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Purdy et al.

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[54] **PHOTOTYPESETTERS**

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[52] **U.S. Cl.** ..... **95/4.5 R**

[51] **Int. Cl.**... **B41b 17/12**, B41b 21/10, B41b 21/20

[58] **Field of Search** 95/4.5, 90

[56] **References Cited**

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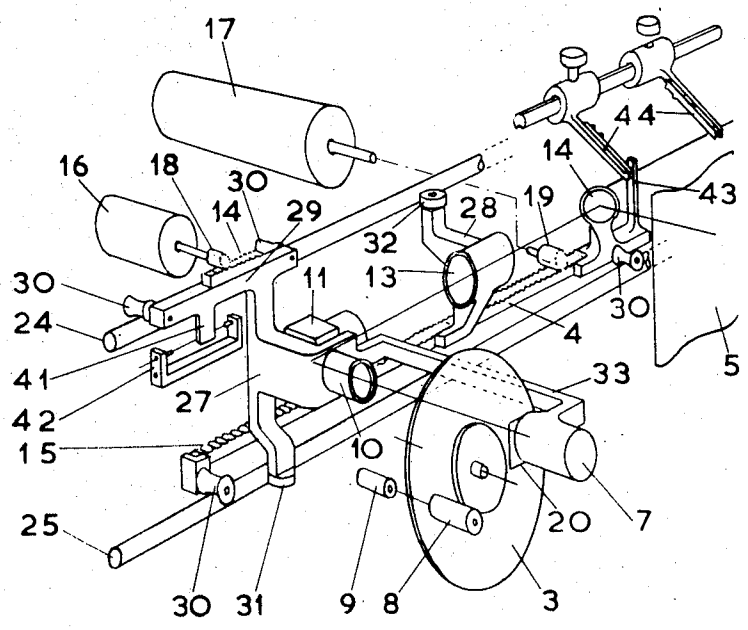
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[57] **ABSTRACT**

A phototypesetting machine employs a continuously rotating character font disc having a plurality of font circles with the character transparencies arranged such that similar characters have a common base line parallel to a radius of the disc. A high speed flash lamp giving a linear light source, is provided with a diffuser to form an essentially rectangular illuminating beam of light that is uniform across the character field. The light source and diffuser are mounted on one side of the disc and a collimating lens member along with a reflector are mounted on the opposite side of the disc all on the same carriage, to align the light source, lens and reflector with a selected font circle. A pair of spaced bars defining a reference plane and a main light transmission path extend parallel to the plane of the disc, and provide a mount for the input carriage. A second or output carriage also is movable along the bars, spaced to one side of the input carriage, and supporting a further lens and reflector which transmits the shaped light back from the main path to a recording plane, also parallel to the reference plane, at which photosensitive material is supported. A stepping motor moves the output carriage according to character widths, to form a successive lines of text on the photosensitive material.

3 Claims, 3 Drawing Figures



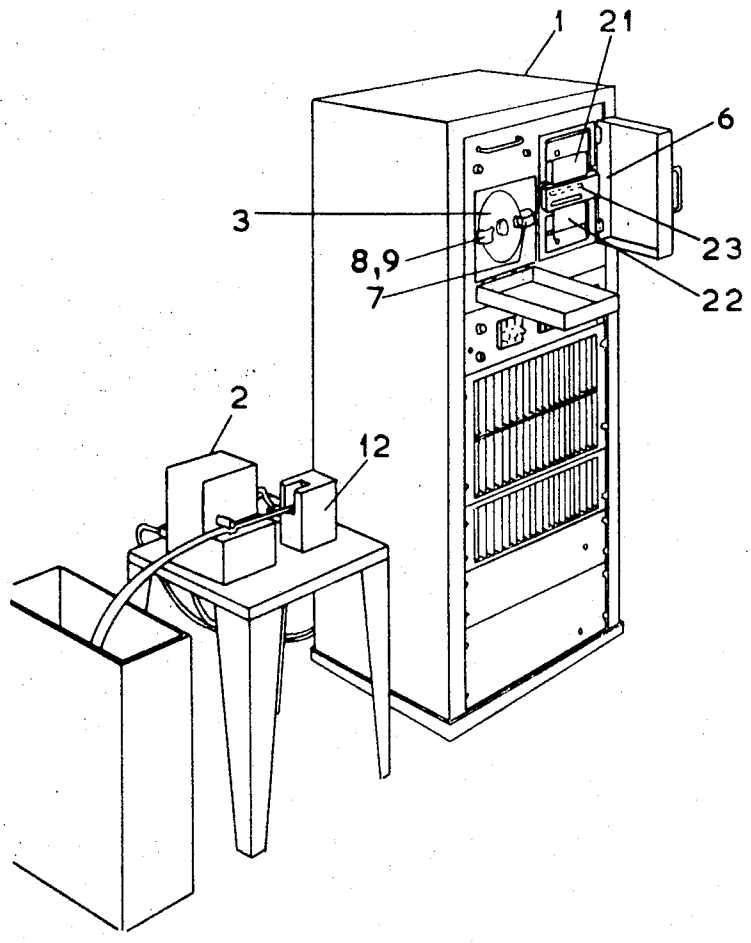


FIG. 1

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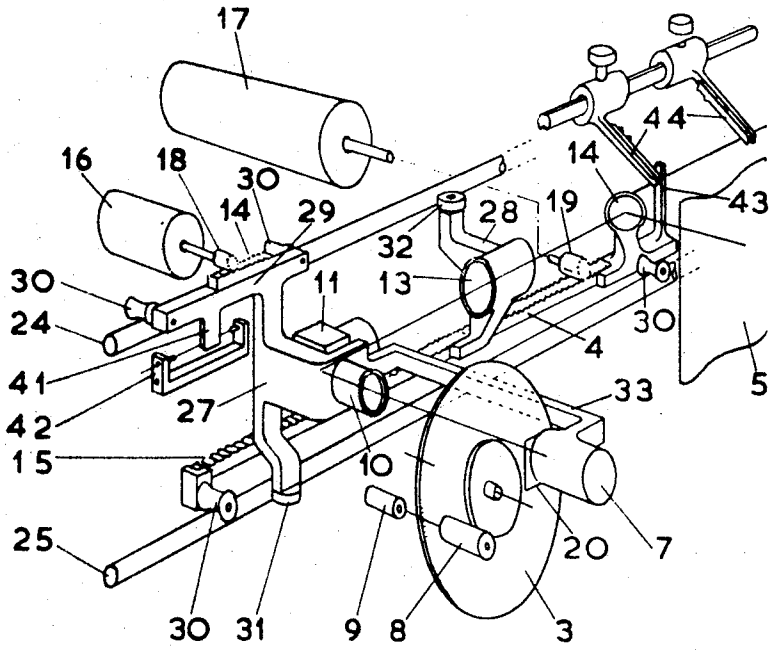

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FIG. 2

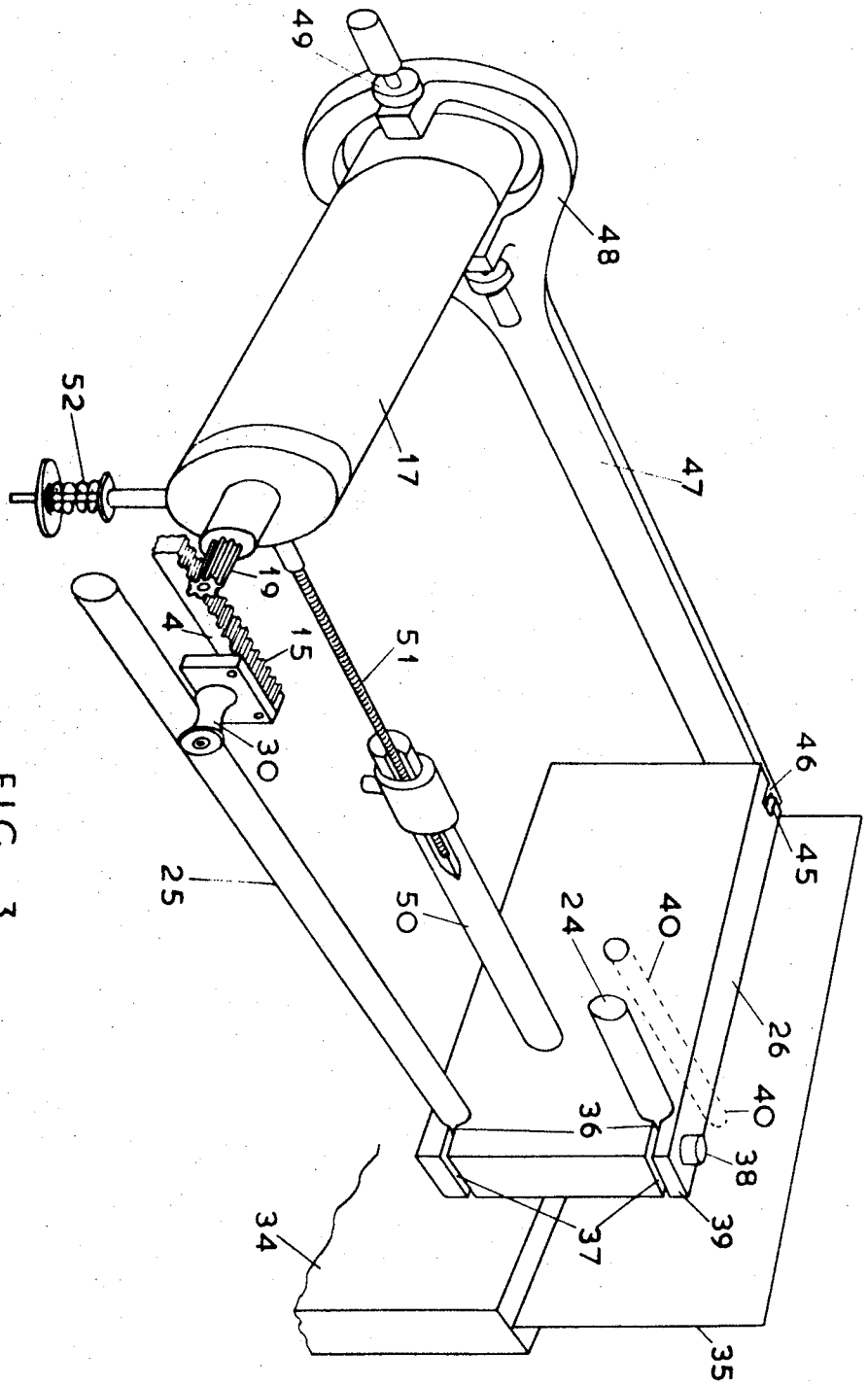


FIG. 3

PHOTOTYPESETTERS

This invention relates to opto-mechanical photographic page-printing, and has for its object mechanical and optical improvements to increase economy and efficiency.

The protection to which the invention is considered to be entitled is postulated in the accompanying Statement of Claim.

The invention will be clearly understood from the following description of a preferred embodiment shown in the accompanying drawings in which:

FIG. 1 is a general view of a page-printing installation incorporating the invention.

FIG. 2 is a schematic view of the main operational machine incorporated in the installation of FIG. 1, while

FIG. 3 is a perspective view of an optical carriage drive.

Referring first to FIGS. 1 and 2, the equipment is contained in a freestanding cabinet 1 containing rack-mounted electronic and mechanical modules. It accepts electrical inputs; normally TTS codes; from an external source, e.g., a paper tape reader 2 fed from a tape dispenser 12.

Input normally consists of sets of justifiable TTS code for individual lines, separated by Return codes. Justification is recalculated electronically, and the characters are selected and flashed from a spinning disc 3 via an exposure window to a reciprocating optical print-out system 28 traversing the plane of the film 5 so as to reproduce justified lines. A new line of characters is read into the line store of the machine during the flyback period of the print-out system.

The photo-sensitive paper or film 5 is contained in a cassette 6 on which is printed positive typographic images of 5 to 14 point and up to 32 pica measure.

The character disc 3 is easily and rapidly changed by hand. The width memory is electronic and changeable by paper tape input.

The disc 3 carries four concentric circular fonts of 90 characters each, in negative image form. Alignment of the four characters in each radial row is to a radial base-line, and the characters conform to absolute lateral units of 0.0026 inches. Reproduction is at a fixed optical ratio, and sizes and fonts can be mixed on one disc.

The stepping of the film for line-spacing is in one-half point steps and is determined by preset switches and controlled by the Return code. Use of an escape code gives extra functions, such as choice of four pre-set film advance movements. Lateral and vertical character placement is plus or minus 0.001 inches.

It is a common feature of existing phototypesetting machines that in order to maintain high standards of typographic excellence those components principally concerned with movement and accurate placement of successive images bear a disproportionate part of the total cost. In the machine to be described, the manufacturing content has been reduced by removing complexity; by minimising the interaction of different areas of the machine's operation, and by providing easy access, both from the operating and servicing standpoint.

Phototypesetters in which whole character images are printed by high-speed flash-light sources must incorporate by one means or another the following essential sub-systems:

1. A photographic alphabet;
2. Light source to illuminate the alphabet;
3. Optical means to project a chosen image on to a chosen location;
4. A film or paper holder;
5. Mechanical means which will dispose characters side by side and on successive lines, as in normal typographic practice.

For the first requirement the machine to be described employs the disc 3 carrying a transparent photographic alphabet on an essentially opaque back ground. The characters are disposed in circular arrays at known angular intervals from an arbitrary reference, the character positions being identified by locating marks in the form of identical narrow transparent bars. Several such circular tracks of characters, conveniently four, are concentrically placed upon the disc, at known radial increments and sharing the same angular increment; conveniently 4° for multiples of 90 characters as commonly used in typography.

The orientation of each character is such that its base is parallel to the radius to which it is referred and this has an important effect on the construction of the machine.

The disc 3 is mounted so as to rotate freely about its axis, under the influence of an electric motor (not shown) at approximately, but not critically, 50 times per second, maintaining all the characters in the same fixed focal plane by means of its rigid mount. The disc may be made of plastic material or Photoplast (Registered trade mark) with a photo-sensitive surface by means of which the transparent characters are obtained.

The second requirement for a light source in this machine takes the form of an electronic flash of short duration; preferably a xenon arc flash tube 7, FIG. 1. The flash duration has a significant relationship to the number of characters presented to the exposure window in a given time, and to the amount of blur due to the continuous movement of the disc which is considered aesthetically acceptable. In a particular case 90 characters are disposed around a disc rotating at 50 revolutions per second, being thus equivalent to 4,500 character presentations at the exposure window per second. Accordingly each character moves past the window in 222 micro-seconds. With an effective flash duration of 2 microseconds, the blur is one hundredth part of the exposure, which is tolerable.

The flash is initiated by the sensing of the appropriate angular location by means of a photocell and lamp assembly 8, 9 placed to observe the character locating bars, and electrical counting means for counting the bars from the known reference point, so as to identify any desired character.

The characteristics of the arc, and the electrical requirements, for such a short-duration, high-energy, flash source are not compatible with the requirements for optimum illumination of a typographical image format, which is substantially square. One way of dealing with this problem is to distribute the light from a linear flash source by means of a bundle of flexible light guides so as to present a square light source of even intensity in close proximity to the character, thus avoiding the depreciation due to the inverse square law appropriate to a free air path from the flash source to the character.

Typically, 80 percent of the light entering such a light guide emerges after one foot length of such a bundle. Further, this exit pupil will possess an effective mass significantly less than that of the original slash source, and can be made to traverse from one concentric ring of characters to another in a very short time. However, the preferred method of distributing the light is by means of a lenticular screen **20.**

To provide the third requirement; to project a chosen image on to a chosen location; the image-forming optical system of the machine takes the form of a pair of lenses each placed at its focal length, the one from the alphabet plane, the other from the sensitive emulsion plane. Both are free to move laterally but are constrained in their focal planes.

The function of the first lens **10,** FIG. **2** is to project a collimated image from the disc, suitably illuminated, via a mirror or prism **11** towards the entry pupil of its complementary lens **13,** which with another mirror or prism **14** reproduces the image seen in the focal plane of lens **10** on to its own focal plane in which the photosensitive film is positioned. If the lenses are of equal focal length, the object and the objective will be of equal size. Similarly, if one be half of the other, for example, the image ratio will be halved accordingly. Since the light leaving the exit pupil of lens **10** and entering the entry pupil of lens **13** is essentially collimated, the distance between the lenses, within certain acceptable limits, does not affect the image in size, intensity or sharpness, so that lens **13** is free to move relative to lens **10,** without image degradation, in increments appropriate to lateral character displacement, across a line of type being imaged in the film plane. Similarly lens **10** may move relative to lens **13** and radially of the character disc to align itself with one or other of the concentric character tracks.

In order to effect such movements, each lens **10, 13** is provided with a rack **14, 15** of a length appropriate to its desired displacement, together with a stepping motor **16,17** carrying a pinion **18, 19** which engages with the respective rack under influence of gravity, so that displacements of any character width can be effected in terms of the smallest increment of which each motor is capable.

The film or paper holder, which constitutes the fourth basic requirement previously stated, takes the form of a separate assembly comprising a first removable container **21** holding a roll of unexposed film or paper freely supported on an axle, and a second removable container **22** disposed beneath it, the film passing between the containers in the vertical film plane.

The fifth basic requirement, that for placing successive lines of characters one below another, is accomplished by a friction roller indicated at **23,** FIG. **1,** disposed parallel and adjacent to the usual exposure slit in a plate (not shown in FIG. **1**) situated adjacent the film plane and against which the photographic emulsion surface is pressed, so as to maintain the appropriate distance between the main light transmission path **11, 13** and the film throughout the linear displacement of the traversing lens.

This friction roller **23** has a diameter appropriate to the typographical unit of measurement in use for interlinear spacing. It is connected in well-known manner by means of a flexible toothed belt to a stepping motor, called the paper feed motor. A pressure roller maintains contact between this friction roller and the paper or film, and enables the roller when rotated by the motor to draw the paper or film past the exposing slit, from container **21.** The exposed film is pushed into container **22** below the exposing slit.

The machine frame, FIG. **2,** comprises two parallel round bars **24, 25** one vertically above the other, which are clamped in end plates **26,** FIG. **3.** Two carriages **27, 28** are each supported at three points by the two bars, which act as runways for the two carriages. The carriage **27** comprises a vertical strut carrying at its upper end a horizontal arm **29,** the ends of which carry horizontal spindles on which are rotatably mounted grooved rollers **30** which run on the upper bar **24.** The lower end of carriage E carries a horizontal roller **31** on a ball-race which rests by gravity against the side of bar **25.** Thus the carriage **27** is supported at two spaced points on bar **24** by the grooved rollers **30** and is positioned by roller **31** resting against bar **25.**

On the carriage **28,** the horizontal arm **4** carrying the grooved rollers **30** is at the lower end of the carriage so that the rollers run on bar **25,** while the rotatable roller **32** rests against the side of bar **24.**

The arms **29, 4** carry on their upper surfaces the horizontal racks **14, 15** which are respectively engaged by the pinions **18,19** on the shafts of the step-by-step electric motors **16, 17,** which can thus step the carriages **27,28** respectively.

The carriage **27** carries the lens **10** and the mirror mounting **11,** while the carriage **28** carries the lens **13** and the mirror **14.** The carriage **27** has a forward horizontal arm **33** carrying at its free end the socket **7** for the xenon flash lamp which is axially aligned with the lens **10.** In close proximity to the front of the lamp socket **7** is mounted the character disc **3** in the manner described below and between the disc and the socket **7** is interpolated the lenticular screen **20** for modifying the linear flash to a square configuration.

The rigid machine frame comprises two spaced vertical brackets **34** on a base, above which respectively extend an upstanding flexible vertical sheet support **35** in substantially the vertical plane of, and welded to, the respective bracket, and an upstanding rigid vertical plate support parallel to the sheet support and horizontally aligned therewith, the plate support being welded to, or formed by the respective bracket. The mechanism is carried by a rigid sub-frame consisting of the two parallel rigid rectangular end-plates **26** connected by the pair of vertically-spaced cylindrical bars **24,25.** The bars **24,25** have flattened ends **36** which slip into horizontal slots **37** in the end-plates near and parallel to their upper and lower edges. Screws **38** pass through the outer tongues **39** defining the slots, beyond the inserted bar ends, into the plates and slightly distort the tongues **39** to clamp the bar ends in the slots.

The distance between the sheet and plate supports of the machine frame is sufficiently greater than the distance between the outer sides of said end-plates so that the sub-frame can be slung between the sheet and plate supports as follows.

Coaxial horizontal connecting rods **40** connect apertures at the centres of the end plates **26** to the sheet and plate supports, e.g., **35,** respectively and a third connecting rod also interconnects the plate support to the adjacent end plate at a position spaced, preferably horizontally, from the other connecting rod therebetween.

Thus the flexible sheet support **35** together with the three-point support of the sub-frame will take up any

slight dimensional inaccuracies between the main and sub-frames, and will prevent distortion of the sub-frame by strain.

Two independent parallel movements are required within the photo-optical system for character spacing along lines of print, and for selection among the concentric character image rings on the disc **3**. The two bars **24,25** are used as runways for the two movements, each of which comprises a carriage freely supported and positioned by the two bars.

The character ring selection carriage **27** has upper and lower laterally-staggered vertical arms and the horizontal arm **33**. The upper arm carries the horizontal bar **29** of rectangular section the ends of which carry spindles normal thereto for the grooved rollers **30** shaped and dimensioned for resting on the upper rod in precise relation thereto, and the top surface of which carries a toothed rack **14** of a length spanning the overall width of the character rings.

The horizontal bar **29** also carries a depending lug **41** positioned between end stops **42** carried by the upper bar **24**. The end of the lower vertical arm carries the horizontal roller **31** which is on ball-bearings and rests by gravity against the side of the lower bar **25**. The grooved rollers **30** resting on the upper bar **24** and the horizontal roller **31** resting against the lower bar **25** locate the character-ring selection carriage **27** in the optical system and allow the carriage to be adjusted along the rods. The horizontal carriage arm **33** has a central off-set length embracing one side of the character disc which is mounted as described below and arm **33** carries at opposite ends of its main axis, the xenon flash tube socket **7** closely adjacent the disc and a right-angle collimator **10,11**, one leg of which is coaxial with the flash tube and the other leg of which is in the main optical transmission axis parallel to the bars **24, 25**. The 'line print-out' carriage **28** also has upper and lower arms but in this case the lower arm carries the horizontal bar **4** with the toothed rack **15** on its upper surface of a length to cover the 'line print-out' required. As before the ends of the bar **4** carry spindles normal thereto for the grooved rollers **30** shaped and dimensioned for resting on the lower rod in precise relation thereto. The upper arm of the carriage **28** carries the horizontal roller **32** on ball-bearings adapted to rest against the upper bar **24**.

The carriage **28** carries the print-out lens **13** in the main optical transmission axis and a pillar on the bar **4** carries the vertical mirror **14** at an angle of 45° to the main optical transmission axis for directing the character images on to the film **5**. The horizontal bar **4** has an upstanding lug **43** between end-stops **44** carried by the upper bar **24**.

Both carriages are driven by electrical stepping motors **16,17** carried and positioned respectively from the left-hand and right-hand end-plates **26** in the manner shown for the 'line print-out' carriage in FIG. **3**. The rear end of plate **26** has an open-topped vertical mortise **45** into which slides a tenon **46** on one end of a horizontal cantilever arm **47** the other end of which carries a pivot ring **48** with horizontally aligned adjustable pivots **49** which take into screw holes in the end of the casing of motor **17**. The front end of the motor shaft directly carries the pinion **19** which rests on the rack. The pressure of the pinion **19** on the rack **15** is determined by an adjustable spring support **52** carried by the bars. The position of the pinion **19** relative to the end plate **26** is controlled by a connecting link **50** between the end plate **26** and the front of the motor **17**, which link includes a length of cable **51** which consists of entwined helical wires of opposite hands and which maintains a constant length but can flex sufficiently to allow the pinion **19** to be raised and lowered on the rack **15**.

The electrical drive motor (not shown) for the character disc **3** is supported from the bars **24,25**. Its outer bearing is extended to support a cantilever extension of its shaft which carries a rigid hub from which the shaft extends sufficiently to receive a character disc, and a quick-release hub cap to hold to disc firmly against the hub. The motor is rigidly supported by an accurately-dimensioned support lug from the bars **24, 25** so that the disc is precisely located with respect to the optical character reader. A suitable form of disc has **100** peripherally spaced character positions and a radial row of five characters in each position forming five concentric character rings. Each row of characters stands on a common radial line. This is important since it is for this reason that the complete optical transmission system from the character selection position to the print-out line position is in a common plane, an arrangement which facilitates simplicity, strength, and accuracy of machine construction.

Timing marks are provided exterior to the character rows, and mark detector equipment comprises the tungsten lamp **8** and the photocell **9** carried by a support also slung from the bars **24,25**. The light source for forming the image of selected characters is a xenon flash tube.

Primary light sources do not provide per se uniform illumination for a rectangular area such as that defining the standard character areas on a character disc. The xenon flash tube provides a line of light. In the present equipment a rectangular beam of uniform intensity is formed by placing between the flash tube and the closely-adjacent disc, a lenticular screen **20** comprising an array of parallel straight-line cylindrical lenses parallel to the flash-line to spread the light in a direction at right angles to the flash-line.

Alternatively the screen may consist of an array of parallel straight-line prisms with a common base plane, but with their apical angles decreasing from the centre outwards in both directions. The plane face of this screen will face the flash tube.

It will be seen that the light source and collimator equipment **7,10,11** are on a common mounting **27,33** so that 'character ring' selection is wholly provided by movement of the ring-selection carriage. Because of the simplicity of the light transmission path; the location of the light source in close proximity to the disc; and the use of rapid film with a small 'blacking' time, a ½ joule, ½ microsecond flash is adequate for print-out, although a joule, and a 2-microsecond flash are tolerable.

The above equipment in its main frame is to be mounted, as shown in FIG. **1**, in the upper part of a cabinet, side-by-side with the independently-mounted film cassettes. In the upper cassette **21** is simply mounted on drop-in end bearings, a roll of film which is drawn, step-by-step, for line spacing from the roll, into an otherwise empty lower cassette **22** slightly wider than the film, in which the exposed film coils up due to the curvature acquired in the original roll.

It is necessary, of course, to position the portion of the film on which printing is to take place accurately

with respect to the optical transmission path. For this purpose an exposure plate is mounted on accurately dimensioned arms slung in an accurate position on the bars **24, 25.** A horizontal slot in said plate defines the printing line position. The film is led down the side of the exposure plate away from the optical transmission path which is slightly proud of the straight film path. A light-tight door over the cassettes in the cabinet has a spring pressed inner plate which presses the film against the exposure plate.

Below the exposure plate, the film passes between a pressure roller and the friction roller **23** driven by a further stepping motor for line spacing.

What we claim is:

1. In a phototypesetting machine having a high speed flash light source and first and second movable reflector members defining a light beam transmission path from said source with parallel input and output light beam paths interconnected by a main light path at right angles to and between said parallel light beam paths, means supporting photosensitive material in an image recording plane intersecting said output light beam path,

a rotatable character carrier having a plurality of character font circles arranged to present individual rows of type characters as transparencies on a common base line at an image generating position adjacent and parallel to said image recording plane and to said main light path and normal to said input and output light beam paths,

movable collimating lens members cooperating with said reflector members for directing character-carrying light beams from said character carrier along said light transmission path and focusing images of individual characters at different positions along a line in said image recording plane which is parallel to said main light path;

the improvement comprising means providing a runway extending parallel to said main light path from said image generation position across said image recording plane,

a first carriage on said runway means mounting said light source and at least one of said lens members and the first reflector member, a first stepping motor connected to said first carriage means for movement to align the input light beam path with a selected one of said font circles,

a second carriage on said runway means mounting another of said lens members and the second reflector member and movable along said main light path in front of said image recording plane, and a second stepping motor connected to said second carriage to translate said second carriage for spacing the character images in a line of print across the photosensitive material.

2. A phototypesetting machine as defined in claim **1,** wherein said high speed flash light includes a linear light source, and a light diffuser screen positioned between said carrier and said flash-light source to spread the linear flash source into a substantially rectangular beam of essentially uniform light intensity across the beam.

3. In a phototypesetter as claimed in claim **1** wherein said diffuser is a lenticular screen.

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