Oct. 2, 1951 M. ARTZT ET AL 2,569,648

FACSIMILE SYSTEM AND APPARATUS

Filed April 30, 1949 3 Sheets-Sheet 1

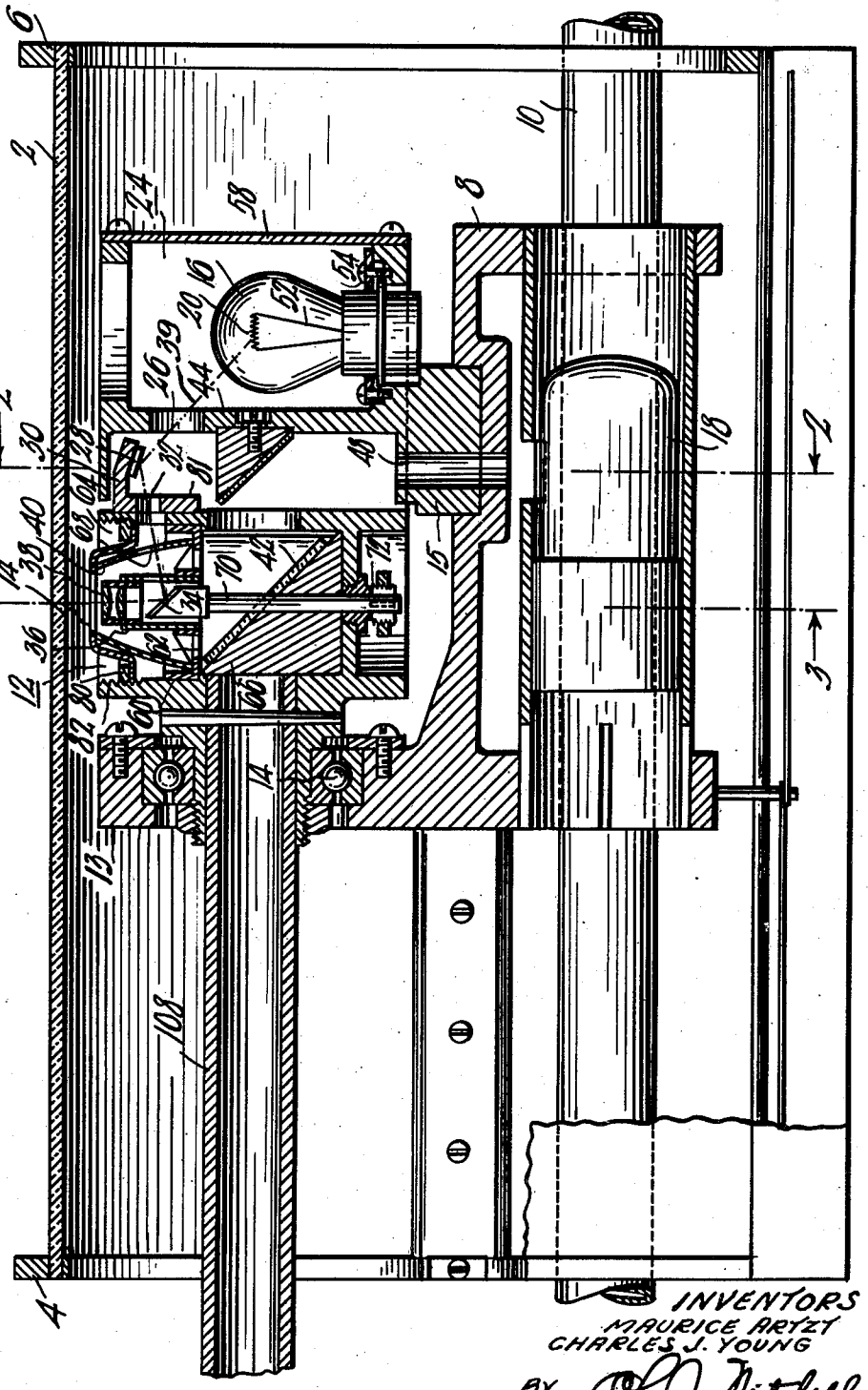


Fig. 1.

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Fig. 3.

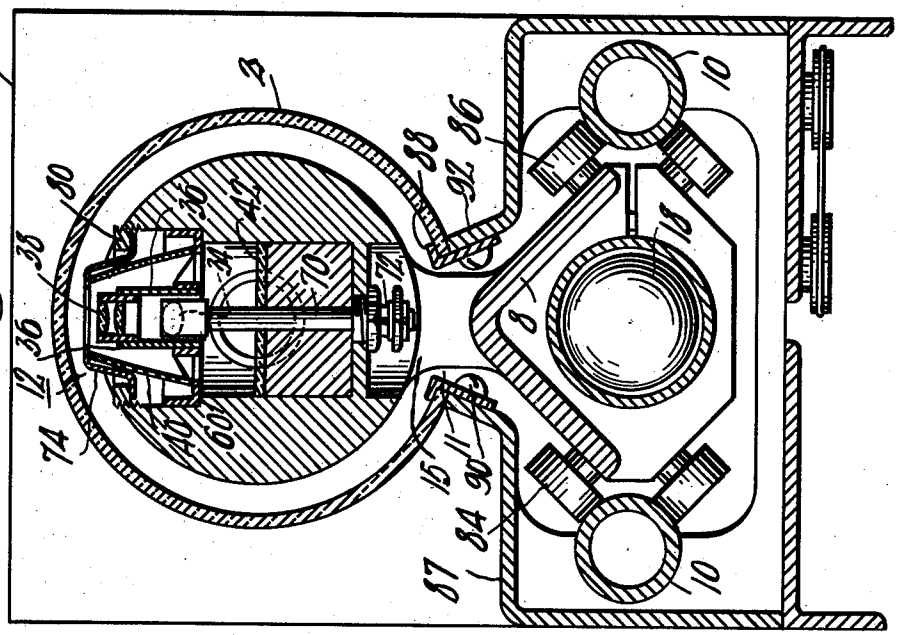
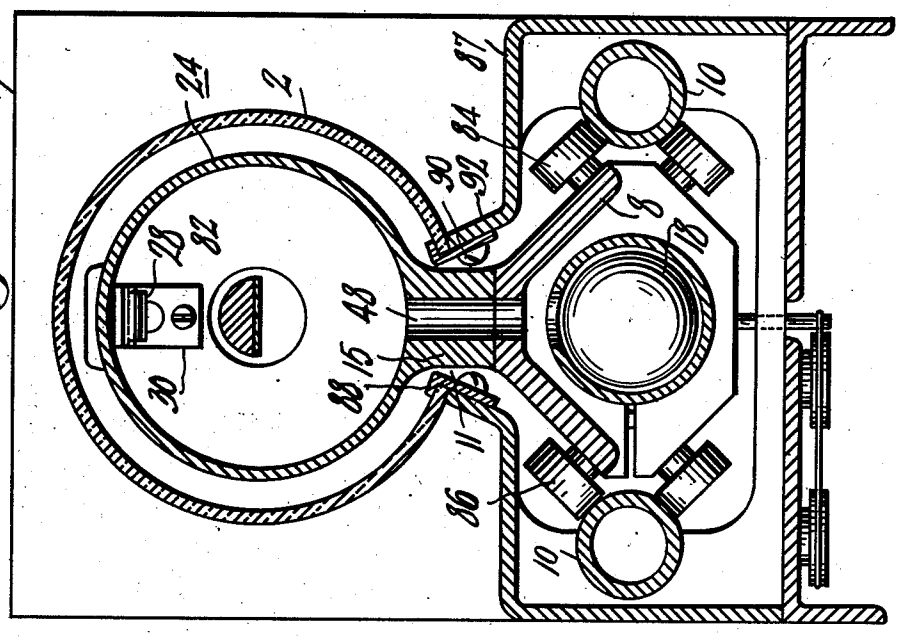


Fig. 2.



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Filed April 30, 1949 3 Sheets-Sheet 3

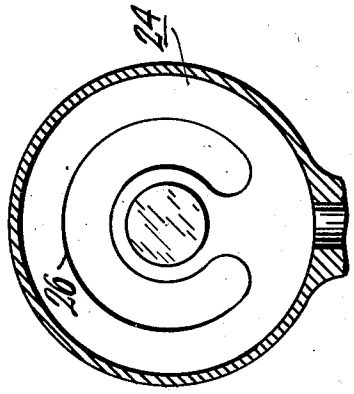


Fig. 4.

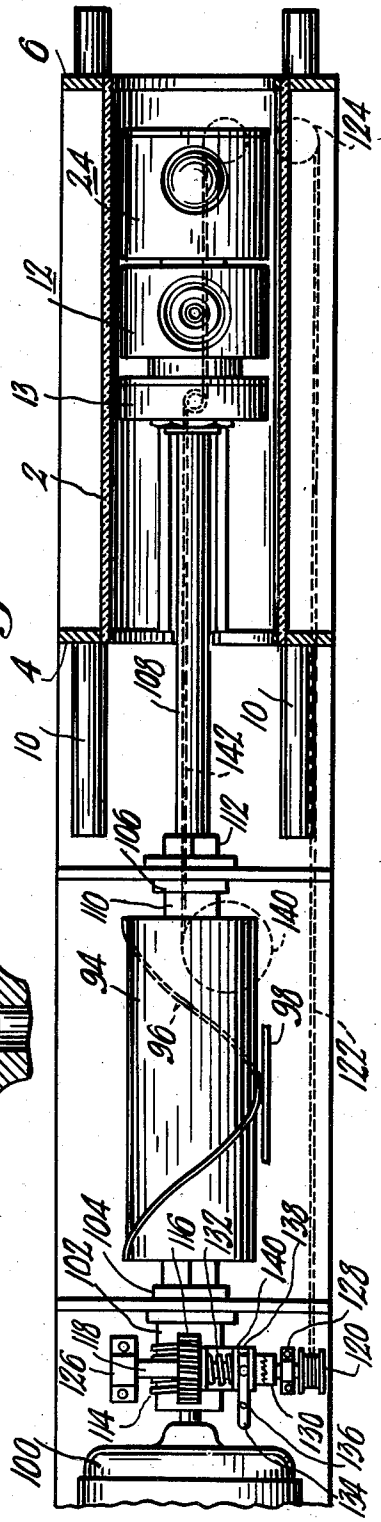


Fig. 5.

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FACSIMILE SYSTEM AND APPARATUS

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4 Claims. (Cl. 178—7.1)

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This invention relates to a system and apparatus for fascimile telegraphy and more particularly to a novel facsimile machine in which the exciter lamp and the photoelectric cell are both stationary.

Generally speaking, this invention relates to a type of facsimile machine in which the copy to be transmitted is wrapped around a stationary cylindrical copy holder and the scanner is rotated about the axis of the copy holder in a corkscrew fashion so as to scan the whole surface of the copy. In this particular arrangement a carriage is mounted for longitudinal motion on guides that are parallel to the axis of the copy holder and a tongue extends from the carriage through a longitudinal groove or slot in the side of the transparent cylinder holding the copy so as to support the rotating scanning head and the source of illumination. The lamp is so mounted as to provide a uniform light to the scanner as it rotates.

An optical means is provided in the scanning head for focussing the image of the filament of the light source onto the surface of the copy that is wrapped around the copy holder and a parabolic reflector serves to pick up the light reflected by the copy and directed to a photoelectric cell that is positioned in the lower part of the carriage.

The requirement that the light be the same for all positions of the scanner led to previous designs in which the light was mounted so as to rotate with the scanning assembly, thereby providing a fixed optical system. Under these conditions, if the filament were not exactly in the axis of rotation, centrifugal forces act on it so as to move it out of focus. Even though the filament might originally be positioned on the axis, the forces due to rotation and vibration, act on the filament supports and thereby move the filament out of the axis of rotation where it is in a position to be acted on by the centrifugal forces. This effect is particularly apparent in the type of apparatus such as herein described, wherein the filament supports must be mounted in the plane of the filament in order to prevent their shadows from being passed through the optical system of the scanner, for in this type of construction the stiffness of the supports is at a minimum.

In this invention these difficulties are avoided as the lamp is fixed with respect to the carriage and an optical system is provided whereby the lamp need not rotate. In order to supply a uniform amount of light to the optical system in the scanning head, regardless of its position, the filament of the lamp is made to coincide with the axis of rotation and light is allowed to escape the cage, surrounding the lamp, through a substantially annular groove or slot so as to engage a mirror that rotates with the scanning head and be

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reflected into the internal optical system of the latter.

One of the advantages of the type of apparatus wherein the scanner rotates about the axis of a cylindrical copy holder, is that the face of the optical system for producing a scanning spot, can be very close to the inner surface of the copy so as to allow a larger source of light or, in other words, a larger filament to be used in forming a scanning spot of a predetermined size.

As stated above, the image of the filament of the light source is focussed by the optical system onto the inner surface of the copy and this means that, with a given lens at a predetermined distance from the copy, a longer light path from the lens to the filament makes it possible to use a still larger light source and thereby form a scanning spot of greater intensity. Naturally, the greater the size of the light source, the higher is the intensity of the scanning spot and the greater is the contrast ratio of the transmitted images. If such a system is used in a receiving apparatus in which photographic paper is mounted on the transparent cylinder and activated by the modulated light spot from the scanner, it is apparent that the pictures are improved. Now, then, if the size of the scanning spot is predetermined and the distance from the inner surface of the copy to the lens system is fixed, then it is readily apparent that, if the optical path from the lens system to the source of illumination is increased, that the source can be made larger and still be focussed within the predetermined area allowed for the scanning spot. If this is done, then the amount of light in the area of the scanning spot is increased and the quality of the transmitted or received images, as the case may be, is improved. The apparatus embodying the principles of this invention has a light path between the filament and the lens system that is inherently greater than that of other designs or, in other words, the ratio of this distance to the distance between the copy holder and the optical system is a maximum. Of course, it might be said that the distance from the filament to the optical system could be made as large as desired, but it is to be understood that the above statement applies to a system in which the light source travels with the carriage and in which the length of the scanner assembly and the light cage are to be maintained at a minimum. If this were not so, the length of the copy holder would have to be unduly increased in order to accommodate the axial motion of the carriage and scanner assemblies.

Another advantageous feature of the present apparatus is that the light in passing from the source to the lens system that focusses it into a scanning spot is twice reflected, but it is also made to pass through a narrow opening, and

these two features combine to prevent light from any other source than the desired section of the filament from being introduced into the lens system. In other designs, where the light is shone onto a mirror and reflected directly into the lens system contained in an optical barrel, it is possible for rays from undesired sources to be reflected from the mirror onto the side walls of the barrel, and, even though the internal reflections of this barrel are reduced by application of black matter to the inner surface, nevertheless, some light is reflected into the lens system in such manner as to decrease the sharpness of the scanning spot. This has the effect of reducing the definition of the transmitted or received images and is especially noticeable where fine print is being transmitted.

In the type of facsimile machine wherein the source of illumination rotates with the scanner, it is customary to use what is called pre-focussed lamp, which is a light source having a base that is carefully set with respect to the filament so as to place the latter in the same position when one lamp is replaced by another. The need for such precision has been discussed above and because pre-focus lamps are expensive, attempts have been made to use ordinary lamps in such apparatus. However, such attempts have not been very successful because the filament has to be placed into the correct optical position for each lens and inasmuch as no special base is supplied, the tolerances normally encountered in manufacture, are too great to always allow the filament to be in the proper position when one lamp is substituted for another. To adjust the proper position of the filament in a facsimile machine having a rotating light source, is a tedious process of trial and error for the machine must be set into operation to check the proper position of the filament and then stopped while the lamp position is re-adjusted. As the lamp is mounted on the scanner and the latter is inside the transparent copy holder, it can be seen that it is difficult to get it and therefore this trial and error process consumes a considerable amount of time and effort and is a very inefficient method of operation. Furthermore, it is possible that, if the filament is initially placed too far from the axis of rotation that the centrifugal forces discussed above will destroy the filament or move it out of line so as to make the lamp useless. In this invention, these difficulties are eliminated and the lamp is mounted on the carriage that moves slowly in an axial direction, thereby permitting adjustments of its position to be made while the scanner is in operation, and it has been found feasible to make these adjustments within a period of less than one minute without the necessity of shutting the machine down.

It might at first be thought that the shadow cast by the filament supports would appear on the optical system and thereby change the intensity of the scanning spot. However, this is not the case because the common plane of the supports and the filament passes through the axis of the cylinder at such an angle as to lie opposite the slot or groove through which the tongue of the carriage is projected.

The facsimile apparatus embodying the principles of this invention has another advantage over machines of the prior art, namely that both the photoelectric cell and the source of illumination are stationary with respect to the carriage thereby eliminating the necessity for slip rings. It was found, even after experimentation

with various types of electrical brushes, that a fine dust caused by the wear of the brushes was deposited on the inner surface of the copy holder. The amount of light in the scanning spot naturally decreased as the machine was used until finally it was necessary to stop operations and clean the inside of the cylinder. The amount of cleaning necessary is greatly reduced if the brushes are eliminated, and in this invention no slip rings or brushes are required as both the phototube and the source of illumination are mounted on the carriage and do not rotate with the scanner.

In view of the foregoing discussion, it is one of the principal objects of this invention to provide a facsimile apparatus of the type wherein no slip rings are required.

A further object of the invention is to provide a facsimile apparatus of the type described in which the source of illumination for a given size of scanning assembly is a maximum.

A still further purpose of the invention is to provide an apparatus of the type described in which the optical path from the filament of the light source to the lens system in the scanner is a maximum.

Another object of the invention is to provide a facsimile machine of the type described in which it is not necessary to use pre-focussed lamps.

A still further object of the invention is to provide an apparatus of the type described in which the position of the filament can be readily adjusted while the machine is in operation.

Another object of the invention is to provide in a scanning assembly of the type described, an optical path for the light that passes through a double reflection so as to eliminate the introduction of undesired rays of light into the optical barrel supporting the lens system.

The method and apparatus by which these and other objects are achieved will be more readily understood from a consideration of the discussion given below in connection with the accompanying drawing in which:

Figure 1 shows a section view of the scanning assembly and the copy holder;

Figure 2 is a cross section of Figure 1 taken at section line 2—2;

Figure 3 is a section taken at 3—3 of Figure 1;

Figure 4 is a view of the side of the light cage adjacent to the scanner; and,

Figure 5 is a top view of the driving mechanism of the carriage and the scanning assembly.

The clearest understanding of the arrangement of the various parts of the facsimile apparatus that is the subject of this invention may be obtained from a consideration of Figure 1, in which a transparent substantially cylindrical copy holder 2 is mounted between the end plates 4 and 6 that are in the form of annular rings, a carriage 8 being mounted so as to slide along the axis of the cylinder on a pair of guides 10, a tongue 15 protrudes into the inner part of the cylinder 2 through a slot or groove 11 in the side of the cylinder, which may be observed in Figures 2 and 3 so as to form a support for the scanner 12 which is mounted for rotation on the tongue 15 by means of bearings 14. A source of illumination 16 and a photosensitive pickup element 18 are mounted in appropriate positions on the carriage so as to move with it, but neither of them rotates with the scanner head 12.

In order to appreciate the advantages that inherently arise from the use of a construction

that is the subject of this invention, a detailed understanding of the optical system used must be obtained. To begin with, the source of illumination 16 is mounted in such manner as to place its filament 20 in alignment with the axis of rotation of the scanning assembly 12 which is, of course, the axis of the copy holder 2. Light from this filament is prevented from escaping the cage 24 surrounding it except through a substantially annular groove or slot 26 that may best be seen in Figure 4. A pickup mirror 28 is positioned on a bracket 30 that is secured to the scanner 12 at such an angle as to reflect the image of the filament 20 through an opening 32 in the walls of the scanner to a reflecting mirror 34. The latter is so placed as to direct the image of the filament along the axis of the optical barrel 36 and through the lens system 38 which focusses the image of the filament on the inside surface of the copy. This optical path is indicated by the dotted line 39. Surrounding the optical barrel is parabolic reflector 40 that serves to pick up the spectral reflection from the surface of the copy and direct the right so received in a direction perpendicular to a reflector 42 that is at 45° with respect to the axis of rotation so as to direct the light in a direction parallel to said axis. A nonrotating mirror 43 is mounted on tongue 44 of cage 24 at an angle of 45° so that it reflects the beam of light in a direction that is again perpendicular to the axis of rotation, and an opening 48 is provided in the tongue 15 that extends through the groove 11 so that the light may fall upon the photosensitive device 18 mounted in the base of the carriage. Therefore, as the pickup mirror 28 rotates, it is always in a symmetrical position relative to the filament 20 and the annular groove 26. Of course, when it passes the tongue 15, the light from the filament is cut out, but this does not interfere with the scanning process as the scanning spot formed by scanning assembly 12 is not directed onto the copy placed upon the cylinder 2 but is directed at that instant into the groove 11. Accordingly, if the filament supports 52 are in plane with the filament and this plane intersects the tongue 15, no shadows of these supports are introduced into the optical system of the scanner.

The scanning spot of light is actually an image of the filament 20 reduced to an appropriate size and, therefore, the position of the filament with respect to the pickup mirror 28 is critical. This being so, it is apparent that, when a lamp must be replaced, the means must be provided for properly positioning the filament of the new lamp. This can be accomplished in two ways—one of which is to use a pre-focussed bulb in which the relative position of the mounting base and the filament have been carefully adjusted for each bulb so as to take care of the tolerances encountered in manufacture, and the other method is to use an ordinary bulb and provide means 54 for moving the filament 20 and the bulb 16 up and down and back and forth. These ordinary bulbs are much cheaper than the pre-focussed type and, inasmuch as the bulb is not rotating with the scanner assembly, as is the case in other designs, it is a simple matter to adjust its position while the machine is in operation. The end plate 58 can be removed and the adjustments 54 reached through the opening in the center of the annular ring 6.

In looking down the optical axis of the barrel 36 and the lenses 38, the image of the pick-up mirror 28 appears to be circular. In other words,

the image of the filament that is reflected by the mirror 28 is just large enough to fill the reflecting mirror 34 and the mirror 28 is of such size as to reflect only the desired rays from the filament 20. Thus, any rays coming from an undesired source having to pass through the opening 32 which is also just large enough to permit the transmission of the desired amount of light, and the double reflection achieved by this arrangement of the component parts prevents light from undesired sources from being introduced into the optical barrel 36. Although the internal reflections of the barrel are reduced by proper treatment, other systems introduce a certain amount of light to the lenses 38 so as to cause the scanning spot to become diffused. For this reason, it is believed that a sharper definition can be obtained by the apparatus herein disclosed.

To go into greater detail, a circular piece 60 having an annular opening 62 and a lip 66 on which the reflector 40 may rest, may be press fit into the cylindrical opening 64 in the scanning head 12. The optical barrel 36 has an inner optical barrel 35 that actually supports the lenses 38 that is slidably mounted within the barrel 36. An opening 68 is provided in the side of the reflector 40 and is positioned opposite the opening 32 so that light reflected from the pick-up mirror 28 may impinge upon the reflecting mirror 34 that is adjustably mounted on a shaft 70 so as to be positioned in a direction perpendicular to the axis of rotation by a means 72. The shaft 70 and the mirror 34 protrude inside the barrel 36 and are aligned with the axis of the barrel 36 and the lens system 38. An annular cup 74 is clamped over the elliptical reflector 40 by a washer 80 that is screwed into the threads 82 in the inside of the opening 64. Means 81 are provided for adjusting the position of the pickup mirror 28. Most of the details are also illustrated in Figures 2 and 3 and, in addition, there is shown two pairs of wheels 84 and 86 respectively that ride on the guide numbers 10 so as to permit free motion of the carriage along the axis of the cylinder 2. A base 87 in which the guide members 10 are mounted serves as a support for the whole machine and the cylinders 2 are mounted by means of clamps 88 and screws 90 to the flanges 92 that form the opening 11 through which the tongue 15 of the carriage is inserted.

Figure 5 is an assembly drawing of a facsimile machine embodying the principles of the invention in which there is shown a receiver for duplicating the master copy that is placed on the transparent drum 2. Of course, the signals picked up from the photoelectric cell 18 may be transmitted to a remote receiver in addition to being supplied to the duplicator, but the latter is included for the purposes of explaining the overall operation. Furthermore, a duplicating machine located at the transmitter makes it possible to monitor the quality of the transmitted image. Broadly speaking, the right hand portion of the drawing is a top view of the scanning assembly shown in Figure 1 with the cage 24, the scanner head 12, and the support 13 for the bearings 14 shown in right to left order. To the left of this transmitter is a reproducing drum 94 having a helical electrical contact 96 and a printer bar 98 which function to pass an amount of current proportional to the signal developed in the photoelectric cell 18 through a sensitized paper that lies between them. The driving motor 100 is coupled to the shaft 102 which is supported by

bearings 104 and 106 that are mounted at either end of the drum 94. Inasmuch as the carriage and the scanning assembly are to be moved back and forth on the axis of the cylinder 2, it is obvious that the shaft 108, on which the scanning assembly is mounted, must telescope with the shaft 110 upon which the drum 94 is mounted and that at the same time rotary motion must be transmitted from the motor 100 via the shafts 102 and 110 to the scanner. To accomplish this, the shaft 108 is made small enough to fit inside the square hollow shaft 110, and a square coupling member 112, that is small enough to slide freely within the shaft 110, is secured to the end of the shaft 108.

As the shaft 102 turns, a worm drive 114, cut on its outside diameter, meshes with a gear 116 which is secured to the shaft 118 so as to rotate a small drum 120 which is mounted upon it. As the drum 120 rotates, it winds up a line 122 which, because it is passed around a pulley 124 and secured to the carriage 8, moves the latter along the axis of the cylinder 2 in a direction away from the reproducing drum 94. The shaft 118 is comprised of 2 parts, one end riding in a bearing 126 and the other in a bearing 128 that are operatively joined together by any suitable clutch mechanism 130 which, for purposes of illustration, is shown as a toothed dog. The coil spring 132 wound around the shaft 118 forces the clutch into contact but may be released by a forked lever 134 pivoted at point 136 so that its forked end rides in the circular groove 138 formed by the collars 140. When the clutch 130 is released, a spring tension drum 140 winds up cord 142 so as to return the carriage 18 to the left in preparation for a succeeding scanning operation.

Various alterations may be made in the present invention without departing from the spirit and scope thereof, and it is desired that any and all such alterations be considered within the purview of the present invention as defined by the hereinafter appended claims.

Having described the invention, what is claimed and desired to be secured by Letters Patent is the following:

1. A facsimile device comprising a light transmitter copy holder, a carriage, means for guiding said carriage longitudinally of said copy holder, a rotary scanner mounted on said carriage having an optical system for projecting a beam of light onto said copy holder, the axis of rotation of said scanner coinciding with the axis of said copy holder, means for rotating said scanner, means for imparting longitudinal motion along said guiding means to said carriage in accordance with the rotation of said scanner, a source of illumination mounted so as to be stationary with respect to said carriage, and a pickup mirror mounted on said scanner so as to intercept light from said source during a predetermined portion of a revolution and direct it into the optical system of said scanner.

2. A facsimile apparatus comprising a transparent copy holder, a rotary scanning head, a carriage for supporting said scanning head for rotation about the axis of said copy holder, means for rotating said scanning head and means for moving said carriage along the axis of said copy holder, a light source mounted on said carriage, a use surrounding said light source, a substantially annular opening in one end of said cage, an overhanging circular use mounted on the same edge of the cage as the annular opening, said lip being concentric with the axis of said copy holder, a ring mounted on said scanning head, said ring being concentric with said copy holder, said ring extending inside said lip so as to prevent the escape of light therebetween, and a pickup mirror mounted on the inside of said ring so as to intercept light from said source through said groove during a predetermined portion of a revolution of the scanning head.

3. A facsimile scanner comprising a cylindrical light transmitting copy holder, a rotatable scanning head, a carriage member for supporting said scanning head adapted to pass through a longitudinal slot in said copy holder, said scanning head being rotatable about the axis of said cylinder and axially movable with said carriage, a light source mounted on said carriage so as to be stationary with respect to said carriage and at the axis of said copy holder, a lip concentric with said copy holder mounted opposite one end of the scanning head, an opening in the end of said scanning head inside said lip, optical means for producing a scanning spot of light on the surface of said copy holder, an elliptical reflector arranged to direct light reflected at the surface of the copy holder in a direction perpendicular to the axis thereof, an axial opening in the end of said scanning head, a mirror for reflecting the light along the axis of the copy holder and through said opening, a reflector mounted on said carriage, said reflector being so positioned that it directs the light received from said mirror in a direction perpendicular to the axis of the copy holder, and a light sensitive device mounted on said carriage in such position as to be activated by the light reflected by said reflector.

4. A facsimile scanner comprising a cylindrical light transmitting copy holder, a scanning device, a carriage member for supporting said scanning device adapted to pass through a longitudinal slot in said copy holder, said scanning device being concentric with said copy holder and axially movable with said carriage, a light source comprised of a filament coinciding with the axis of said copy holder, supports for said filament, said supports being in a plane passing through said axis and in the same radial position with respect thereto as said slot, optical means for producing a scanning light spot on a surface of said copy holder and arranged to direct the reflected light from subject matter in contact with said surface so that it passes out of said scanning device along said common axis, and a phototube mounted on said carriage to receive said reflected light.

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