frame is adjusted until the paper passes very near to, but not in frictional contact with, the bottom of the pan 7.

The electrode assembly, carrying the straight electrode 30, is then put in place, the ends of the bar 35 entering the slots 36. If the adjustment is not already correct, the screws are adjusted in the slots 32 until the contact between the lower edge of the electrode 30 and the paper at the point where it is supported by the projecting electrode 22 is of the right pressure.

The pan 7 contains the material with which the paper is to be wet. If the paper is already impregnated with a suitable solution for cooperation with the electrodes, the pan may be filled merely with water. For example, if the image is to be formed by the reaction of starch with free iodine, the paper may have been soaked in a solution containing both starch and potassium iodide, dried and wound upon the roll 2. Then the tank would contain only water.

On the other hand, the paper may be impregnated with one of the two constituents needed to make the sensitive electrolyte, and the pan 7 may contain a solution of the other ingredient. In the illustration chosen, the paper may be impregnated with starch and the pan 7 may contain a solution of potassium iodide.

It is also feasible to have, in the pan 7, a solution of the sensitive electrolyte, in which case, unimpregnated paper is provided on the roll 2.

For example, the electrode 30 which, in this case, should be the anode, may be made of silver, and the pan 7 may contain a properly proportioned solution of ammonium ni-

trate, potassium bromide, potassium iodide and pyrocatechin in water. With the passage of current, the silver at the edge of the anode, where it makes contact with the paper as pushed up by the helical cathode 22, dissolves in proportion to the current passed, in accordance with Faraday's law. The dissolved silver at once reacts with the bromide and iodide ions to form silver bromide and iodide, which are very insoluble in the solution impregnating the paper, and, seemingly, are adsorbed on the surface of the paper so tightly, as soon as formed, that the outlines of the record do not run or smear. The silver bromide and iodide, which are only slightly colored, later react with one or more of the other ingredients in the solution to form a more highly colored image.

Though we have secured our best results with the above solution and a silver anode, we have also had very good success using an iron anode, which also dissolves with the passage of current and the formation of a good image in a solution containing ammonium nitrate, ammonium chloride and gallic acid in water. With this last solution, the iron anode may be replaced by one of konel or any one of several other metals. It is not our wish to be limited in this disclosure by the nature either of the electrodes used or the solution, for we are primarily concerned in this application with a special procedure and mechanism by which satisfactory pictures may be continuously received by an electrolytic process.

After passing through the pan 7, the paper is supported by the surface of the cylinder 21, but is lifted from this surface, over a portion of its width, by the electrical electrode 22 which projects slightly from said surface. The straight electrode 30 makes contact only with the lifted portion of the paper and makes contact firmly with only that portion of the paper between it and the helical electrode. Current from the one electrode to the other flows only in that portion of the paper which is between the electrodes and flows, in a perceptible amount, only in the very small area which is subjected to pressure by the electrodes. Only a very small area of the paper is discolored by the action of the current upon the electrolyte in the paper.

The pitch of the helix is such that, during one revolution of the cylinder 21, the point at which the electrodes affect the paper, travels the width of the paper. The cylinder 21 is caused to rotate at a considerably higher speed than the longitudinal movement of the paper. Many lines across the paper are thus traced by the working point of the electrodes for each unit of length of paper. If, for example, it is desired to make a picture with a fineness of

grain corresponding to 100 lines per inch, the cylinder 21 will be made to rotate 100 times for each travel of the paper through the machine.

The slipping between the electrode 22 and the paper is much greater than the slipping between the electrode 30 and the paper. For this reason, it is preferable that the electrode 22 have a dull edge to avoid too great a scraping action upon the paper, but the electrode 30 may have a sharp edge without producing an objectionable amount of scraping of the surface of the paper, even though the paper be wet. To produce this sharp edge without requiring the electrode to be ground to a knife edge is a reason why the electrode is thin and, because of this thinness, it must be reenforced, as described in connection with the bars 35 and 37.

The provision of a helical electrode cooperating with a straight electrode to provide a motion of the working point across the paper for each revolution of the cylinder has been proposed before, but the mounting of such electrodes whereby they are replaceable, the provision for wetting the paper just before its passage between the electrodes and many details of instruction and operation are new. Certain features of this invention which we believe to be new are expressed in the following claims, but no limitation is intended except as may be stated in the claims or may be imposed by the prior art.

We claim as our invention:

1. In combination, a helical electrode, a thin straight electrode for cooperation therewith, a reenforcing strip extending along said straight electrode and securing means for maintaining said straight electrode against said reenforcing strip, whereby said straight electrode is prevented from flexing.

2. In combination, a helical electrode, a thin straight electrode for cooperation therewith, a reenforcing strip extending along said straight electrode, and means for adjusting the spacing of said straight electrode from said helical electrode and for supporting said straight electrode in the adjusted position.

In testimony whereof, we have hereunto subscribed our names this 10th day of January, 1930.

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HOWARD M. ELSEY.