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MAY 18, 1943.
BY A. P. C.

L. DE TAVY
PRODUCTION OF ROLLERS
Filed April 27, 1937

Serial No.
139,213
2 Sheets-Sheet 1

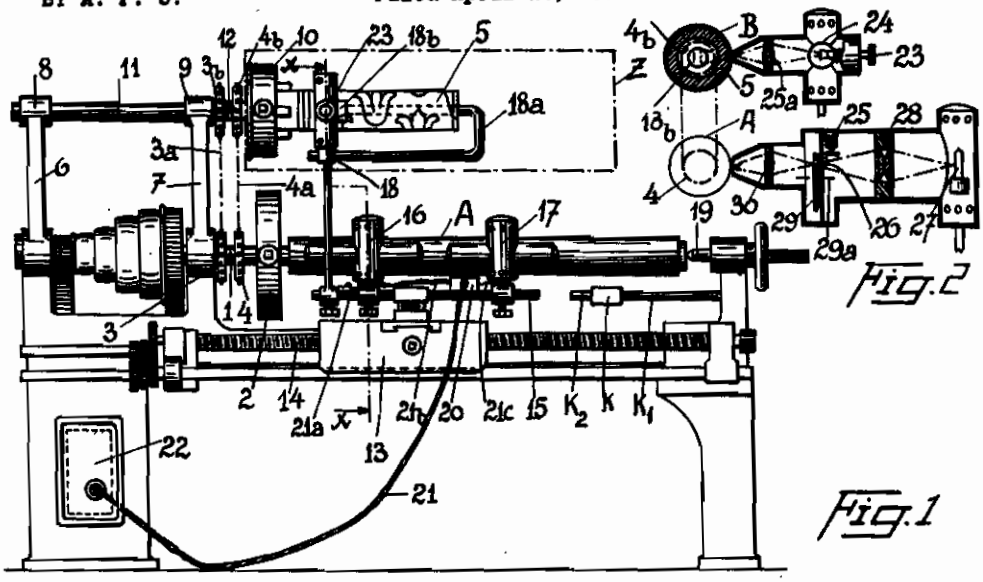

Fig. 2

Fig. 1

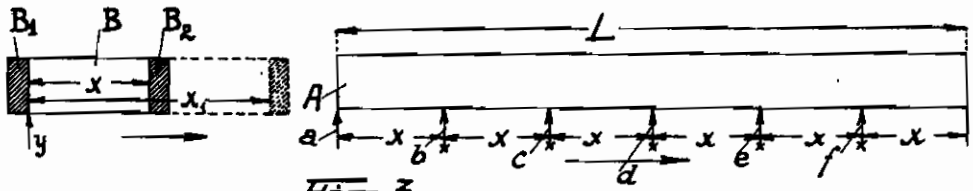

Fig. 3

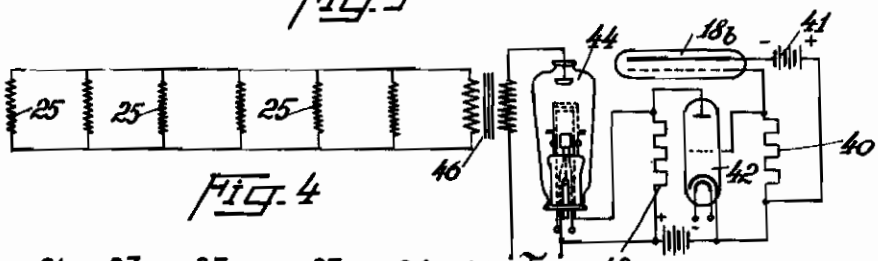

Fig. 4

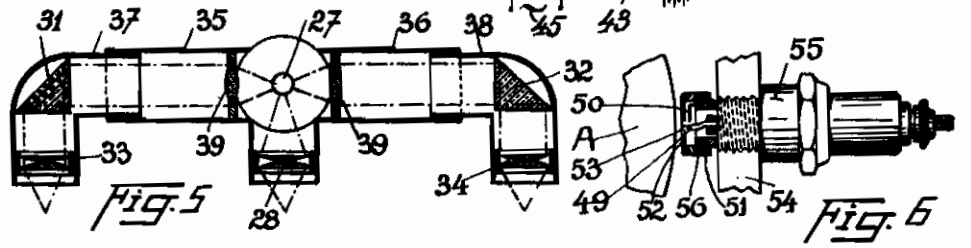

Fig. 5

Fig. 6

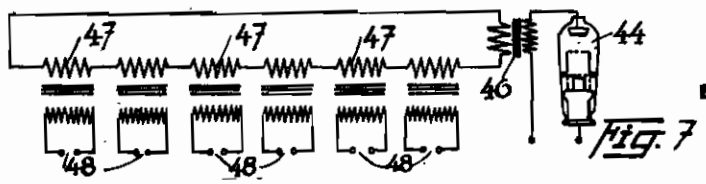

Fig. 7

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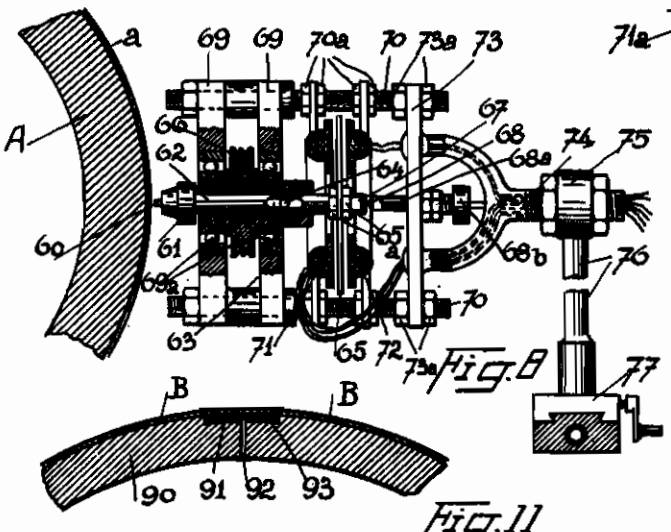

Fig. 8

Fig. 11

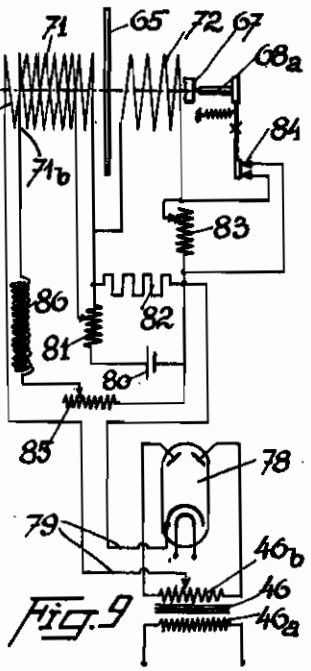

Fig. 9

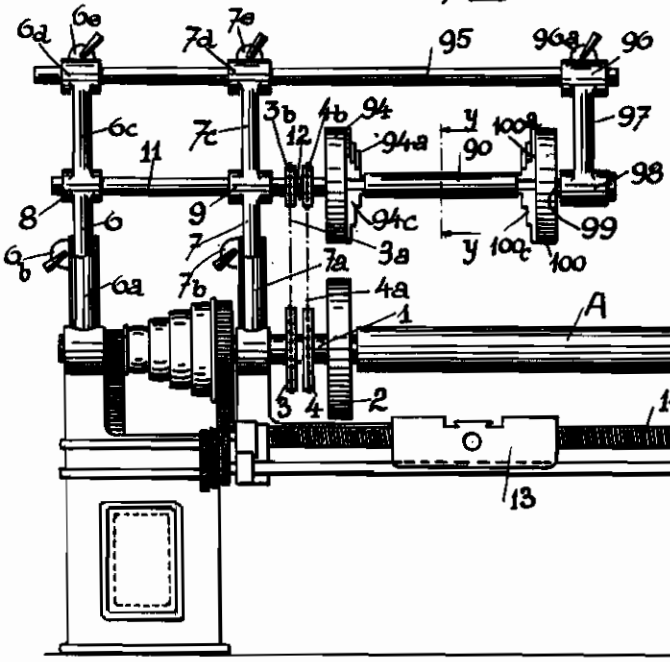

Fig. 10

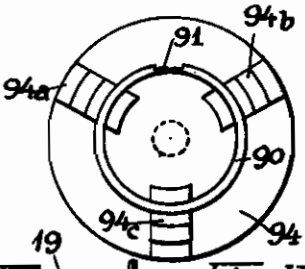

Fig. 12

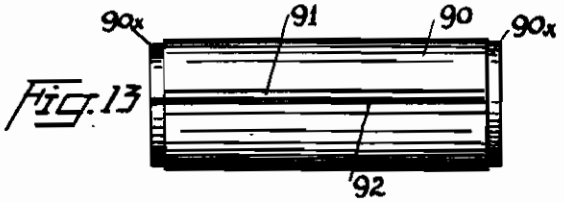

Fig. 13

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ALIEN PROPERTY CUSTODIAN

PRODUCTION OF ROLLERS

Loránd de Tavy, Budapest, Hungary; vested in the Alien Property Custodian

Application filed April 27, 1937

This invention relates to the production of such rollers of embossed surface, the embossments of which consist of one or more design elements, for example in intaglio or relief, these being registered on the surface of the roller at least in the direction of the circumference of the roller, but usually also in the direction of the axis of the roller, in such a way that they cover the surface of the roller without any gap or overlapping occurring between, respectively of, their ends or sides.

Such registration of the design element or elements on the surface of the roller is usual in the art and necessary in such cases, when the roller is to be used for transferring the design element or elements, for example by printing, on indefinite lengths of material, for example textile fabric, in such a way, that the design element or elements should be repeated on the material in faultlessly regular and registered, uninterrupted succession indefinitely. Such registration of the design elements is also necessary, when using the roller for transferring the design element on plastic sheet material, such as rubber, by rolling said material between rollers, at least one of which has the said embossed surface. It is further necessary when the roller, for example the well-known hand-engraved steel roller used in the art of preparing printing rollers for printing on textile fabric, is used for transferring its relief design element to the surface of another roller of greater diameter, such as a printing roller consisting of copper, by means of pressing the hard steel roller to the surface of the copper roller and revolving both together with their surfaces in mesh with each other, until the whole circumference of the copper roller has been impressed with the design element or elements of the steel roller, in correct registration.

The term "design element" used in this specification and in the claims signifies no pictures in the ordinary sense of the word, such as halftone pictures, but only all kind of mainly "black-and-white" material, such as drawings, ornamental patterns, designs and the like, for instance such as are used in intaglio printing on textile fabrics, especially artificial silk, and on wall papers, i. e. materials of great paint-absorbing quality, and in which design elements also portions of text or other portions may appear in some cases.

Many kinds of methods have been proposed up to now for the production of the above-mentioned rollers of embossed surface, some of which are mentioned and described in the specification of the Patent No. 1,878,347, and in all these methods, the most serious difficulty was caused by the necessity of the exact registration of the design element or elements on the surface of the roller.

The main object of the present invention is to provide a process, by means of which the above-mentioned drawback consisting in the difficulties of the circumferential registration of the design element or elements on the surface of the roller is removed. This object is, according to the invention, achieved by transferring the design element or elements from the design carrier, for example drawing or film, carrying on its surface one or more design elements, and being preferably shaped as an endless band continuously covered by the design element, by means of scanning said design carrier with a ray of light, and of recording, effected on the external surface of the roller to be covered with the design elements in registration, by any suitable method, i. e. by transmitting the design element from its carrier onto the roller according to the principles of picture telegraphy, and thereby simultaneously registering it on said roller.

Another object of the present invention is to provide a process by means of which also the drawback of the difficulty of the axial registration of the design-elements is removed without necessitating for this purpose the use of such a design carrier, for example film, the axial length of which is substantially equal to that of the roller to be produced. This is according to the invention accomplished by controlling with the photo-electrical tension or current of a single scanning device a plurality of recording devices acting on the same roller, said recording devices being preferably positioned in respect to each other in such a way, that they should record along the same generatrix of the cylindrical roller, but on various points of said generatrix, the axial distances between said points being equal with each other and/or with the axial length of the design element to be transmitted.

A further object of the present invention is to provide a process by means of which the design elements can be transferred to the surface of the roller with the desired sharpness and yet with the necessary speed of operation, and by means of which undesirable parts of the image to be transmitted can be suppressed or omitted from being transferred to the roller, this being, according to the invention, accomplished by controlling the recording device or devices with the scanning device in a special electrical connection,

more fully explained hereinafter and shortly termed as a "toppling circuit".

Another object of the present invention is to provide a process by means of which, in the production of such rollers, on the surface of which the design element repeats itself several times in succession also in the direction of the circumference of the roller, a design carrier can be used, which bears only a smaller number of design elements or preferably even only a single design element, this being, according to the invention, accomplished by using an apparatus of the well-known drum type, on which, however, the diameter of the scanning drum substantially differs from the diameter of the recording drum, i. e. of the roller to be produced, and driving, during the transmission, these drums with substantially equal circumferential, but different angular speeds, one of which speeds preferably being a whole-numbered multiple of the other.

A further object of the invention is to provide a process by means of which several or all the separate individual rollers of the set of rollers necessary for printing a multi-coloured design on textile or other material can be produced by transferring the separately-coloured parts of the design element to the individual separate rollers from a single, identical, multi-coloured design carrier. This is, according to the invention, accomplished by "selective scanning" of the design carrier, as more fully explained hereinafter.

Other objects of the invention, the manner in which the same are attained, and the apparatus with which the process according to the invention may be preferably carried out in practice, will appear from the following description, in which, with these and other ends in view, I illustrate, in connection with the accompanying drawings, such examples of adaption as will clearly disclose the broad underlying features of my invention, without limiting myself to the specific fields of practice and details of process and apparatus shown thereon and described herein.

In the drawings

Fig. 1 is a side view of an apparatus for producing printing rollers for printing on textile material.

Fig. 2 is a partial cross-section of the apparatus shown on Fig. 1 in the plane of the line X—X of Fig. 1.

Fig. 3 is a diagram illustrating the axially multiple recording of a design element.

Fig. 4 is a diagram of an electrical circuit adapted for use in the apparatus according to Fig. 1.

Fig. 5 is a diagrammatical partial cross-section through one of the multiple recording devices of the apparatus according to Fig. 1.

Fig. 6 is a diagrammatical partial section through an alternative recording device.

Fig. 7 is a diagram of an electrical circuit adapted for use with the recording device according to Fig. 6.

Fig. 8 is a diagrammatical cross-section through an alternative, mechanical recording device.

Fig. 9 is a diagram of an electrical circuit, relating to the recording device shown in Fig. 8.

Fig. 10 is a diagrammatical side view of an alternative apparatus similar to that shown on Fig. 1, but illustrated with the scanning and recording devices taken off.

Fig. 11 is an enlarged partial cross-section in the plane of the line Y—Y of Fig. 10.

Fig. 12 is a cross-section in the plane of the line Y—Y of Fig. 10.

Fig. 13 is a side view of a scanning drum.

In utilizing my system in practice I may employ whatever alternatives or equivalents of process, structure and circuits that the exigencies of varying conditions may demand, for example the more complicated circuits known in the art of picture telegraphy, photoradio or photoelectric printing-plate engraving, without departing from the spirit of the invention, which consists, shortly, of effecting the transferring and registering of the design elements electrically, in a continuous single operation.

It has been proposed heretofore to scan and to record by mechanical engraving on the surface of rollers, as instanced in Patent No. 2,029,103 issued January 28, 1936, to Walter Howey. The proposed engraving, however, is not suitable for producing the large copper rollers necessary for printing on textile materials, or the small steel rollers used for the production of the aforesaid rollers, and, furthermore, it has not been proposed to transfer design elements to be registered in relation to each other on the surface of the roller, and has not been found that when employing the methods of picture telegraphy, according to this invention, an automatic circumferential registering of the transmitted design elements occurs, such method rendering the occurrence of gaps or overlapping impossible in itself. Therefore when the circumferential length of the design carrier used in my process is not exactly equal with the circumference of the roller, or with its predetermined fraction or multiple, only a slight and scarcely noticeable distortion of the transmitted design element occurs, in my process, instead of the production of a spoiled roller, which inevitably resulted in such case, when using the methods of manufacture proposed for making such rollers up to now. Furthermore, with the scanning apparatus known up to now, it has been impossible to transfer design elements to a roller in a circumferentially registered way, as the scanning drums of this apparatus were always provided with gripping means preventing the whole circumference of the drum to be covered with the carrier carrying the image to be transmitted by them.

On Fig. 1 of the drawing I have shown an apparatus in which six recording devices are controlled by a single scanning device, but in the production of rollers of considerable length I preferably employ twelve recording devices recording on points situated on the same generatrix of the surface of the roller, these points being at equal distances from each other, corresponding to one twelfth part of the axial length of the roller surface to be covered with the design elements. Notably, in this case, the axial length of the design element to be transferred may be equal to the following fractional parts of the length of the roller surface to be covered with the design: $\frac{1}{12}$, $\frac{1}{6}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$. As shown on Fig. 1, the apparatus comprises a lathe, which, if it is used for transmitting only, may be of light weight and inexpensive, seeing that it is hardly subjected to any appreciable mechanical stresses. It is, however, advantageous to employ a massive lathe on which it is also possible to remove the old design from the roller by turning, because in that case the removal of the old design by turning, the smoothening of the surface thus obtained, its coating with a light sensitive layer and the transference of the design can be effected with a single fixing of the roller on the lathe, i. e. with a great saving in time and labour, and it is absolutely assured that the roller will, during transference, run accurately in relation to the recording devices.

The lathe is converted into the apparatus according to the invention in the manner shown diagrammatically on Fig. 1, by mounting the chain wheels 3 and 4, having preferably equal diameters and equal tooth pitches, between the main shaft 1 and the head stock 2 of the lathe, whilst on the body of lathe the arms 6 and 7 holding the mechanism for fixing and rotating the scanning drum 5 made, in this apparatus, of transparent material e. g. of glass or celluloid, are mounted, in the bearings 8 and 9 of which the shaft 11 carrying the head stock 10 of the scanning drum is supported in such a manner as to be assured against any lateral displacement. On this shaft 11 there is keyed the chain wheel 3*b* driven from the chain wheel 3 by means of the chain 3*a*, whereas the chain wheel 4*b* driven from the chain wheel 4 by means of the chain 4*a* is mounted loosely on the shaft 11 and the strong spiral spring 12 is endeavoring to turn this chain wheel 4*b* relatively to the wheel 3*b*. This kind of drive will render the exactly synchronous running of the shafts 1 and 11 independent in a high degree of the wear of the chain.

In addition to the above, all that is necessary for converting the lathe into an apparatus according to the invention—by which conversion the said lathe is not rendered unfit for its normal purpose—is only to fix the scanning and recording devices in a removable manner on the carriage 13 and possibly to fix the arm K_1 to the tail stock base, because the ratio of transmission between the main shaft and the spindle 14 for moving the carriage is variable in any case on all lathes, and thus the necessary gear ratio depending on the width of lines employed for any transmission can be easily adjusted.

The transferring devices comprise a bar 15 fixed in a removable manner on the carriage, the multiple recording devices 16 and 17 and the scanning device 18, all of which can be displaced on this bar 15 and fixed in their respective positions at any time. The arm 18*a* of the scanning device, projecting into the scanning drum 5, carries the photocell 18*b*. The copper roller A on which the design is to be transmitted is fixed in any desired manner between the headstock 2 and the tailstock 19 and the lathe is driven during the time of transference at a substantially uniform speed, e. g. by means of a small synchronous motor (not shown). The electric conductors 21*a*, 21*b*, 21*c* leading into the scanning and recording devices meet in the cable box 20 mounted on the bar 15, from which box the flexible cable 21 leads to the control box 22 which has been shown on the drawing as being located in the body of the lathe. It is in this box that the various elements of construction of the circuit shown on Fig. 4 (with the exception of the photocell 18*b* and of the magnets 25) are located. When employing highly light-sensitive layers, it is advisable to locate the scanning device in the casing impervious to light indicated by the broken line C.

The manner of operation of the scanning and recording device is shown on Fig. 2. The design carrier B, shaped as an endless band closely fitting on the surface of the scanning drum 5 rotating at a peripheral speed exactly or approximately equal to that of the roller A, but in any case at an angular speed exactly identical with that of the roller A, (the diameter of the scanning drum 5 being exactly or approximately equal with that of the roller A) is scanned by the light rays of the motor car lamp 24 or of some other source of light supplying light of any desired suitable wave-length and intensity, concentrated on the said design carrier by means of the lens or lens system 25*a*, by which rays the photocell 18*b* is illuminated in due course, the motor car lamp or other source of light referred to being capable of being adjusted into focus by means of the screw spindle 23. The photo currents are, in the connection according to Fig. 4, actuating the light shutter member 26, by means of the electromagnet 25, for controlling the beam of light rays illuminating the light-sensitive layer, consisting, for example, of chrome albumin, coating the cylindrical surface of the roller A. In consequence hereof the light of the source of light 27 of the recording device, which is the arc, burning in a high-pressure bulb of quartz glass and having a high surface light density, is concentrated by means of the lens system 28 on the plane of the light diaphragm 29, which is a diaphragm of the disc type rotatable around the shaft 29*a* and fitted with holes of different size and is allowed to pass through or is shut off by the said light-shutting member 26 in the order of sequence and at the time rate controlled by the scanning device. The beam of light rays is projected in the form of a picture point of the desired size, which size is adjustable by means of the diaphragm 29, on the light-sensitive layer with which the roller A is coated. The size of the scanning picture point of light, which must be substantially equal to the size of the recording picture point, is adjusted either by means of the screw spindle 23 or by varying the distance between the whole scanning device and the design carrier B or it is adjusted in such a manner that for the purpose of scanning an optical apparatus similar to that of the recording device is employed instead of the more simple arrangement shown on Figure 2, and the light diaphragms of the scanning and recording devices are adjusted so as to make their openings equal. It is in accordance with the diameter of these openings used at any time that I adjust the ratio of transmission between the main shafts and the carriage screw-spindle of the lathe, whilst the time of exposure is adjusted by the suitable selection of the speed of the main shaft of the lathe. In the diagram of Fig. 3 the scanning of the design carrier B by means of the light ray *y* is begun at its left border, progressing in the right-hand direction. The length X of that part of the design carrier which is covered with the design element amounts in the case of this example to one-sixth of the length L of the roller, in consequence whereof the distances between the points of action of the rays of light *a, b, c, d, e, f* of the multiple recording device also possess the length X. If, for instance, the axial length X_1 of the figure carrier amounts to one third of the length L, the rays of light *b, d,* and *f* are simply shut off. If accordingly the length of that part of the design carrier B, on which a design is provided, can be selected at will, whilst the length of roller on which a design is to be provided, is constant, it is also possible for the mutual axial distances of the recording beams of light to be constant and the adjusting devices for varying these distances can be dispensed with. That part of the design carrier, on which part the design element is provided, is limited from the right hand and from the left hand side in the axial direction by black parts B_1 and B_2. If the ray of light *y* reaches the black part on the right hand side, it is possible for the machine to be automatically stopped by a suitable mechanical or electrical signal pick-up

device. Such a signal pick-up device may be controlled by an electric contact mounted, for instance, on the body of the lathe and closed in this position by the carriage, it being possible for the said contact to be located in the box K shown on Fig. 1. This box may for the purpose of correct adjustment be displaceable on the bar K_1 on which it is supported and this bar may be fixed to the tail-stock base. In the case of such an arrangement the contact is operated by the end of the bar **15** if the said bar end is pushing in the peg K_2.

Fig. 4 shows the "toppling circuit" employed for controlling the multiple recording device. In this specification and claims the term "toppling circuit" designates a circuit, wherein the variations of the incoming electrical tension or current (the "input") control the outgoing electrical tension or current, or the position of the member controlled by the input, in such a manner that the output or member controlled are inaffected by such variations of the input, the maximum instantaneous value of which lies below a certain, preferably adjustable, limit. If, however, the input surpasses this limit, the output or member is caused to tend to attain instantaneously its maximal predetermined value or position, and to remain at this value or position unaffected by such fluctuations of the input, the minimum value of which does not fall below the limit mentioned above. As soon, however, as this occurs, the output or member tends to regain its above-mentioned original value or position at once and remains there unaffected by such fluctuations of the input the maximum value of which lies below the limit mentioned above, which will be termed hereinafter as the "toppling limit."

In the circuit shown in Fig. 4, on the resistance **40** connected in series with the photocell **16***b* the current of the battery **41** produces a voltage drop depending on the illumination of the photocell, which acting as grid tension on the grid circuit of the electron tube **42** will produce a varying voltage drop in the resistance **43** situated in the anode circuit of the said electron tube, which voltage drop is utilised for the grid control of the thyratron tube **44**. This tube is fed by the source of alternating current **45** with an alternating current of relatively high frequency (e. g. 500–10.000 Hertz), which current is transformed by means of the transformer **46**, the primary coil of which is connected into the anode circuit of this tube, to a voltage suitable for feeding the magnets **25** connected in parallel with each other in the secondary circuit of this transformer and which voltage, before being conducted into these magnets, is preferably rectified by means of a rectifier, not shown on the drawing, which may be of any desired type. The higher the speeds of transmission and the degree of fineness with which transmission is taking place, the higher should be the figure selected for the frequency of the source of current **45**. The connection, moreover, may comprise means for changing the sense of transmission, for example from position to negative, to positive from positive or the reverse. Such means may comprise a change-over switch, a further amplifying tube or stage, or other means suitable for this purpose, all well-known in the art, and the circuit may also comprise means for adjusting the toppling limit, for example by changing or adjusting the working value of any or both of the resistances **40** and **43**, in any suitable way.

Fig. 5 shows the way of operating, with a single source of light, three recording devices. The light of the lamp **27** (shown also on Fig. 2) illuminates not only the lens system **28** shown also on Fig. 2, but also the mutually identical lenses **39**. The parallel beams of light produced by these are reflected by prisms **31** and **32** onto the lens systems **33** and **34**, from which they are thrown further in the way shown in Fig. 2. In view of the fact that parallel beams of light rays are produced by the lenses **39**, the recording devices containing the lens systems **33** and **34** are displaceable relatively to the recording device containing the system **28**, for which purpose their tubes **37** and **38** respectively are displaceable in the tubes **35** and **36** fixed to the casing of the lamp **27**.

I do not wish to limit myself to the optical recording device described, as also other devices may advantageously be employed, for example the well-known glow-tube devices of photoradio apparatus, or the device described hereinafter in connection with Figures 6 and 7 of the drawing.

This device is specially suitable for use with highly light sensitive layers and/or fine scanning, because its source of light consists of electrical discharges taking place under atmospherical pressure, such as spark discharges, preferably attaining after the first discharge, the characteristics of an arc, and these discharges may be brought so near to the light-sensitive layer as to enable the optical systems of the recording devices to be dispensed with, and moreover, in accordance with the above, the mechanical control of the rays of light can also be dispensed with. The circuit which can be employed in this case is shown by Fig. 6. This differs from the circuit according to Fig. 4, only in that the transformers **47** feeding the spark gaps **48** are mutually connected in series in the circuit of the secondary coil of the transformer **46**. These transformers **47** are preferably igniting coils such as used for the storage battery ignitions of the internal combustion engines of motor cars, whilst the spark gaps **48** may be modified sparking plugs. In case of connecting the primary coils of the igniting coils in series, it is also possible to dispense with the transformer **46**.

Such a sparking plug modified and mounted so as to be suitable for being used as a source of light is shown on Fig. 7. The insulated central electrode **49** of the sparking plug is deflected in such a manner as to ensure that the centre of the spark gap provided between this electrode and the other electrode **50** fixed into the body and also suitably deflected should fall into the axial centre line of the sparking plug. The spark gap is preferably adjusted to smaller than the normal e. g. to 0.2–0.4 mm. On the thread cut on the end of the long stem sparking plug shown on the drawing, the cap **51** is screwed, the front wall **52** of which is made of insulating material impervious to light, e. g. of mica plate varnished black, at the centre of which a hole **53** of suitable diameter is provided. The mica plate **52** is held in position by the border provided on the cap, which latter may for instance be made of brass. In certain cases two parallel such mica plates in some distance of each other may be provided. The sparking plug **55** is screwed with the normal sparking plug thread into the iron plate **54** which to some extent corresponds in this apparatus to the bar **15** of Fig. 1 and accordingly carries all the sparking plugs, each of which is screwed into the thread of one of the holes provided at suitable distances from each other on the said iron plate. Fig. 7 shows that with this arrangement

it is possible to bring the source of light constituted by the spark gap very near to the light sensitive layer by which the surface of the roller A is coated but far enough to prevent that the spark should be able to spark over from the electrode 49 to the roller A, for which purpose the plate 54 and the parts connecting the igniting coils with the same may be insulated from the lathe. In the cap 51 it is advisable to provide the holes 56 and 57 situated in the shell parts of the same, projecting beyond the end of the sparking plug, the said holes assuring the necessary air circulation and being also suitable for being used as test openings.

According to my invention, I can also use as photographical recording means Lenard rays issuing preferably from a metal-bulbed Lenard tube provided with a Lenard window the size of which approximately corresponds to the line width of the transmission, and is therefore very small. Lenard tubes suitable for this purpose are preferably incandescent cathode tubes fitted with grid control, which are preferably in the connection according to Fig. 5 connected in place of the thyratron and controlled directly by the amplified photovoltage, because with these tubes it is possible to operate with so high speeds of transmission, at which the lag of the thyratron could already have a disturbing effect. This way of transmission possesses the drawback that the Lenard tubes which are rather expensive and are at present only made to order, and which are preferably completely evacuated, have, in the interest of their correct operation and of maintaining their term of life, to be pumped or gettered from time to time, or permanently, for the purpose of removing the air entering them by diffusion, but this is offset by the advantage that it is possible, owing to the very strong actinic effect of the rays and of the possibility of controlling them accurately without any lag, to raise the speed of transmission very high, and in consequence hereof it is possible to operate at completely satisfactory speeds also with the employment of less delicate layers of lower light-sensitivity. Owing to this high speed of transmission, perfectly satisfactory performance is obtained with apparatus of this type also if only a single Lenard tube operating as recording device is controlled by the scanning device. It is, however, also possible to employ a plurality of Lenard tubes, or the single Lenard tube may be controlled in succession by a number of scanning devices situated at a distance from each other equal to the axial length of the design carrier, if it is not desired to employ a design carrier of an axial length corresponding to the total length of the roller. Owing to the well-known dispersion of the Lenard rays in air, it is necessary that the window of the Lenard tube also should be brought so near to the roller surface that the path of the rays in the air should be of the order of magnitude of one tenth of a millimetre or at most of a millimetre, but there is no difficulty in doing so.

With all the photographic recording methods mentioned above, wherein the light sensitive layer of any suitable known kind is distributed on the surface on the roller in known manner and "developed" after exposure, whereon the roller is being etched in any suitable known manner, it is necessary that the transference, or, in case that the scanning and recording devices are spaced apart from each other for the purpose of distance transmission or simultaneous transmission onto a plurality of rollers, at least the recording should take place in a dark room, as was usual also in case of the photolitographic processes used up to now. With the process according to my invention it is possible to obviate this drawback by using some suitable kind of visual recording. This may be done by using as recording devices the "ink vapor" devices known in the art of photo-radio transmission, by means of which a suitable solution may be sprayed onto the surface of the roller, thereby for example rendering the same locally acid-proof or affecting it or any suitable layer adherent to it chemically in any other desired way. It is also possible to use electrical discharges acting directly on the surface of the roller or the layer adherent to it. In first case, for example, the metal surface, for example of aluminium, may be locally oxidixed, the oxide layer thus produced adhering strongly to the metal, whereafter the roller may after suitable treatment be etched. In the second case, the oxidation may locally remove the acid-proof layer, for example of suitable varnish, containing, for example, nitrocellulse and carbon black, by burning it off and thus also rendering the roller ready for etching. In case the electrical discharge is allowed to act directly on the surface of the roller or the layer adhering thereto, it is also possible to employ spark plugs as electrodes in a manner similar to that shown on Fig. 7. In this case the electrode 50 shown on this figure is removed, the electrode 51 is left in its central position, its end is sharpened into a point and the discharge is allowed to spark over through the opening 53 of the mica plate 52 to the roller A connected as the other electrode. The distance between the roller and the sparking plug can in both cases be easily adjusted by screwing the sparking plug 55. If it is desired to work in a stream of oxygen, the electrode 49 is, at least at its point, made of platinum, a cap 51 closing gas-tightly is employed, and, employing by way of sparking plug the known type of sparking plug comprising a central electrode perforated in its axial direction, the oxygen is introduced through the perforation of this electrode and allowed to stream through the hole 53 on the roller surface arranged at a distance of the order of magnitude of one tenth of a millimetre from it.

According to my invention, I may also employ mechanical recording means, in which case, however, I prefer to work in a widely different manner from those proposed up to now for the photoelectrical engraving of printing plates or rollers. According to my invention, I prefer to cut into the material of the roller itself, or, more preferably, to remove the material of an acid-proof layer adhering to the surface of the roller, in such a way that both the width and the depth of the resulting grooves should be constant. Therefore, if I employ cutting tools, these preferably have a flat cutting edge instead of the usual V-shaped edges, but I preferably employ constantly revolving cutting means, such as milling cutters, as described below in connection with Figures 8 and 9 of the drawings.

The cutting tool of the recording device shown on Fig. 8 consists of the constantly revolving milling cutter 60, which may consist of steel or tungsten wire of suitable diameter corresponding to the desired scanning and recording line width, and provided with cutting edges in any suitable manner. The cutter 60 is held by the socket 61, this being fastened to the hollow shaft

62, made of light metal alloy and borne by the ball bearings 69a mounted into the supporting plates 69. This shaft 62 is rotated by means of the pulley wheel 66, which bears the pin 64 extending through a slit 63 of the shaft, so that the shaft can be displaced axially in respect to the driving wheel 66 and yet be constantly driven by the same. The disk 65 of ferromagnetic material, such as soft iron, is fastened on the shaft 62 by means of screw nuts 65a, and the shaft bears on its end the cap 67. The electromagnets 71 and 72 are fastened to the supporting bolts 70 by nuts 70a, these bolts also being fastened by nuts 73a to the shield plate 73, which in turn is fastened by welding to the hollow supporting fork 74, the end of which is held in the head 75 of the brace 76 fastened to the piece 77 inserted into the carriage 13 of the lathe shown on Fig. 1. The shield plate 73 also bears the hollow pin 68, provided with a slidable feeler 68a, which actuates an electrical contact (not shown on this figure) located in the casing 68b. The milling cutter 60 is normally spaced from the varnish layer *a* adhering to the surface of the roller A to a little distance of the order of magnitude of some tenths of millimetres, and revolves at a high speed of say 3000 or more revolutions per minutes, the pulley wheel being driven to this end by pulley drive from any suitable motor (not shown). The electrical connecting wires of the magnets and contact are led through the hollow fork 74, to be connected as shown in Fig. 9, into a magnetical toppling circuit. The diagram of Fig. 9 shows in its upper part the magnet windings 71a and 71b of the left-hand magnet, the disk 65, the winding 72 of the right hand magnet, and the cap 67 operating by means of the feeler 68a the contact 84, and in its lower part the transformer 46, the primary winding 46a is connected in the anode circuit of the thyratron tube 44 shown on Fig. 4. This tube, however, can be substituted in this case by a large output electron tube, as the toppling character of the connection is already ensured by the arrangement of its magnetic fields acting against each other. The secondary coil 46b of transformer shown on this figure is connected to the rectifier 78 to supply a rectified current to the leads 79, through which no current flows when the milling cutter does not touch the surface of the roller A, as in the positions shown on Figures 8 and 9. In this position of the device no current flows through the coil 71a, but the coils 71b and 72 are supplied with direct current from the battery or rectifier 80. The coil 72 is supplied with current through the resistance coil of the potentiometer 81 and through the adjustable resistance 82, as the contacts 84 adapted to short-circuit this resistance are being held open in this position of the device by the feeler 68a and cap 67. The coil 71b is supplied with current through the adjustable contact of the potentiometer 81, the adjustable resistance 85 and the (omissible) self-induction coil 86. These currents and the distances of the poles of the magnets 71 and 72 from the disk 65 are adjusted so as to let the disk 65 rotate in close proximity to the poles of the magnet 72, although the coil 71b is carrying current, and that therefore the cutter 60 is out of contact with the roller. If a suitable current flows through the leads 79, the cutter 60 is instantaneously brought into full action, i. e. pressed onto the roller with full force, because the winding 71a now receives current through the resistance 82. This resistance has such a value that the voltage drop caused on it by the current of the coil 71 is of about the same magnitude, but of opposite sense than that caused by the current of battery 80, and therefore compensates the latter to the effect that the coil 72 receives less or no current from this battery. To obviate the necessity of very exact compensation a rectifier (not shown) or unidirectional valve may be inserted between resistance 82 and battery 80, and another between resistance 82 and coil 72. If now coil 72 receives no current, the voltage drop along the resistance 81 is diminished so as to cause coil 71b to receive a stronger current than formerly. As soon as the cutter 60 has been moved to touch the roller, the feeler 68a causes the contacts 84 to close, and therefore if now the current flowing through leads 79 is interrupted, coil 72 will receive a stronger and coil 71b a weaker current than those corresponding to the position of the device shown in Fig. 9, and the cutter 60 will therefore be rapidly moved back to its original position, on reaching which it again opens the contacts 84. The self-induction 86 is intended to lessen the fluctuations of magnetic force caused by the fluctuations of the rectified current by shifting the relative phases of the fluctuations of current in coils 71a and 71b. This device can be adjusted so that the time necessary for the cutter to come into contact with the roller be the same as that of its coming out of contact with the roller, and both can be very short, thus ensuring good and suitably rapid transmission, and has the advantage that the mechanical power necessary for removing material from the roller has to be supplied only to a very small extent by the motor rotating the roller during transmission, thus greatly reducing vibrations.

Figures 10 to 13 show details of an apparatus especially suitable for scanning with reflected light, according to usual practice, and for transmitting the design elements from a design carrier bearing only a single design element. In Figure 10 identical reference symbols indicate identical parts with those shown on Fig. 1.

According to the process described in connection with Fig. 1, the design carrier having the shape of an endless band had to be made to exactly or approximately the same peripheral length as the circumference of the roller to be prepared, and therefore, if the peripheral length of the design element to be transmitted was a fraction of the circumferential length of the roller, the design element had to be reproduced on the design carrier in peripheral direction several times in registered succession. In order to obviate this necessity, in the apparatus according to Fig. 10, the gear ratio of the positive drive between the rotating means of the scanning drum and the rotating means of the roller is variable, and can be adjusted so that the scanning drum having a smaller diameter than the roller can be rotated at an angular speed, which is such a whole-numbered multiple of the angular speed of the roller that their peripheral speeds are exactly or substantially equal. With such an arrangement, the design element of the scanned design carrier will be transferred to the roller in peripheral direction as many times in succession, as many revolutions the scanning drum makes during one revolution of the roller, it being understood that the scanning and recording devices be moving in axial direction with identical linear speeds during the transmisston.

It is obvious that this process can also be reversed, driving the roller with a multiple of the angular speed of the scanning drum, if a small roller has to be made from a design carrier bearing the design element several times in peripheral succession.

In the apparatus shown on Fig. 10, the lathe is provided with hollow holders **6***a* and **7***a*, provided with clamping means **6***b* and **7***b*, and the members **6** and **7** supporting the bearings **8** and **9** of the shaft **1**1 are slidably and adjustably mounted in these holders. The brackets **6***c* and **7***c* are provided with the gripping means **6***d* and **7***d*, provided with the clamping means **6***e* and **7***e*, for holding the rod **95**. On this rod the gripping means **96** provided with the clamping means **96***a* are slidably mounted, for holding, by means of the bracket **97**, the bearing **98** of the shaft **99**, rotatably mounted in bearing **99**. The shaft **99** bears the headstock **100**, provided with three gripping means **100***a*, **100***b* and **100***c*, the first- and last-mentioned of these being visible on the drawing. On the end of the shaft **1**1 an exactly alike headstock **94** is mounted, provided with the gripping means **94***a*, **94***b* and **94**c, all of which are shown on Figs. 10 and 12 of the drawing. These headstocks hold and are apt to rotate the special scanning drum **90**, shown also in detail on Figures 11, 12 and 13. The chain wheels **3** and **4** are changeable on the shaft **1**, and in the present example, where the diameter of the scanning drum **90** is one-half of the diameter of the roller A, provide, together with the chain wheels **3***b* and **4***b* and the chains **3***a* and **4***a*, a positive drive, by means of which shaft **1**1 is driven with twice the angular speed of shaft **1** from this latter. Therefore, if the design carrier to be applied to drum **90** bears a single design element, this will be transferred to the roller B twice in peripheral succession, if the design carrier bears a design element twice repeated on it in peripheral succession, this will be transferred to the roller four times in peripheral succession, and so on.

The special scanning drum **90** consists of a hollow metal tube, bearing a longitudinal slit **92**, preferably positioned in the longitudinal groove **91**. The ends of this tube are preferably turned to a smaller diameter, and rings **90***x* shown on the left side of Figure 13 in cross-section and on the right side of the same figure in side view are adapted to be placed on these ends, after the drum has been compressed so as to cause the slit **92** to close. The design carrier is formed to an endless band, the circumference of which corresponds to that of the scanning drum, by pasting, with any suitable adhesive, its ends to the stripe **93** of suitable material, e. g. film or paper, which can take place in the groove **91**. This having been done, the design carrier is slipped in a manner similar to the placing of a phonograph record on its cylinder, onto the scanning drum **90**, with the strip **93** in the groove **92**. Thereafter the rings **90***x* are removed, whereon the drum, owing to the elasticity of its material, tends to regain its former exactly cylindrical shape, thereby tightening the fit of the design carrier B on it to such an extent that no additional fastening is necessary as a rule. If, however, the design carrier should still be loose on the drum, the diameter of the latter can be iscreased by tightening the clamping means of the headstocks **94** and **100**, engaging the internal surface of the drum **90**, to the extent necessary for a tight fit of the design carrier on the drum. If the ends of the design carrier B should not fit exactly to each other, the groove formed between them can be filled out with a suitable plastic, rapidly hardening material like dentists cement, and the connecting lines ensuring the continuity of the design on the design carrier be drawn on this material. Eventually disturbing lines of boundary shown by the ends of the design carrier can be suppressed from transmission by suitable adjustment of the toppling limit of the toppling circuit.

If I wish, according to my invention, with any of the processes and apparatus described above, to manufacture several individual rollers for printing a multicoloured design from an identical, multicoloured design carrier by selectively scanning the samc, I proceed as follows.

I prepare, for example by hand drawing and painting on paper, a design carrier, on which the differently-coloured parts of the design are painted with different colours, preferably of the kind described hereinafter, and not identical with the colours intended to print with the roller. This having been done, I cover all those parts of the design carrier, which are still uncoloured, with solid blaek or other such paint, as will not let through or (in case of scanning with reflected light) reflect light to any appreciable degree. I now scan this design carrier, preferably also previously formed to an endless band, either in a toppling circuit several times in succession, and readjust the toppling limit of said circuit with simultaneous change of the photocell for each scanning, or scan it repeatedly with changes of the light filter interposed in this case between the source of light and the photoelectric means affected by it, preferably also in toppling circuit with the recorder or recorders, or employ more of these steps in combination with each other.

In the case of repeated scannings with the same photoelectric means in toppling circuit, with the same photocell, but changes of the light filter, I use a design carrier, on which the different colours are such ones that the spectrum of each of these contains no such lines, which occur also in another colour, or at least in no appreciable extent, i. e. the spectra of these colours do not overlap to any appreciable extent. Each scanning is made with an interposed colour filter or other means to give a light of suitable wavelength corresponding to the colour just to be scanned, so that when the scanning ray of light falls through or on parts of the design carrier bearing another colour than that I just wish to transmit, or black, the photoelectric means remain unaffected, and therefore by each scanning I transfer only those parts of the design, which are painted with the colour I just wish to transmit, thus successively producing the different individual rollers of the set. Owing to the different sensibility of the photocell I preferably adjust the toppling limit of the circuit for each scanning to suit the individual requirements of that scanning. Although I may vary the wavelength and/or spectral width, i. e. the range of wavelengths contained in the spectrum of the light used within wide limits ranging, for example, from monochromatic to white, the expression "light" designating in this specification and claims any radiation able to affect photoelectric means, I prefer to use visible light of a wavelength of about 4200 to 7000 Angström, and colour filters giving a light, the spectrum of which has a width of about 100 to 500 Angströms generally.

I wish to point out that although I have de-

scribed by process in connection with scanning a design carrier in the shape of an endless band, my invention is not limited to this way of proceeding, as I may attain the registering of the design element also on other ways, such as, for example, scanning a design carrier covering only one-half of the circumference (180 central geometrical degrees) of the scanning drum with two scanning devices diametrally opposite to each other on different sides of the scanning drum, thus with each of these scanning the same drum along two of its generatrices opposite to each other, and therefore also distant from each other on the circumference of the drum with 180 geometrical degrees, both of these devices controlling the same recording device or devices alternatively in succession.

Also, various other changes may be made in the details disclosed in the foregoing specification without departing from the invention or sacrificing the advantages thereof.

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