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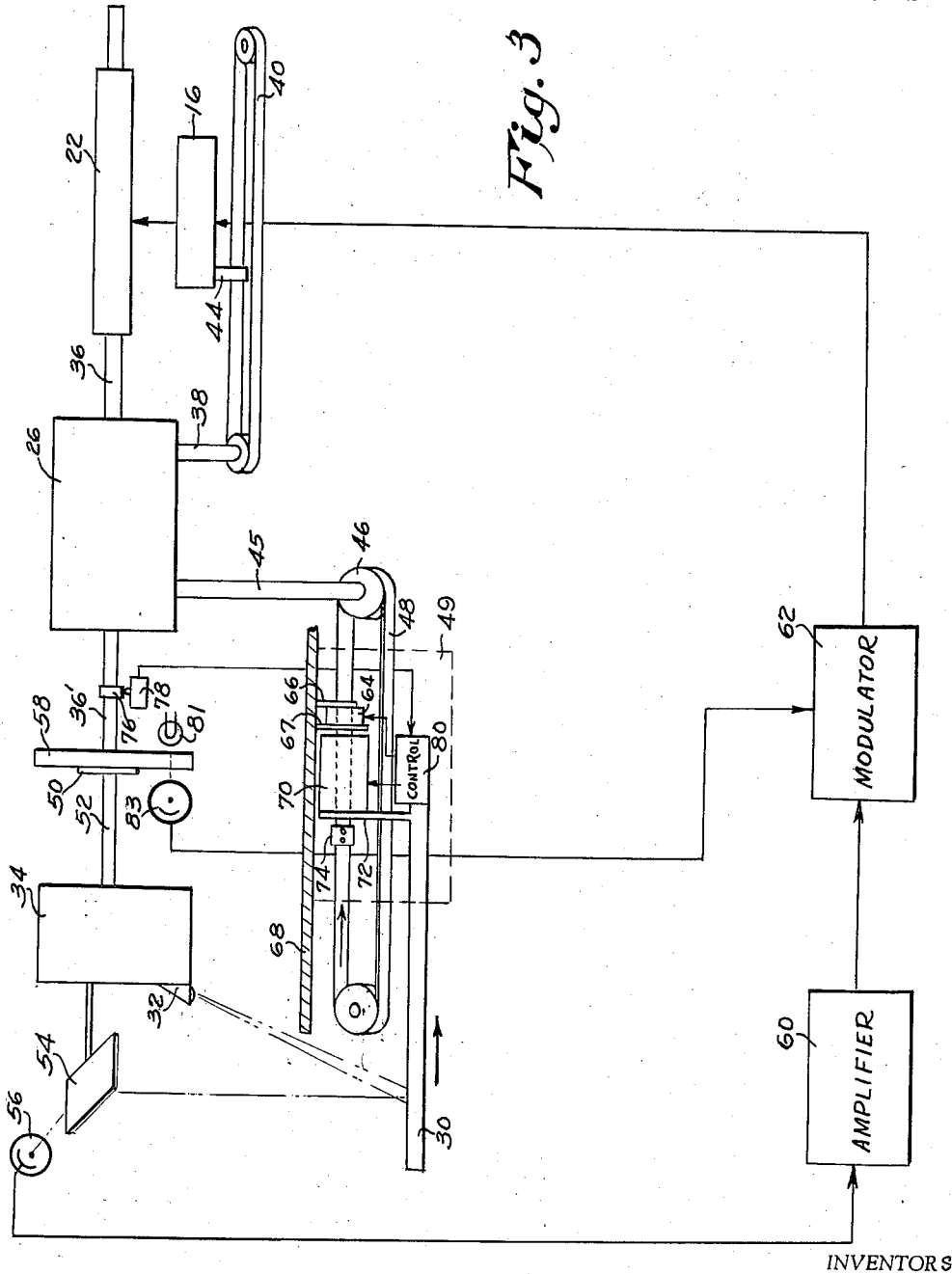
S. W. LEVINE ET AL

2,881,247

STEP FEED FOR ELECTRONIC LINE SCAN AND RECORDING MACHINES

Filed Jan. 7, 1958

3 Sheets-Sheet 2



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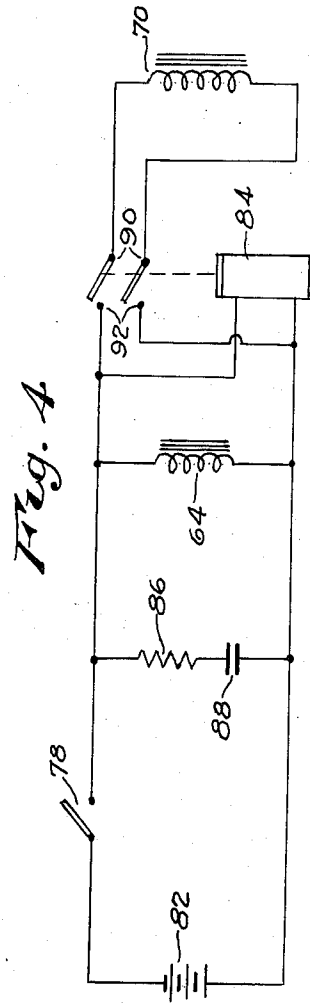
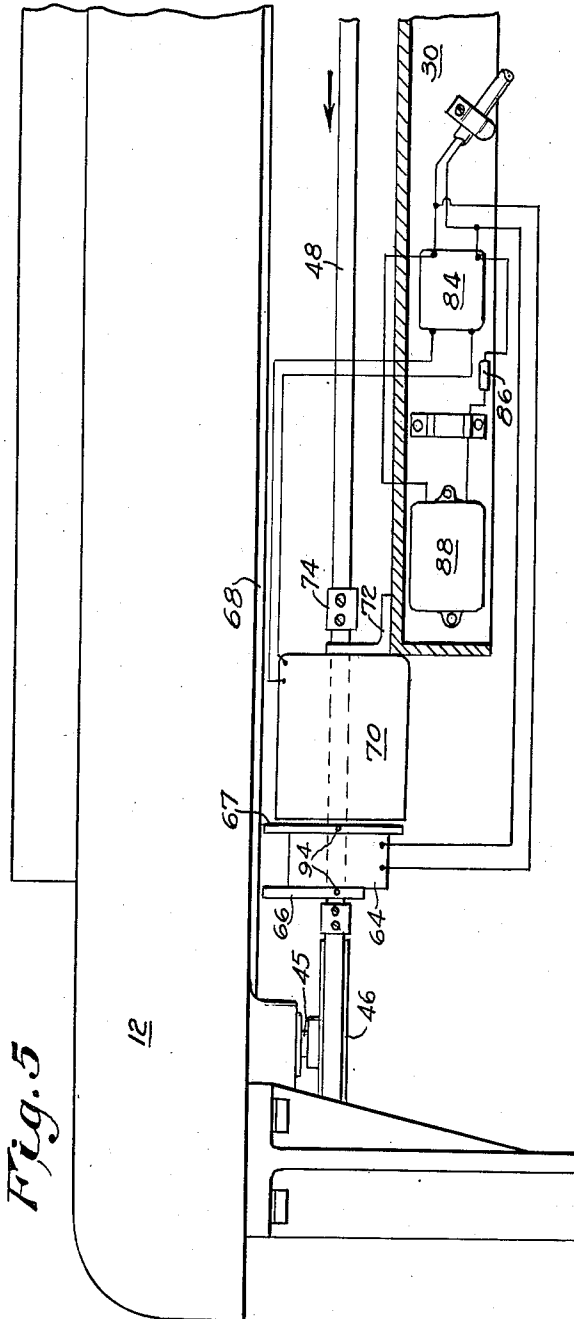
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STEP FEED FOR ELECTRONIC LINE SCAN AND RECORDING MACHINES

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14 Claims. (Cl. 178—6.6)

This invention pertains to automatic line scanning and recording machines, and particularly to machines of the type which provide an engraved plate or film reproduction for printing purposes, directly from original subject matter such as a photographic positive or negative which is line-scanned during the process. More particularly, the present invention deals with an improved machine of this type in which any desired size enlargement or reduction (within the limits of the machine design) can be obtained as between the original subject matter and the film reproduction or engraved plate. Additionally, the invention provides an improved and simplified copy table feed mechanism for producing a step-wise advance thereof without imparting any undue load on the drive source.

A machine of this general nature has already been proposed which will produce automatically and at a desired speed of operation an engraved plate or film reproduction suitable for use in the printing process, and having any desired size relationship to the original subject matter. Such a machine is disclosed in the copending application of Frederick P. Willcox, Serial Number 428,606, filed May 10, 1954, and provides for both enlargement and reduction, between selected limits in each case, by means which can be adjusted readily to provide any desired finished size of the engraved plate. In addition, this latter machine provides for reproduction from either flexible or rigid original matter, since the material need not be curved but may remain flat on a linearly advanced copy support or bed during the engraving process. Reference will be made below to this prior design on which the present invention is an improvement.

As disclosed in the aforementioned application of Willcox, the copy support is continuously advanced as the scanning is performed. However, in many applications of machines of this type it is found more desirable to advance the copy support in small incremental steps for each cycle of operation of the scanning head. Further, in the Willcox apparatus the means which meter the movement of the copy support is also called upon to actually transmit the motive force necessary to effect the movement. This is disadvantageous in that the metering means is required to be both a precision device to transmit with extreme accuracy the magnitude of the desired copy table movement, and a relatively husky mechanical power transmitting device by means of which the copy support is moved.

It is accordingly a principal object of the invention to provide means for advancing in small incremental steps the copy support of a machine of the general nature herein disclosed, wherein the means for metering the desired incremental movement is distinct from the means for effecting such movement.

Another object of the invention is to provide a photo-electric engraving machine having a copy support or bed which is caused to advance along a linear path in incremental steps of selectable magnitude.

A further object of the invention is to provide a photo-electric engraving machine which will automatically pro-

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duce an engraved plate or film reproduction suitable for use in a printing process and having any desired size relationship to the original subject matter, which subject matter is carried by a support which is caused to advance along a linear path in incremental steps of selectable magnitude.

In accordance with the present invention, the above and other objects are achieved by means of a novel arrangement including a pair of solenoids, one of which is moved along a path parallel to the path of movement of the copy support in incremental steps corresponding to the desired movements of such support, being energized during the time interval between such steps to fixedly clamp itself to a reference member of fixed position and having securely fixed thereto an armature for the other solenoid, the other solenoid being secured to the copy support and being energized only when the first solenoid is energized whereby the second solenoid is drawn up to such armature to effect the desired movement of the copy support. Appropriate control circuitry is provided to operate the solenoids in the proper sequence both with respect to each other and with respect to the operation of the scanning mechanism of the engraving or film recording machine.

With the above considerations and objects in mind, the invention itself will now be described in connection with a preferred embodiment thereof given by way of example and not of limitation, and with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of the entire machine of the invention, showing the general relationship of the major components.

Fig. 2 is a schematic and block diagram illustrating the general functional operation of the device.

Fig. 3 is a partly schematic view illustrating in detail the functional operation of the device.

Fig. 4 is a wiring diagram of the electrical circuitry which controls the operation of the advancing means for the copy support.

Fig. 5 is a fragmentary view in elevation showing the actual mechanical layout of certain components indicated schematically in Fig. 3, but to a larger scale.

Referring now to Figures 1 and 2 of the drawings, and first to Fig. 1 alone, the general arrangement of the apparatus is shown. Numeral 10 designates a casing or housing in which are contained the principal electrical circuit elements, amplifiers and the like required for the machine, and which serves also as a support for the major manipulative parts. Thus, the housing 10 is surmounted by a machine table or top plate 12 carrying a horizontal guide rail 14 upon which is slidably mounted the carriage 16 on which are supported the engraving head 18 and optical parts 20 constituting a stroboscopic illuminator and microscope for viewing the engraving during initial preparation or as the work proceeds. As in the prior application referred to above, the sheet being engraved or the film being exposed is wrapped around a cylinder 22 mounted for rotation between end bearings carried by the tail stock assembly 24 and the transmission casing 26, both of which are mounted upon the table 12 and at opposite ends of the guide rail 14.

Since it is desired to make engravings or film recordings with varying degrees of enlargement or reduction from originals which may not be in flexible condition, provision is made for supporting the original copy 28 upon a flat rigid table 30 mounted for longitudinal sliding motion upon suitable guides within the housing 10. By means to be described, the scanning operation is preferably started with the copy mounted on table 30 in its most extended condition, and proceeds as the table is withdrawn into housing 10 by mechanism to be described below. As indicated in Fig. 1, the scanning is accomplished a line at

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a time crosswise of the table 30, and the region being scanned at any one table position is illuminated as by lamps mounted above the moving table upon the top plate 12 and provided with suitable reflectors as generally indicated at 32 to throw their light downwardly and concentrated upon a laterally extending zone or strip of the original 28.

A scanning head containing the necessary optical parts and mechanical elements for the scanning operation is indicated generally at 34, and this head is energized mechanically from the transmission housing 26 by means to be described.

A more complete idea of the operation of the machine is furnished by Fig. 2. Here, the shaft carrying the cylinder 22 is indicated by numeral 36, and is rotated by transmission 26 from a motor, not shown. The transmission 26 has an output shaft 38 to which is secured a wheel driving an endless belt 40 which passes around a second wheel 42. To one portion of the endless belt (actually an inextensible metallic ribbon) is secured a clamp 44 connected with the carriage 16 carrying the engraving transducer or light modulator, so that as shaft 36 rotates, the carriage 16 is translated longitudinally to record in a line pattern a sheet carried by cylinder 22. This part of the arrangement is generally the same as that of the application referred to above. So that a test recording can be made while cylinder 22 is rotating but with carriage 16 stationary, shaft 38 can be disengaged by suitable means not shown.

Transmission 26 also drives a shaft 45 carrying a tape wheel 46 about which another and similar endless belt 48 is wrapped, being held in taut condition by a parallel wheel at the far end of the tape travel. A suitable variable ratio device may be included in transmission 26 (as disclosed in the Willcox application) to provide variable relative rotation of shafts 36 and 45. Intermediate the two wheels is an intermittent drive 49, to be described, to which the copy table 30 is secured, and by means of which table 30 will be drawn into the housing in intermittent steps at a rate corresponding to the rotation of shaft 36, but at a relative effective speed dependent upon the adjustment of the aforementioned variable ratio device in transmission 26. As the table 30 moves inwardly, a portion 36' of shaft 36 to the left of transmission 26 transmits (via a clutch 50) rotation to shaft 52 which drives the mechanism in the scanning head 34 to cause reflector 54 to oscillate through an arc of predetermined but adjustable size. Suitable optics are provided so that at any instant the light reflected from only a minute spot of the original copy will be directed by mirror 54 to the scanning photocell 56 whose output principally determines the output amplitude of the recording transducer 18.

The portion 36' of shaft 36 has secured thereto a disc 58 forming with other parts a tone generator and comprising an optically transparent member having a plurality of radially displaced concentric circular paths each of alternately transparent and opaque segments of equal width in any given path. The operation of the tone generator is described below in connection with Fig. 3. For the purpose of describing Fig. 2, suffice it to say that the plurality of circular paths determine different frequencies for the tone generator output, a selected one of which is used to modulate the amplified output from scanning photocell 56 to produce a recording pattern consisting of regularly spaced dots, as opposed to the continuous recording which would otherwise result. The proper track or circular path on disc 58 is selected manually or automatically in accordance with the desired "screen" spacing of the recording. The manually operated clutch 50 is connected between the disc 58 or shaft portion 36' and shaft 52, so that during initial adjustment or setting up of the apparatus, the drive for the scanning gear 34 may be disconnected; a suitable clutch (such as disclosed in the aforementioned Willcox application) operates to

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disconnect the drive of table 30. With both clutches disengaged, the machine operates to provide a photocell output representative of a particular selected spot or spots on the original copy. By energizing the main drive motor with these clutches disconnected, it is thus possible in one form of the machine for a marginal portion of the plastic sheet to be engraved or recorded, and such test engraving or recordings inspected for particular selected values of highlight and shadow regions in the original copy. Since clutch 50 is to the left of drum 58, the screen modulating signals from drum 58 will continue to be produced during this initial machine adjustment period.

Fig. 2 also illustrates schematically the general flow of signal intelligence in the apparatus. The scanning signals from the photocell 56 are conveyed to an amplifier 60 and the amplified product is applied to the modulator 62 where the tone signals from disc 58, suitably amplified, are added to provide an output to the transducer on carriage 16, which output includes components both of the scanning signals and the constant frequency screen modulation tone from the disc 58.

Fig. 3 shows in detail the improved drive system for the movable copy table or support 30. In the apparatus of the prior Willcox application, the table 30 is connected directly to one reach of the tape 48, and, as a result, the table is pulled along its path by the tape. Due to the mass of the table, a rather severe mechanical load is thus placed on the tape and its drive, since it is required not only to meter the movement of the table but actually to provide the mechanical force necessary to produce the metered motion. The present invention separates these functions for optimum accomplishment of both, by means of the intermittent drive 49, shown in Fig. 3 and comprising the majority of the elements which distinguish the present invention. The copy support or table 30, instead of being directly connected to the tape or belt 48 as before, is intermittently advanced in incremental steps which are metered by the movement of the belt 48, but the mechanical force which produces the table motion is produced by means distinct from the belt. These means include a clamp solenoid 64 which is securely attached as by set screws to belt 48, and which solenoid has pole pieces 66 and 67. Adjacent these pole pieces is a ferromagnetic plate 68 as of steel, which extends along the path of travel that solenoid 64 follows as it traverses the distance between the two wheels which carry belt 48. Plate 68 is securely attached to the rigid frame of the engraving machine and serves as a positioning anchor for solenoid 64 when the latter is energized (by means to be described) and thereby clamped to the plate through pole pieces 66 and 67.

A second solenoid 70, which serves as the advance solenoid, is securely attached to copy table 30 by means of bracket 72. Solenoids 64 and 70 are coaxially aligned, and belt 48 passes centrally through each, the former solenoid being secured to the belt which passes loosely through the latter. Pole piece 67 of solenoid 64 also serves as an armature for solenoid 70, so that when the latter is energized (by means to be described) it will pull itself up to the armature or pole piece 67. In order to prevent the solenoids 64 and 70 from becoming separated to such an extent that the armature 67 is out of the effective magnetic field of solenoid 70, a mechanical stop 74 is secured to belt 48 as shown.

Positioned on one side of the tone generator disc 58 is a light source 81, and in registry therewith on the other side of the disc is a photosensitive cell 83. These two members are mounted on the frame of the engraving machine by means not shown, and are adapted to be so mounted that they may be moved radially of the disc 58 in order that the light emanating from source 81 may pass through a selected one of the plurality of concentric circular light-modulating paths described above. As disc

58 rotates, the light is modulated in accordance with the number and spacing of segments in the selected path.

Affixed to shaft 36' and rotating therewith is a cam 76 which contacts the operator of a normally open electrical switch 78 once per revolution of shaft 36'. Switch 78 is mounted by any suitable means to the frame of the engraving machine, and is in an electrical circuit which includes solenoids 64 and 70 as well as further control circuitry indicated schematically as box 80 in Fig. 3 and shown in detail in Fig. 4.

Referring now to Fig. 4 of the drawings, a suitable source 82 of D.-C. voltage, which voltage may be derived from the main power input to the engraving machine, is shown in a series circuit with switch 78 and clamping solenoid 64. Connected across solenoid 64 is the operating winding of a relay 84, and the series combination of resistor 86 and condenser 88. Advance solenoid 70 is connected between the movable contacts 90 of relay 84, and when the latter is energized contacts 90 are closed upon stationary contacts 92, thereby connecting advance solenoid 70 across voltage source 82.

Fig. 5 is a partial elevation from the back side of the engraving machine showing the physical relationship of the several components of the invention and their mounting on the machine. As previously stated, the plate 68 is fixed to the frame of the machine, as by bolting to the under side of the table 12. Solenoid 64 is attached by set screws 94 to belt 48 which passes centrally through the solenoid. Upon rotation of shaft 45 and wheel 46, tape 48 carries solenoid 64 along a linear path with its pole pieces 66 and 67 always in close proximity to plate 68. Tape 48 also passes centrally through solenoid 70, but the two are free for relative movement to the extent that solenoid 70 is allowed to travel between stop 74 and pole piece 67 on solenoid 64, both of which are fixed to the tape. In this manner stop 74 and solenoid 64 define the limits of travel of solenoid 70 relative to tape 48, which prevents excessive separation of 64 and 70 when support 30 is moved manually back to its starting position. Copy support 30, which is attached to solenoid 70 by bracket 72, carries relay 84, resistor 86 and condenser 88, which are electrically connected to the other components as described in connection with Fig. 4.

In the operation of the apparatus of the invention, and with particular reference to Figs. 3 and 4, shafts 36, 36' and 52 are driven by a motor not shown. As previously described, the rotation of these shafts causes the properly synchronized operation of the scanning means 34, the tone generator which includes elements 58, 81 and 83, and (through the transmission 26) the engraving head drive including tape 40. The transmission 26 also drives shaft 45 and wheel 46 carried thereon, which in turn causes tape 48 to travel in the direction indicated by the arrow in Fig. 3. As tape 48 moves in this manner, it carries with it the clamp solenoid 64. Due to the mass of the copy support 30 and the fact that no drive is being applied to it (neglecting for the moment that the stop 74 would eventually cause tape 48 to carry support 30 to the right as seen in Fig. 3), the copy table remains stationary.

The clamp solenoid 64 is thus advanced to the right, as viewed in Fig. 3, until the rotation of shaft 36' causes cam 76 to operate switch 78 closing the circuit to voltage source 82. Upon the closing of this circuit, solenoid 64 is immediately energized and is thereby fixedly clamped to plate 68 by means of the magnetic flux produced at pole pieces 66 and 67. Since solenoid 64 is fixed to belt or tape 48, the latter is also held stationary at this time, as is drive wheel 46. In the applications for which this apparatus is designed, the incremental advance for each step is considerably less than the unavoidable play or backlash between shaft 36' and shaft 45, and wheel 46 may as a result be held stationary (even though shaft 36' is continuously driven) for the period of time neces-

sary for advancement of the copy support. A short time after solenoid 64 is energized and securely clamped to plate 68, relay 84 operates to energize solenoid 70. The delay between the energization of the two solenoids is due to the operating time characteristic of relay 84 as compared to that of solenoid 64, and is necessary for the reason that clamp solenoid 64 must be firmly anchored before advance solenoid 70 is energized to provide the pulling force between the two to draw the copy table 30 up to its next position. When solenoid 70 is thus energized, it attracts armature 67, and, since the latter is now fixed in position with respect to plate 68 and the frame of the engraving machine, solenoid 70 is drawn up to abut the armature, carrying table 30 through an incremental advance equal to the magnitude of tape travel which has occurred since the clamp solenoid was last energized in the previous cycle of operation.

The operation of switch 78 by cam 76 is but momentary, the switch being closed only for a time sufficient to encompass the energization and the drawing-together of the two solenoids, and after such operation the switch returns to its normally open condition. As switch 78 is thus opened, the series combination of resistor 86 and condenser 88 becomes the voltage source for solenoid 64 and the operating winding of relay 84, the condenser having been charged to a voltage determined by the parameters of the R-C circuit, as well as the magnitude of the applied voltage and the length of time switch 78 was closed. Due to the release time characteristic of relay 84, the relay drops out while solenoid 64 remains energized by the charge carried on the capacitor. Shortly after the relay is de-energized, the charge on the condenser is dissipated in solenoid 64 and the latter is thus de-energized. As in the case of initiating the energization of the two solenoids, the order of operation is also important in their de-energization. If the clamp solenoid were to be de-energized before de-energization of the advance solenoid, then the former would again be advanced by the tape 48, and the latter would follow, with the copy support 30 being advanced beyond the desired and previously metered position.

With both solenoids de-energized, the tape 48 again meters a desired incremental distance, and the cycle is repeated as cam 76 again operates switch 78.

The invention has been described above in considerable detail, and particularly with reference to its application to the making of engraved plates either for direct use in a printing operation, or as matrices for duplication by the well-known stereotype processes. However, it will be apparent to those skilled in the art that the invention is also applicable to the making of reproductions of the original matter in forms other than engraving plates. For example, the cylinder 22 may carry a photosensitive or photographic material, and instead of an engraving cutter or hot stylus type of transducer, the carriage 16 may carry an output transducer which directs a beam of light upon the photosensitive sheet to produce a photographic type of image in response to the signals derived from the scanning mechanism, as shown and described in the copending application of Samuel W. Levine, Serial No. 455,117 filed September 10, 1954. Again, the sheet carried by the cylinder 22 may be of a suitable plastic or the like which can be locally hardened by the light emanating from the transducer, to produce a sheet which can be then treated after the manner of photo-engraving processes to produce a direct printing element. Hence, the invention is not to be considered as limited to the particular details given, nor to the specific application to which reference has been made during the description of the apparatus, except insofar as may be required by the scope of the appended claims.

What is claimed is:

1. An advancing mechanism for the movable bed of an image scanning and reproduction machine or the like,

comprising a first solenoid, means for moving said first solenoid along a path parallel to the path of movement of such bed in incremental steps corresponding to desired movements of same, a second solenoid fixedly secured to such bed, an armature for said second solenoid fixedly secured to said first solenoid, pole pieces for said first solenoid, a fixed elongate ferromagnetic member parallel to said path and positioned adjacent said pole pieces, a voltage source, electrical switch means in circuit with said voltage source and said first and second solenoids, means for operating said switch means intermittently in timed relation with the motion of said means for moving said first solenoid to connect said first solenoid to said voltage source and thereafter to connect said second solenoid to said voltage source so as to attract said armature.

2. An advancing mechanism for the movable bed of an image scanning and reproduction machine or the like in accordance with claim 1, wherein said first and second solenoids and said armature are coaxial, and said means for moving said first solenoid comprises an inextensible member coaxially aligned with and passing through said first and second solenoids and said armature.

3. An advancing mechanism for the movable bed of an image scanning and reproduction machine or the like in accordance with claim 2, and stop-means secured to said means for moving said first solenoid to limit the relative movement of said first and second solenoids.

4. An advancing mechanism for the movable bed of an image scanning and reproduction machine or the like, comprising a first solenoid, means for moving said first solenoid along a path parallel to the path of movement of such bed in incremental steps corresponding to desired movements of same, a second solenoid fixedly secured to said first solenoid, pole pieces for said first solenoid, a fixed elongate ferromagnetic member parallel to said path and positioned adjacent said pole pieces, a voltage source, electrical switch means in circuit with said voltage source and said first and second solenoids, means for operating said switch means in timed relation with the motion of said means for moving said first solenoid intermittently to connect said first solenoid to said voltage source and thereafter to connect said second solenoid to said voltage source so as to attract said armature for only a portion of the time during which said first solenoid is so connected.

5. An advancing mechanism for the movable bed of an image scanning and reproduction machine or the like in accordance with claim 4, wherein said first and second solenoids and said armature are coaxial, and said means for moving said first solenoid comprises an inextensible member coaxially aligned with and passing through said first and second solenoids and said armature.

6. An advancing mechanism for the movable bed of an image scanning and reproduction machine or the like in accordance with claim 5, and stop-means secured to said means for moving said first solenoid to limit the relative movement of said first and second solenoids.

7. A photoelectric image scanning and reproduction machine comprising a copy support for flat original copy, a scanning head having an optical element rotatable through an arc about a fixed axis for scanning the copy carried by said copy support in a linear path perpendicular to and offset from said axis, means for moving said copy support progressively in a linear path parallel to said axis and perpendicular to the scanning path, a cylindrical support for a reproduction sheet rotated synchronously with the movement of said copy support, means for deriving from said scanning head electrical signals corresponding to tone values of copy carried by said copy support and scanned by said head, a carriage including a reproduction transducer mounted for move-

ment parallel to the axis of said cylindrical support, means for energizing said transducer from said signals, and means for driving said carriage along its path in synchronous relation to the rotation of said cylindrical support, said means for moving said copy support comprising a first solenoid, means for moving said first solenoid in a linear path parallel to said axis and perpendicular to the scanning path in incremental steps corresponding to desired movements of said copy support, a second solenoid fixedly secured to said copy support, an armature for said second solenoid fixedly secured to said first solenoid, pole pieces for said first solenoid, a fixed elongate ferromagnetic member parallel to said axis and positioned adjacent said pole pieces, a voltage source, electrical switch means in circuit with said voltage source and said first and second solenoids, means for operating said switch means intermittently in timed relation with the rotation of said optical element to connect said first solenoid to said voltage source and thereafter to connect said second solenoid to said voltage source so as to attract said armature.

8. The invention in accordance with claim 7, wherein said first and second solenoids and said armature are coaxial, and said means for moving said first solenoid comprises an inextensible member coaxially aligned with and passing through said first and second solenoids and said armature.

9. The invention in accordance with claim 8, said means for moving said first solenoid including stop means secured thereto to limit the relative movement of said first and second solenoids.

10. A photoelectric image scanning and reproduction machine comprising a copy support for flat original copy, a scanning head having an optical element rotatable through an arc about a fixed axis for scanning the copy carried by said copy support in a linear path perpendicular to and offset from said axis, means for moving said copy support progressively in a linear path parallel to said axis and perpendicular to the scanning path, a cylindrical support for a reproduction sheet rotated synchronously with the movement of said copy support, means for deriving from said scanning head electrical signals corresponding to tone values of copy carried by said copy support and scanned by said head, a carriage including a reproduction transducer mounted for movement parallel to the axis of said cylindrical support, means for energizing said transducer from said signals, and means for driving said carriage along its path in synchronous relation to the rotation of said cylindrical support, said means for moving said copy support comprising a first solenoid, means for moving said first solenoid in a linear path parallel to said axis and perpendicular to the scanning path in incremental steps corresponding to desired movements of said copy support, a second solenoid fixedly secured to said copy support, an armature for said second solenoid fixedly secured to said first solenoid, pole pieces for said first solenoid, a fixed elongate ferromagnetic member parallel to said axis and positioned adjacent said pole pieces, a voltage source, electrical switch means in circuit with said voltage source and said first and second solenoids, means for operating said switch means in timed relation with the rotation of said optical element intermittently to connect said first solenoid to said voltage source and thereafter to connect said second solenoid to said voltage source so as to attract said armature for only a portion of the time during which said first solenoid is so connected.

11. An advancing mechanism for the movable bed of an image scanning and reproduction machine or the like, comprising a first solenoid, means for moving said first solenoid along a path parallel to the path of movement of such bed in incremental steps corresponding to desired movements of same, a second solenoid fixedly secured to such bed, an armature for said second solenoid fixedly secured to said first solenoid, pole pieces for said

first solenoid, a fixed elongate ferromagnetic member parallel to said path and positioned adjacent said pole pieces, a voltage source and electrical switch means connected in series relation with said first solenoid, a resistor and a condenser connected in series across said first solenoid, a relay having its winding connected across said first solenoid for controlling said second solenoid, and means for operating said switch means intermittently to produce incremental steps of movement of said first solenoid.

12. A photoelectric image scanning and reproduction machine comprising a copy support for flat original copy, a scanning head having an optical element rotatable through an arc about a fixed axis for scanning the copy carried by said copy support in a linear path perpendicular to and offset from said axis, means for moving said copy support progressively in a linear path parallel to said axis and perpendicular to the scanning path, a cylindrical support for a reproduction sheet rotated synchronously with the movement of said copy support, means for deriving from said scanning head electrical signals corresponding to tone values of copy carried by said copy support and scanned by said head, a carriage including a reproduction transducer mounted for movement parallel to the axis of said cylindrical support, means for energizing said transducer from said signals, and means for driving said carriage along its path in corresponding timed relation to the rotation of said cylindrical support; said means for moving said copy support comprising a first solenoid, means for moving said first solenoid in a linear path parallel to said axis and perpendicular to the scanning path in incremental steps corresponding to desired movements of said copy support, a second solenoid fixedly secured to said copy support, an armature for said second solenoid fixedly secured to said first solenoid, pole pieces for said first solenoid, a fixed elongate ferromagnetic member parallel to said axis and positioned adjacent said pole pieces, a voltage source and electrical

switch means connected in series relation with said first solenoid, a resistor and a condenser connected in series across said first solenoid, a relay having its winding connected across said first solenoid for controlling said second solenoid, and means for operating said switch means intermittently to produce incremental steps of movement of said first solenoid and of said copy support.

13. A photoelectric image scanning and reproduction machine comprising a copy support, a scanning head, a cylindrical support for a reproduction sheet, drive means for rotating said cylindrical support, a first electromagnet, means for moving said first electromagnet in timed relation to said drive means, a second electromagnet mounted on said copy support, and means operated periodically in timed relation to the drive means for sequentially energizing said first electromagnet to clamp the same fixedly with respect to the machine frame and for thereafter energizing said second electromagnet to pull said copy support to a position defined by the position of the first electromagnet.

14. A photoelectric image scanning and reproduction machine comprising a copy support, a scanning head, a cylindrical support for a reproduction sheet, drive means for rotating said cylindrical support, a first electromagnet, means for moving said first electromagnet in timed relation to said drive means, a copy-advance electromagnet, a copy-advance armature for said copy-advance electromagnet, one of said copy-advance members being mounted on said copy support, the other of said copy-advance members being secured to said first electromagnet, and means operated periodically in timed relation to the drive means for sequentially energizing said first electromagnet to clamp the same fixedly with respect to the machine frame and for thereafter energizing said copy-advance electromagnet to pull said copy support to a position defined by the position of said first electromagnet.

No references cited.