May 22, 1962 F. R. BONSCH 3,035,517

ROTARY MACHINES FOR SELECTIVE DUPLICATING OR PRINTING

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Fig. 1a.

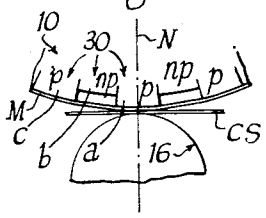

Fig. 1b.

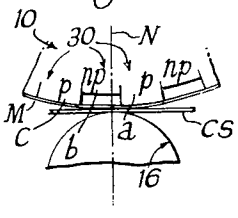

Fig. 1c.

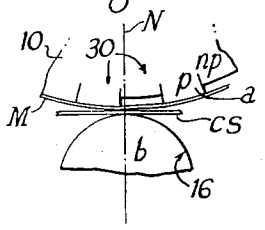

Fig. 2a.

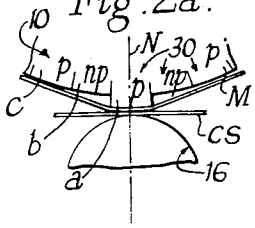

Fig. 2b.

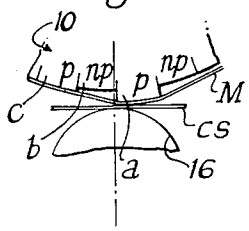

Fig. 2c.

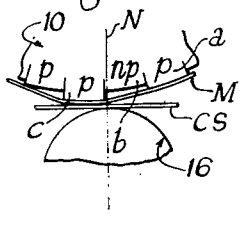

Fig. 3a.

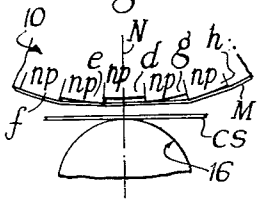

Fig. 3b.

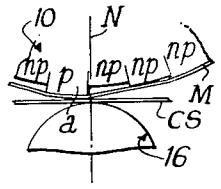

Fig. 3c.

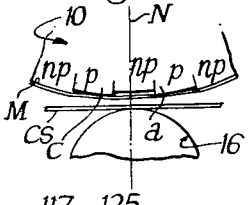

Fig. 8.

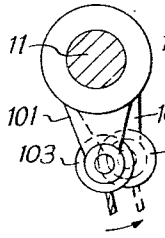

Fig. 9.

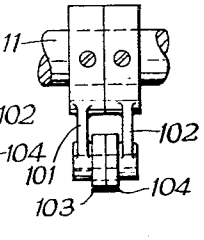

Fig. 11.

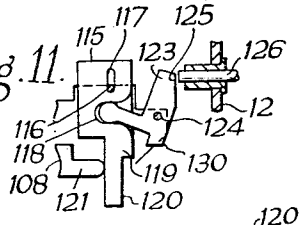

Fig. 12.

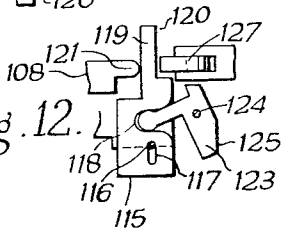

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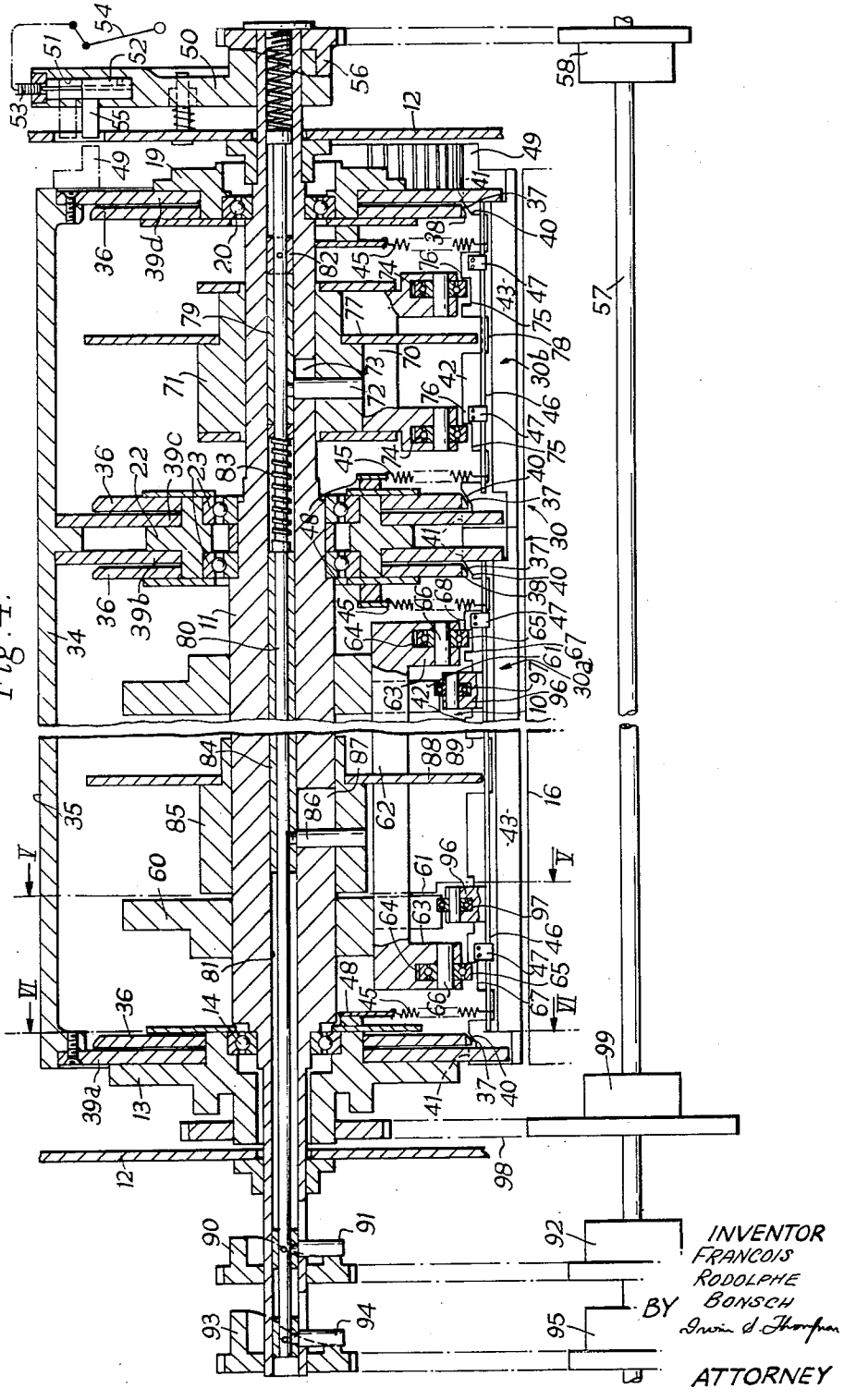
Fig. 4.



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ROTARY MACHINES FOR SELECTIVE DUPLICATING OR PRINTING

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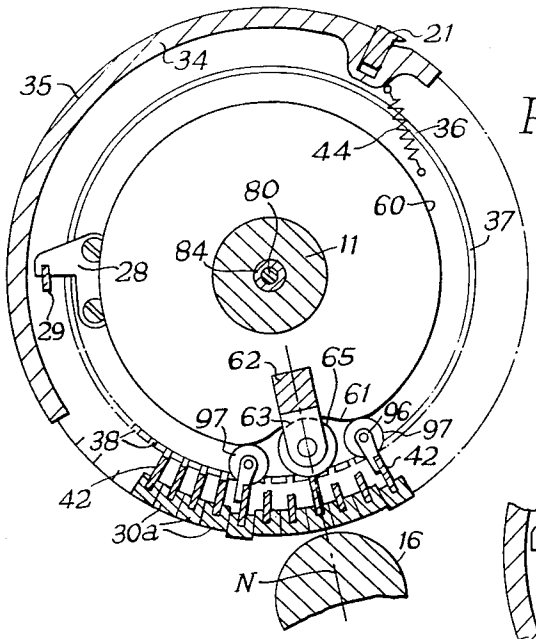

Fig. 5.

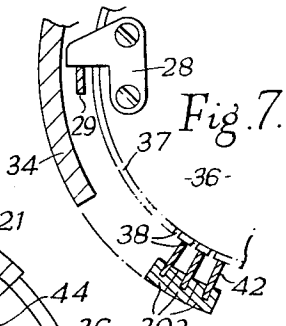

Fig. 7.

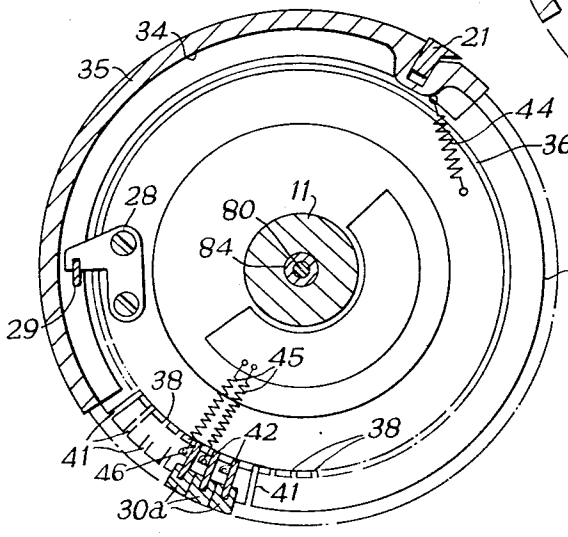

Fig. 6.

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ROTARY MACHINES FOR SELECTIVE DUPLICATING OR PRINTING

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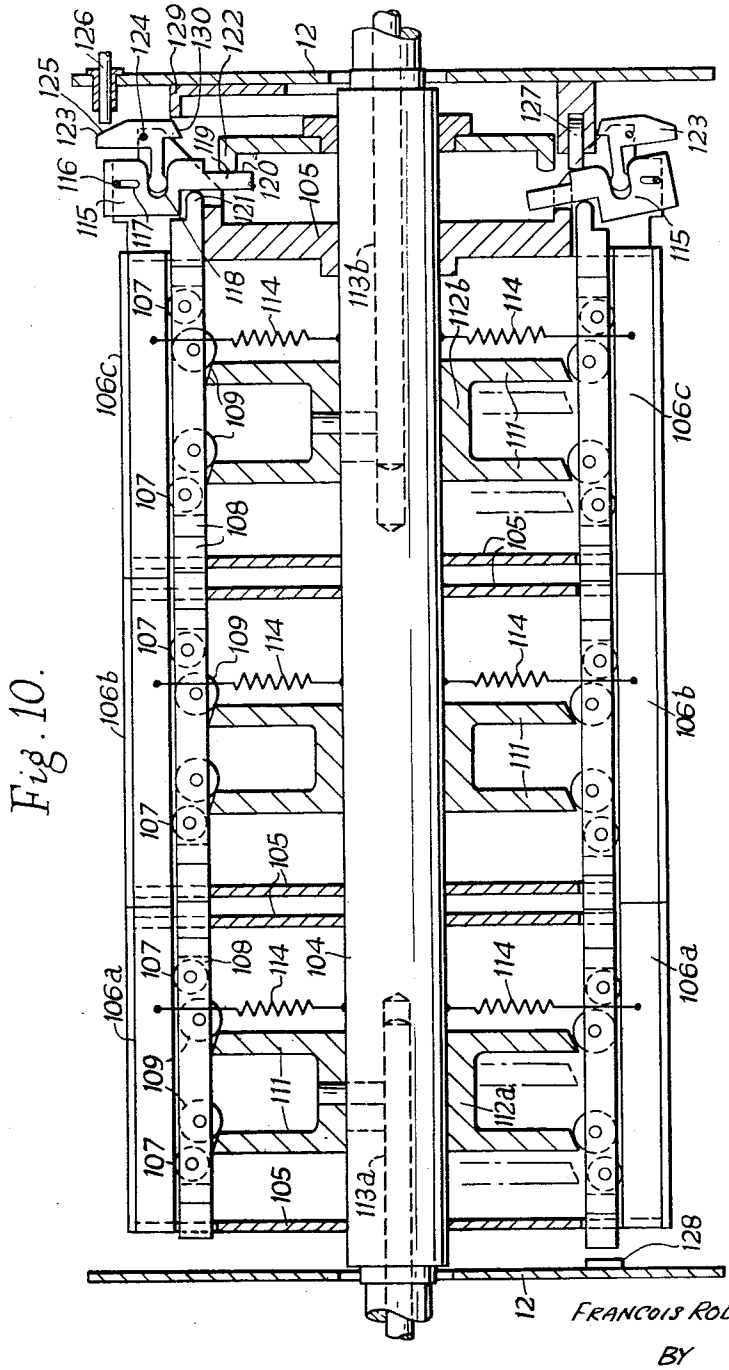

Fig. 10.

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United States Patent Office

3,035,517
Patented May 22, 1962

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ROTARY MACHINES FOR SELECTIVE DUPLICATING OR PRINTING

Francois Rodolphe Bonsch, Paris, France, assignor to Block & Anderson Limited, London, England, a British company

Filed Aug. 18, 1958, Ser. No. 755,763
Claims priority, application Great Britain Aug. 19, 1957
16 Claims. (Cl. 101—132.5)

This invention relates to rotary duplicating and printing machines and is more particularly concerned with machines intended to take copies of selected items from the master image, for instance a hectographic master sheet.

Machines of the type referred to above usually comprise a printing couple including a rotatable printing drum and a parallel counterpressure roller to the nip or bight between which are fed copy sheets. The surface of such copy sheets facing the printing drum is, in the case of a hectographic duplicator, moistened with a solvent for the hectographic ink of the master sheet which is secured by one edge to and is caused to wrap around the surface of the printing drum during rotation thereof.

In order to effect selective printing of one or more items of the master image, it has already been proposed in my co-pending application No. 703,973, filed December 19, 1957, now U.S. Patent No. 2,980,014, to construct a machine with a rotatable printing drum adapted to carry the master image with its lines of text or other equivalent items arranged longitudinally of the drum, i.e., parallel with the drum axis, and to form the working peripheral surface of the drum so that an arcuate region thereof is subdivided into a number of separate segments each of which is individually displaceable, under the control of associated pre-selection means, in a radial direction relative to the drum axis between an operative or printing position, where the segment concerned is capable of setting up the requisite printing pressure upon a copy sheet in the bight between the drum and the counterpressure roller, and an inoperative or non-printing position, which is nearer to the drum axis than said printing position and where the segment is ineffective to exert printing pressure upon the copy sheet when in the aforesaid bight.

In the arrangements described in the aforesaid co-pending application, the pre-selection means operates to set the various segments in their required operative (printing) or inoperative (non-printing) positions before the printing drum commences to rotate to effect a printing operation. A difficulty which arises with such a form of construction in a spirit duplicator or other similar type of machine in which the master image is carried by a flexible member, such as a paper sheet, wrapped around the drum surface, is that due to having certain non-consecutive but closely spaced segments of the drum placed in the operative or printing position. The master sheet, in being stretched tightly between such operative segments over the intervening inoperative segments, may still be at such a radius from the drum axis that it will contact the copy sheet while passing through the printing bight and will cause smudging or offset from the unwanted item or items overlying the inoperative segment or segments. A certain amount of unwanted feeding movement of the copy sheet may also occur.

Another difficulty which can arise with such earlier form of construction is that of misalignment between the items or text lines of the master with the related printing segments, particularly towards the lower or trailing end of the master sheet. As the master sheet is secured to the drum by its leading edge and is drawn tightly around the drum surface while in operation, it will be evident that the positioning of the different items or

text lines of the master must be in accordance with the respective circumferential distances of the related segments from the clip or other means by which the master is held upon the drum. Such circumferential distances however, are not constant but vary according to the particular combination of operative/inoperative setting positions of the preceding segments, being greatest when all the preceding segments are in the printing position and least when all such preceding segments are in the inoperative position.

An object of the present invention is to provide an improved form of construction of a printing or duplicating machine of the general type described in the aforesaid co-pending application by which such difficulties are reduced or overcome.

In accordance with one feature of the present invention the pre-selection means for controlling the setting pattern of the printing segments of the printing drum are arranged to cause the positioning of such segments in their chosen inoperative (non-printing) or operative (printing) positions only while they are each in the immediate vicinity of the printing zone in the bight between the drum and counterpressure roller.

In one particular form of the invention the normal position of each of the printing segments is in said inoperative position and the pre-selection means is arranged to cause each of those segments which are required to be operative to move radially outwards into the printing position as the segment approaches the counterpressure roller and to move radially inwards again as such segment departs from the counterpressure roller.

In a modification of such particular form, for the purpose of ensuring enhanced accuracy of alignment of the text lines or items of the master with their related printing segments over the range of different possible setting combinations of such segments, the normal position of certain predetermined segments at spaced intervals around the drum is arranged to be in the outer or printing position and further control means are provided for causing each of said predetermined segments to move radially inwards into its inoperative position as the segment approaches the counterpressure roller and to move radially outwards again as such segment departs from the counterpressure roller, unless such predetermined segment is one required to be operative in which event the pre-selection means are effective to cause the maintenance of such segment in its operative or printing position while passing through the bight between the drum and counterpressure roller.

In an alternative form of the invention, also directed to ensuring accuracy of registrations under different setting combinations of the printing segments, the normal position of each of the various printing segments is in the outer or printing position and means are provided for causing each segment in turn to move radially inwards into its inoperative position as the segment approaches the counterpressure roller and to move outwards again as such segment departs from the counterpressure roller, the pre-selection means being then arranged to cause each of those segments which are required to effect selective printing to remain in its printing position while passing through the aforesaid printing zone or bight.

A further feature of the invention relates to the provision of means for effecting selective copying of a part only of the selected text line or lines of the master image and for this purpose at least one and preferably each of the printing segments is subdivided with respect to its length into separately movable part-segments which are individually controllable by the pre-selection means.

In order that the above and still further features of the invention may be more readily understood a number of embodiments of the invention will now be described in

some detail by way of illustrative example only and with reference to the accompanying drawings in which:

FIGS 1*a*, 1*b* and 1*c* are diagrams illustrating one of the difficulties which can arise with a machine construction in accordance with the aforesaid co-pending application.

FIGS. 2*a*, 2*b* and 2*c* are further diagrams, similar to FIGS. 1*a*, 1*b* and 1*c*, illustrating the manner of operation of one form of the present invention.

FIGS. 3*a*, 3*b* and 3*c* are further diagrams, also similar to FIGS. 1*a*, 1*b* and 1*c*, illustrating the manner of operation of an alternative form of the present invention.

FIG. 4 is a longitudinal axial sectional view through the printing drum and certain ancillary parts of a rotary hectographic duplicating machine according to one embodiment of the invention.

FIG. 5 is a transverse cross-sectional view taken on the line V—V of FIG. 4.

FIG. 6 is a further transverse cross-sectional view taken on the line VI—VI of FIG. 4.

FIG. 7 is a fragmentary view of part of FIG. 6 showing certain elements in a different operative position.

FIGS. 8 and 9 are fragmentary detail views of a modified arrangement of the segment control rollers.

FIG. 10 is a partly diagrammatic axial sectional view of an alternative form of drum construction according to another embodiment of the invention, while

FIGS. 11 and 12 are fragmentary detail views of parts of the device shown in FIG. 10.

Referring first to FIGS. 1*a*, 1*b* and 1*c*, which illustrate the operation of the known form of machine according to the aforesaid co-pending application, **10** indicates the printing drum and **16** the co-operating counter-pressure roller defining the bight or printing line N at which the master sheet M carrying the master image thereon is, or may be, pressed against the copy sheet CS to effect the desired printing.

The printing drum **10** has part of its peripheral surface divided into segments **30** which can be placed, under the control of associated pre-selection means, either into the operative or printing position as shown by the segments *p* or into the inoperative or non-printing position as shown by the segments *np* before the drum starts to rotate to effect a printing operation. In FIG. 1*a*, the operative segment marked *a* is shown opposite the counterpressure roller **16** to effect printing upon the copy sheet CS of that text line or item of the master M which overlies such segment. Corresponding forward feeding movement of the copy sheet takes place at the same time. The operative segment *a* is followed by an inoperative segment *b* which, in turn, is followed by a further operative segment *c*.

FIG. 1*b* illustrates the position where the first operative segment *a* has just left the printing line N. At this instant, the previous forward feeding movement of the copy sheet CS should cease to await the arrival of the next operative segment *c* while there should not be any contact between the facing surfaces of the master M and the copy sheet CS in order to avoid risk of offset or smudging by the unrequired image line or item on the master overlying the inoperative segment *b* as it passes over the now stationary copy sheet. Due, however, to the relatively close location of the next operative segment *c*, the master is stretched across the gap caused by the inoperative segment *b* and, instead of lying in contact with such segment at a position well clear of possible contact with the copy sheet, is still very close to the copy sheet and may well cause offset or smudging and even produce some undesired forward feed movement of the copy sheet.

As the radial centre line of the inoperative segment *b* approaches the printing line N the master-to-copy sheet spacing tends to increase but a repetition of the unsatisfactory conditions of FIG. 1*b* occurs when the next operative segment *c* approaches the printing line N as shown in FIG. 1*c*.

FIG. 2*a* illustrates the relative positions of the various parts when the arrangements of one embodiment of the invention are in the condition corresponding to FIG. 1*a*. Here the operative segment *a* is, alone, the only segment in its operative or printing position. Both the adjacent inoperative segment *b* and the next following operative segment *c* are in the inoperative or non-printing position. As the operative segment *a* leaves the printing line N, the next operative segment *c* commences to move radially outwards as shown in FIG. 2*b*, so as to reach its outward or printing position just before its leading edge reaches the printing line N as shown in FIG. 2*c*. As may be seen from these figures, the spacing between the master M and the copy sheet CS changes abruptly at the trailing and leading edges of the segments as they leave and enter the printing zone and the previously described risks of offset or smudging and undesired feed movement of the copy sheet are much reduced or even eliminated.

With the arrangements as shown in FIGS. 2*a*, 2*b* and 2*c*, the normal position of all the segments, whether selected for printing or not, is the inward or inoperative position. In some circumstances, with a view more particularly to obtaining maximum possible accuracy of registration of the different text lines or items of the master with their related printing segments under each of the different possible setting combinations of operative/inoperative segments, it is desirable that selected segments or even all segments shall have a normal position which is the outward or printing position at which the effective radius of the segmentally divided part of the drum is equal to that of the undivided part. FIG. 3*a* illustrates the relative positions of successive non-operative segments as they pass the printing line N in the case where all segments normally occupy the operative position. Here segment *d* opposite the counter-pressure roller **16** has been fully withdrawn to its inoperative position while the succeeding segments *e* and *f* are at different stages of their respective withdrawal movements. The immediately preceding segments *g* and *h*, after having been withdrawn like the segment *d* are at different stages of their respective return movements back to the normal outward position. As may be seen, the master M is kept well clear of the copy sheet CS at all times. Any segment pre-selected to be operative in order to effect printing has a further movement superimposed thereon, resembling that of the segments *a* and *c* shown in FIGS. 2*a*, 2*b* and 2*c*. FIG. 3*b* shows how one segment *a*, after commencing its normal withdrawing motion, reverses direction and moves outwardly to arrive at its printing position just prior to its arrival at the printing line N. FIG. 3*c* shows the further position slightly later when such segment *a* has passed the printing line N and the next but one segment *c*, also pre-selected to be operative, is approaching the printing line N. By such an arrangement the circumferential distance from the centre of any segment to the securing point of the master to the drum is kept sensibly constant regardless of the number and relative positions of the segments selected for effecting printing while adequate clearance between the master and the copy sheet under non-printing conditions is maintained at all times.

Referring now to the particular practical embodiment shown, more particularly in FIGS. 4, 5 and 6, it will be understood that the drum formation as illustrated, although more particularly adapted to form part of a largely automatic power-driven machine, may also be used with suitable minor modifications on a hand-operated machine similar to that shown and described in the aforesaid co-pending application. For this reason and in the interest of simplicity, detailed showing and description of the parts has been restricted as far as possible to the parts of the drum itself, the elements

provided for effecting the various control movements and the rotation of the drum by one revolution in each printing cycle being indicated only schematically since they may be of any convenient and known or obvious form.

The drum construction shown generally at **10** employs a stationary rigid axle **11** which is secured at each end in stationary vertical frame plates **12** which may be the normal side plates of the machine. The co-operating counterpressure roller, shown at **16** in FIGS. 5 and 6, is also journalled for rotation between the plates **12** about an axis parallel with that of the drum **10**. This counterpressure roller, which forms a printing couple in conjunction with the drum **10**, is mounted in any well known and convenient manner, such as by spring-loaded support arms whereby the pressure exerted by it upon the parts of the drum surface which are at a radius from the drum axis equal to the operative or printing position of the various segments may be varied, preferably in discrete steps.

At the left hand end of the axle **11** is provided a hub bushing **13** freely rotatable upon the axle by means of a roller bearing **14** while at the opposite right hand end of the axle there is provided a similar hub bushing **19** rotatably mounted by means of roller bearing **20**. An intermediate hub bushing **22** is also provided and is rotatably mounted upon the axle **11** by roller bearings **23**. A pair of generally circular end plates **39***a*, **39***d* are secured respectively to the inner faces of flanges on the hub bushings **13**, **19** while a further pair of similar plates **39***b*, **39***c* are likewise secured one on each side of a flange of the hub bushing **22**. The plates **39***a*, **39***b*, **39***c* and **39***d* are each rigidly secured to an arcuate or part-cylindrical member **34** whose outer peripheral surface **35** constitutes the undivided region of the working surface of the drum. The arcuate extent of this member **34** is conveniently rather less than half the circumference of the drum. In this member is disposed the usual master clamping or securing clip **21** which, with its means for effecting controlled opening and closing thereof, may be of any convenient and known form.

The arcuate peripheral edge regions of the plates **39***a*, **39***b*, **39***c* and **39***d* not covered by the member **34** are provided with a plurality of equi-spaced radial slots **41**, the various slots in the different plates being in axial alignment. Mounted in each pair of aligned slots of the plates **39***a*, **39***b* is the web **42** of a part-segment **30***a* whose enlarged section head portion **43** has a curved outer surface conforming to the radius of the surface **35** of the member **34** when the segments are disposed in their outer operative positions as described later. Each part-segment **30***a* is displaceable both axially and radially within its mounting slots **41**, being retained in position by a pair of associated tension springs **45**, one near each end, which springs are each threaded by one end upon a thin metal rod **46** fixed to one side of the associated web **42** by clamp pieces **47** and secured by their opposite ends to arcuate securing plates **48** fixed respectively to the hub bushings **13** and **22**. A similar series of part-segments **30***b* are provided and mounted within the slots **41** of the plates **39***c* and **39***d*, by a corresponding arrangement of springs **45**, rods **46**, clamp pieces **47** and securing plates **48**. The respective part-segments **30***a*, **30***b* carried in each set of axially aligned slots **41** are themselves in axial alignment and may be regarded as a composite segment **30** subdivided into a major part **30***a* and a minor part **30***b*.

The extreme right hand end of each minor part-segment **30***b* is provided with an outwardly projecting integral nose **49** for the purpose of selecting the segments required to effect printing. On the outside of the adjacent frame plate **12** is mounted an axially slidable but non-rotatable body **50** provided around that part of its periphery which is in alignment with the group of segments **30** when the drum **10** is in its initial or rest position, with a series of radially directed bores or channels **51**, each in radial alignment with a related segment **30**. In each bore **51** is mounted a slidable plunger **52** connected to the inner wire of a Bowden type cable **53** leading to an associated control lever **54**, of which only one is shown, situated on a conveniently located control panel. On such control panel, the group of control levers **54** is mounted, preferably as a vertical bank of levers, at positions which correspond with the actual spacing between successive text lines or items of the master sheet M so that, by securing a full copy of such master immediately adjacent the lever bank, immediate identification of the respective text lines whose selection is controlled by any lever **54** is greatly facilitated.

To each plunger **52** is rigidly secured a laterally projecting interposer lug **55** which is so positioned that when the associated plunger **52** is in its inward location within the bore **51**, the lug lies opposite the related nose **49** whereas when such plunger **52** is moved to its outward position, the associated lug **55** is not in alignment with such nose **49**. Such lugs **55** project through the adjacent side plate **12** by way of suitable slots or other form of clearance aperture. Means, shown schematically as a helical cam **56** arranged for rotation by a constantly rotating drive shaft **57** through a one-revolution trip-clutch **58**, are provided for moving the body **50** first to the left and then back again to the position shown, after the appropriate setting of the control levers **54** has been made. By reason of such movement those part-segments **30***a*, **30***b* which lie opposite the inwardly placed interposer lugs **55** are themselves moved bodily to the left whereas the remaining part-segments **30***a*, **30***b* are left undisturbed. The major part-segment **30***a* in alignment with any shifted minor part-segment **30***b* is also moved to the left by an equal amount due to its right hand end being in abutting contact with the left hand end of the related minor part-segment **30***b*.

Rigidly secured upon the fixed axle **11** within that part of the drum **10** containing the major part-segments **30***a* are two spaced cam discs **60** having a circular contour except for a valley region **61** whose purpose will be described later. Secured within axially aligned slots in such valley regions **61** is a longitudinally disposed bracket **62** of elongated U-shape. The short end limbs **63** of this bracket extend radially outwards and are directed towards the centre of the co-operating counterpressure roller **16**. Each of these limbs is slotted as shown at **64** to accommodate ball-bearing rollers **65** mounted upon axle pins **66** secured in the limbs **63**.

The web **42** of each major part-segment **30***a* is formed with two notches **67** which, when the part-segment is in the axial position shown, are respectively in circumferential alignment with the rollers **65** whereby such rollers do not engage each web as the drum is rotated. If, however, any part-segment **30***a* is displaced axially to the left, the notches **67** in that segment are moved out of alignment with the rollers which then engage with the adjacent region **68** of the web and, by reason of the greater inward projection of such regions, cause the part-segment to be moved bodily outwards in a radial direction as such regions **68** ride over the rollers **65**. Such movement is accommodated by radial sliding movement of the web within the radial slots **41** in the plates **39***a* and **39***b* against the tension of the springs **45**.

A further generally U-shaped bracket **70** within that part of the drum containing the minor part-segments **30***b* is secured to a collar **71** mounted in a slidable but non-rotatable manner upon the fixed axle **11** by the passage of a securing pin **72** carried thereby through an axially directed slot **73** in the axle **11**. Each end limb of the bracket **70** carries a roller **74** mounted in a manner similar to that of the rollers **65**.

The web **42** of each minor part-segment **30***b* is formed with two notches **75** which, with the part-segments in the axial position shown, align with the rollers **74** whereby

the latter do not engage each web as the drum is rotated. If, however, any minor part-segment is displaced axially to the left, the notches **75** no longer align with the rollers which then engage the adjacent regions **76** of the web and cause outward radial movement of the part-segment **30***b* against the tension of springs **45** in a manner similar to that already described with reference to the major part-segments **30***a*.

Secured to an intermediate shoulder on the collar **71** is a resetting plate **77** which may be of either circular or part-circular shape, its constant-radius part embracing the arc occupied by the group of part-segments **30***b* when the drum **10** is in its initial or starting position. The edge of this resetting plate **77** lies within further notches **78** formed, one in each web **42**, so as not to interfere with normal rotation of the drum during operation. Each notch **78** is of an axial length which permits the requisite axial displacement of the associated part-segment towards the left by the action of the interposer lugs **52** as already described.

The securing pin **72**, after passing through the slot **73**, enters and is secured to a sleeve **79** surrounding an operating rod **80** located within an axial bore **81** through the axle **11**. The right hand end of this sleeve **79** normally abuts against a stop collar **82** fixed to the rod **80**, by the pressure of a helical compression spring **83** held trapped between the left hand end of the sleeve **79** and the right hand end of a further sleeve **84** which surrounds and is secured to the rod **80** within the region of the drum **10** which carries the major part-segments **30***a*.

Between the cam discs **60** a further collar **85** is slidably but non-rotatably mounted upon the axle **11** by the passage of a securing pin **86** in such collar through an axially directed slot **87** in the axle **11** into a tapped hole in the sleeve **84**. Secured to a shoulder on the collar **85** is a second resetting plate **88** similar to the plate **77**. The peripheral edge of this plate is located within further notches **89** formed in the webs **42** of the major part-segments **30***a*, such notches **89** extending somewhat further to the right than the equivalent notches **78** of the minor part-segments **30***b*.

The operating rod **80** extends beyond the left hand end of the axle **11** and is provided, beyond the adjacent side plate **12**, with means for imparting thereto either of two predetermined and different amounts of axial movement to the right.

The first of these means is shown schematically as a rotatable cam plate **90** engaging a radial pin **91** secured to the rod **80**. The cam plate is arranged to be rotated, when desired, through one revolution by its geared interconnection with the constantly rotating drive shaft **57** by way of a one-revolution trip clutch **92**. The axial throw of the cam plate **90** is such that the pin **72** is moved to the right hand end of the slot **73** and then back again. If any minor part-segment **30***b* has been displaced axially to the left prior to this axial movement of the rod **80**, the resultant movement of the resetting plate **77** causes such plate to engage the right hand edge of the notch **78** in the web of the displaced part-segment and thereafter to return the latter to its normal right hand position as shown. With this first, limited, amount of axial movement, the accompanying movement of the resetting plate **88** is insufficient to bring it into contact with any displaced major part-segment **30***a* owing to the greater length of the related notches **89**.

The second means for imparting a greater extent of axial movement to the rod **80** is shown schematically as a second rotatable cam plate **93** engaging a second radial pin **94** secured to the rod **80**. This cam plate is also arranged to be rotated, when desired, through one revolution by its geared interconnection with the drive shaft **57** by way of a one-revolution trip clutch **95**. The throw of this second cam plate **93** is such that the pin **86** is moved to the right hand end of the slot **87** and then back again. The accompanying movement of the resetting plate **88** brings the edge of such plate into engagement with the right hand edge of the notch **89** in any axially displaced major part-segment **30***a* and causes the return movement of such part-segment to the right into its normal position.

Secured to the inner edge of the web **42** of certain predetermined major part-segments **30***a*, for example, every fifth or every sixth segment, are two bifurcated lugs **96** located respectively at positions where small rollers **97** journalled in such lugs **96** can roll around the contoured peripheral surface of the cam discs **60**. The axial width of these peripheral surfaces is such that the rollers **97** remain in contact therewith whether the associated part-segment is axially displaced or not. The radius of the circular part of each of the cam surfaces is such that each part-segment carrying the rollers **97**, i.e. every fifth or every sixth part-segment, is displaced radially outwards into the outer or printing position where the effective radius of the outer surface of the head portion **43** from the drum axis is equal to the radius of the outer surface of the part-cylindrical member **34**, except during that period of each revolution of the drum **10** when the rollers **97** move into the valley **61** of the cam discs. At this point, which coincides with the positioning of the associated part-segment opposite the counterpressure roller **11**, the part-segment moves inwardly into its inner or inoperative position unless it has also been displaced axially by operation of the pre-selection means constituted by the control levers **54** and the interconnected interposer lugs **55**.

Rotation of the drum **10** to effect a printing operation is effected by the means shown schematically as the geared driving connection **98** by way of one-revolution trip-clutch **99** from the constantly rotating drive shaft **57**.

The manner of operation of the parts so far described is as follows. Assume first that all of the part-segments **30***a*, **30***b* are in the normal, right hand position as shown. The majority of the part-segments **30***a* and all of the part-segments **30***b* will lie in their inner or non-printing positions, the only part-segments **30***a* displaced outwardly to the printing position being those provided with rollers **97** resting upon the cam discs **60**. If the drum is now rotated bodily, as by operating the trip clutch **99**, even with a master sheet secured thereto, no printing whatever will take place, since even those part-segments **30***a* which are provided with the rollers **97** will withdraw inwards to the non-printing position as they approach and come opposite the counter-pressure roller **11**. The purpose of maintaining such spaced part-segments in the outer position is to make the effective radius of the drum surface supporting the master substantially equal to that of the undivided part **34** with a view to reducing alignment errors between the text lines or items of the master and the related printing segments under the wide range of possible setting combinations of the latter.

Pre-selection of any one or more printing segments **30** for effecting printing from the related region of the master is effected by operating the associated control lever **54**, while the drum is at rest in its initial position, to the position which moves the interconnected interposer lug **55** radially inwards into alignment with the nose **49** of the minor part **30***b* of the required segment. The required setting pattern having been made by such operation of the control levers **54**, the trip clutch **58** is tripped by an associated control (not shown) whereby the helical cam **56** is rotated once thereby shifting the body **50** to the left and then returning it again to the position shown. As a result of this movement of the body **50**, each of those minor part-segments **30***b* whose noses **49** were opposite the inwardly located interposer lugs **55**, are shifted axially to the left and, with them, the corresponding major part-segments **30***a*.

Such axial movement of the selected printing segments moves the notches **67** and **75** in the webs **42** of these major and minor part-segments **30***a* and **30***b* respectively out of circumferential alignment with the rollers **65** and **74** and brings, instead, the adjacent web regions **68**

and 76 into positions which are in circumferential alignment with such rollers 65 and 74.

If now the drum 10 is caused to rotate through one revolution to effect a printing operation by operating trip clutch 99, those part-segments 30*a*, 30*b* which have been displaced to the left will come into contact, by their respective regions 68 and 76, with the rollers 65 and 74 and will be moved outwardly into the printing position as they each approach the counterpressure roller 16 and will then move inwardly again as they depart from such roller in the manner as already explained with reference to FIGS. 2*a*, 2*b* and 2*c*. Those part-segments 30*a* which are provided with the rollers 97 running upon the cam discs 60 will operate as already described to move inwardly as they approach the counterpressure roller 16 and then outwardly again as they depart from such roller unless any one of them happens to be selected for printing operation by axial displacement to the left. In this case, such part-segment 30*a* operates initially as before, due to the continued engagement of its rollers 97 with the cam discs 60, up to the time when it commences to withdraw inwardly on approaching the counterpressure roller 16. At about this instant its regions 68 engage the rollers 65 and cause it to reverse its direction of radial movement and to move outwardly again into the printing position until after it has passed the counterpressure roller 16. Then, after commencing to move inwardly again, it once more reverses direction, as its rollers 97 again contact the cam discs 60, and moves outwardly again to its normal, printing position.

If printing of only the left hand parts of the selected text lines or items of the master is required, for instance in the preparation of lists, schedules and the like from a master which is also provided with costing information on the right hand side, the trip clutch 92 is operated before commencing rotation of the drum 10. This causes axial reciprocation of the rod 80 over its lesser throw distance to move the resetting plate 77 to the right and then back again to the position shown. Any minor part-segment 30*b* which was previously displaced to the left by operation of the pre-selection means is now returned to its normal position and as a result the notches 75 in the web of such part-segment again align with the rollers 74 whereby no part-segment 30*b* can move outwardly to the printing position as it nears the counterpressure roller 16. The related major part-segments 30*a* which were displaced during operation of the pre-selection means are left in the displaced position and become operative in turn to effect printing.

To reset all of the part-segments 30*a* and 30*b* back to their normal positions prior to setting up a different combination by the pre-selection means, the trip clutch 95 is operated to produce axial reciprocation of the rod 80 over its greater throw distance. This causes axial movement to the right and then the return of the resetting plates 77 and 88, the movement of the rod 80 in excess of the length of the axial slot 73 being absorbed by the spring 83. As a result of such movement of the resetting plates 77 and 88, all displaced part-segments, both major and minor, are returned to their normal right-hand position as shown by the engagement of the edges of the plates 77, 88 with the right hand sides of the related notches 78 and 89.

It is of considerable operational convenience to be able to convert the drum construction as already described into one resembling a normal undivided drum wherein all of the segments or part-segments are continuously held in their outer or printing position at all times. Such a drum formation is desirable for continuous full-copy printing.

For this purpose the arrangements shown are additionally provided adjacent each plate 39*a*, 39*b*, 39*c* and 39*d* with discs 36 each having a bevelled edge 37 and a series of short radial slots 38 angularly spaced to align, in the normal position of such discs, with the webs 42 of the part-segments 30*a*, 30*b*. Adjacent each disc 36, the webs 42 are each provided with a ramp surface 40 conforming to the bevel of the edge 37. Each disc 36 is rotatably mounted upon the adjacent hub bushing 13, 19 and 22 for rocking movement over a small arc approximately equal to half the angle subtended by any part-segment and means are provided for rocking the discs in unison between a normal position as shown in FIG. 6 where the slots 38 are in alignment with the webs 42 and a full-copy position as shown in FIG. 7 where such slots are out of register with the webs and the bevelled edge regions of the discs in between such slots are brought opposite the ramp surfaces 40 of the webs.

The means for effecting rocking movement of the discs 36 comprises an L-shaped abutment plate 28 secured to the edge of each disc at a position within the arc covered by the member 34, and an axially slidable bar 29 mounted in the plates 39*a*, 39*b*, 39*c* and 39*d*, said bar projecting slightly beyond each end of the drum for engagement with movable operating members carried by the stationary parts of the machine when the drum is in its normal or rest position. The bar 29 is provided with a ramp-edged notch opposite each plate 28 and the discs are each urged by a spring 44 to cause the radial edge of each plate 28 to bear upon the edge of the bar 29. When such bar is in one axial position the plates 28 rest within the notches in the bar whereby the discs 36 are positioned as shown in FIG. 6 with their slots 38 in alignment with the webs 42 whereas, by movement of the bar to the opposite axial position, the plates 28 are caused to ride up the ramp surfaces of the notches and rest upon the normal edge of the bar thereby rocking each disc 36 to the position shown in FIG. 7 where the ramp surfaces 40 of the webs lie opposite the bevelled edge regions 37 of the discs.

In the operation of these additional parts, the bar 29 is normally positioned so that the plates 28 rest in the notches of the bar. Under these conditions the discs 36 are inoperative and selective printing can be effected as already described. To convert the drum to the full-copy printing state, the bar 29 is moved axially to rock the discs 36 to the position shown in FIG. 7. All of the control levers 54 are now thrown over to the position which selects each segment for operation. To facilitate this, a separate control lever capable of shifting all of the levers 54 in unison may be provided. The trip clutch 58 is now operated to reciprocate the body 50 whereby each interposer lug 55 engages its related nose 49 and every part-segment 30*a*, 30*b* is shifted to the left. In view of the position of the discs 36, such shift movement produces a compound axial and radially outward movement of each part-segment to its operative or printing position, such segments remaining in this outward position by reason of the flat underside edge of the webs 42 resting upon the narrow truly cylindrical region of each disc 36 adjacent the bevelled region 37. The outer surface of the drum is now effectively equivalent to that of a normal undivided drum and full-copy printing can be effected therewith in the conventional manner. Retraction of the minor part-segments 30*b* alone can be effected when desired by operating trip clutch 92 while retraction of all part-segments can be effected by operating trip clutch 95.

Various modifications may obviously be made in the constructional form of the device without departing from the scope of the invention. For example, if an arrangement resembling that described in connection with FIGS. 3*a*, 3*b* and 3*c* is required, each of the major part-segments 30*a* can be provided with rollers 97 or equivalent cam-follower means. Similarly, if corresponding movement of predetermined spaced minor part-segments 30*b* or even all of the minor segments is required, further means corresponding to the cam discs 60 and rollers 97 may be provided for such minor part-segments.

Means may be provided for controlled circumferential adjustment of the position of the rollers 65 and 74 to allow accurate control of the angular position of outward and inward movement of each selected printing segment. If extended outward displacement of the selected printing segments is required to be maintained over an adjustable

arc of movement of the printing drum a pair of radial arms as shown at 101 and 102 in FIGS. 8 and 9 may be employed instead of the single limb 63 of FIG. 4. Each arm carries a roller 103, 104 and means are provided for fixedly securing the arms to a stationary part, for instance the axle 11, in a manner permitting adjustment of the angular relationship of the arms to each other as well as their joint relationship to the counterpressure roller 16.

Another embodiment of the invention in which the need for axial displacement of the actual printing segments or part-segment is avoided is shown in FIGS. 10, 11 and 12.

In this form of construction the drum is carried upon a rotatable central axis 104 to which are secured, at appropriately spaced positions, a number of guide discs 105 each provided around a part of its circumference with radial slots for receiving and supporting the webs of the various part-segments in a manner generally similar to that already described. In the embodiment shown, each printing segment is subdivided into three equal parts 106*a*, 106*b*, 106*c*. The innermost edge of each part-segment rests upon a pair of rollers 107 mounted at spaced intervals upon an axially directed lifting bar 108 formed as three abutting sections arranged end to end and also supported in the slots of the discs 105. Such bars, which extend from one end of the drum to the other, carry further lifting rollers 109 which project radially inwards for co-operation with ramp surfaces formed by the bevelled edges 110 of a number of spaced discs 111. The two discs 111 associated with the central group of part-segments 106*b* may be rigidly secured to the axle 104 but the two end discs 111 associated with the part-segments 106*a* are secured to a collar 112*a* which is slidable along but rotatable with the axle 104 and is connected to a central operating rod 113*a* slidable in a bore within the axle. This rod is arranged to project from the left hand end of the axle 104 for connection to shift control means (not shown) whereby the discs 111 connected thereto may be placed either in the position shown in full lines or in a position displaced to the left as indicated in chain-dotted lines. The third pair of discs 111 associated with the part-segments 106*c* are similarly secured to a collar 112*b* which is slidable along but rotatable with the axle 104 and whose position can be controlled by means of operating rod 113*b* to place these discs either in the position shown in full lines or shifted leftwards to the position indicated in chain-dotted lines. Springs 114 between the part-segments and the axle 104 maintain such segments in contact with the lifting bars 108 and the latter in contact with the discs 111.

At the right hand end of the drum 10, in the adjacent end guide disc 105, there is provided in alignment with each lifting bar 108 an operating lever 115 disposed in a plane which includes the axis of the axle 104. Each lever 115 is capable of radial movement and pivotal movement about a pin 116 located in a slot 117 of the lever. Each lever 115 is also shaped as shown to provide a substantially axially directed slot 118 in its side edge together with an inwardly directed arm 119 which is reduced in width towards its inner end by the provision of a notched region 120. This arm 119 bears upon the nose end 121 of the associated lifting bar 108 at one side and against a stop member 122 in the form of a flanged disc rigidly secured to the side plate 12 of the machine framework at the other side. A rockable selecting lever 123 is also provided for each lifting bar 108, such lever being of L-shape and pivoted upon a pin 124 carried in an extension of the disc 105. Each lever 123 has an arm thereof directed into engagement with the slot 118 of the adjacent operating lever 115 and another arm directed radially outwards and provided with a striking surface 125.

Arranged around an arcuate region of the side plate 12 in positions which lie opposite each of the respective striking surfaces 125 of the selecting levers 123 when the drum 10 is in its normal or rest position, are a number of axially movable selecting rods 126 connected, as by Bowden cable or other motion-transmitting means, to individual control levers or knobs whereby any desired rod 126 or combination of such rods may be moved first inwardly towards the associated lever 123 and then withdrawn outwardly again.

At a position in the common plane intersecting the respective axes of the drum 10 and the counterpressure roller 16 (not shown) the side plate 12 carries a striking roller 127 so positioned that it will engage and rock any operating lever 115 which is in its inward position but will not engage such lever if it is in its outward position.

The operation of this embodiment is as follows. With the drum 10 stationary in its normal or rest position, the selecting rods 126 associated with the printing segments required to be made operative in order to effect selective printing of chosen line items of the master, are caused each to reciprocate to the left and then return to the right. By such movement, the selecting lever 123 engaged by each operated rod 126 is rocked about its pivot from the normal position as shown in FIG. 11 to that shown in FIG. 10. As a result, the associated operating lever 115 is moved radially inwards.

After setting of the selecting levers 123 and operating levers 115 in this manner, the drum 10 is caused to rotate through one revolution. As any inwardly displaced operating lever 115 approaches the printing position it engages the striking roller 127 and is accordingly rocked about is pivot pin 116 thereby moving the associated lifting bar 108 to the left. The striking roller 127 does not engage any non-displaced operating lever 115 as is shown in FIG. 12. By such axial movement of the lifting bar, the lifting rollers 109 thereon ride up the bevelled edges of the discs 111 and in so doing displace the overlying part-segments 106*a*, 106*b* and 106*c* radially outwards to the printing position. After passing the striking roller 127 the lifting bars are returned to the right either by spring means (not shown) or by the positive engagement of the left hand end of the bar with a ramped abutment 128 secured on the opposite side plate 12.

If restriction of the printing width is desired either or both of the circumferential groups of part-segments 106*a*, 106*c* may be disabled by moving the discs 111 associated therewith to the left-shifted position by means of the operating rods 113*a*, 113*b*. When thus displaced, the bevelled edges of the discs 111 are out of range of the related lifting rollers 109. Resetting of the displaced selecting levers 123 and, hence, of the associated operating levers 115, is effected by momentary inward axial movement of an axially movable reset plate 129 which engages the tail end 130 of each displaced lever 123.

Although the embodiments specifically described relate to spirit type duplicating machines and wherein the arcuate width of each displaceable segment is made equal to the normal line spacing distance of the master, it will be evident that the same general principles are applicable to various other forms of printing and duplicating machines such as offset type printing machines.

I claim:

1. A rotary duplicating or printing machine which includes a rotatable printing drum arranged to carry the master image with its text lines or other similar items disposed so as to be parallel with the axis of the drum, said printing drum having the arcuate region thereof which underlies said master image subdivided into a plurality of separate segments of equal circumferential width and each of which is individually displaceable in a radial direction between an outward operative printing position and an inward inoperative position which is nearer to the drum axis than said printing position, a co-operating counterpressure roller parallel with said drum and preselection means for effecting the individual positioning of each of said segments in either its operative printing position or its inoperative non-printing position in accordance with the required pattern of item selection from

the master image characterised in that said preselection means include timed segment-shift means imparting radial movement to said printing segments successively in timed relationship to the rotation of said printing drum whereby each of those segments selected to effect printing of the related text line item of the master image is moved to reach said outward operative position immediately before it reaches the printing zone opposite said counter pressure roller and is moved to depart from said printing position immediately after it leaves such printing zone.

2. A rotary duplicating or printing machine in accordance with claim 1 in which the normal position of every one of said printing segments is in said inoperative position and in which said pre-selection means is arranged to cause each of those segments which are selected to be operative for printing to move radially outwards from such inoperative position to such printing position as the segment approaches the counterpressure roller and to move radially inwards again to said inoperative position as such segment departs from the counterpressure roller.

3. A rotary duplicating or printing machine according to claim 1 in which at least one of said printing segments is subdivided with respect to its length into separately movable part-segments, said part-segments being individually controllable by said preselection means.

4. A rotary duplicating or printing machine according to claim 1 in which said segment-shift means comprises one or more fixed position abutments within the drum and directed towards the counterpressure roller and co-operating abutment surfaces on each printing segment and in which said preselection means includes axial shift means for causing axial displacement of said segment whereby said abutment surfaces either register with or do not register with said fixed position abutments during rotation of the printing drum.

5. A rotary duplicating or printing machine according to claim 4 wherein said fixed position abutments comprise a pair of spaced rollers for each series of segments and wherein said co-operating abutment surfaces comprise inwardly directed webs on said segments, said webs being provided with notched regions which may be moved into or out of register with said rollers by axial movement of chosen segments.

6. A rotary duplicating or printing machine according to claim 1 in which said printing segments are mounted for purely radial movement with respect to the printing drum and in which said pre-selection means comprises an individual lifting bar beneath each segment, said lifting bar being mounted for both axial and radial movement with respect to the drum, a plurality of cam-surfaced members within the drum and rotatable therewith and abutment surfaces on each of said lifting bars for co-operation with said cam surfaces to cause outward displacement of a segment by axial movement in one direction of the associated lifting bar and inward return displacement of such segment by return axial movement of such lifting bar.

7. A rotary, duplicating or printing machine in accordance with claim 6 having each printing segment divided into at least two part-segments in which the cam-surfaced members associated with at least one circumferential group of part-segments are arranged to be movable axially to a position free from possible engagement by the abutment surfaces on said lifting bars in order to disable such group of part-segments.

8. A rotary duplicating or printing machine as claimed in claim 4 in which the means for effecting axial displacement of selected printing segments or lifting bars comprises a series of two-position interposer members, one for each segment or lifting bar, and individual manual control means for setting each of said interposer members into or out of a position where it is effective to transmit movement from a common operating member to the related segment or lifting bar.

9. A rotary duplicating or printing machine as claimed in claim 1 which includes means for positioning all of the displaceable segments or part-segments continuously in the outward operative position to convert the drum to an equivalent of a normal constant-radius printing drum.

10. A rotary duplicating or printing machine which includes a rotatable printing drum arranged to carry a master image thereon with its text lines or other similar items disposed so as to be parallel with the axis of the drum, said printing drum having an arcuate region thereof which underlies said master image subdivided into a plurality of separate segments of equal circumferential width and each of which is individually displaceable in a radial direction between an outward printing position and an inward non-printing position which is nearer to the drum axis than said printing position, a co-operating counterpressure roller parallel with said drum and preselection means for effecting the individual positioning of each of said segments in either its outward printing position or its inward inoperative position in accordance with the required pattern of item selection from said master image characterised in that, firstly, the normal position of certain predetermined ones of said segments located at spaced intervals around the drum is that of said outward printing position whereas the normal position of the remaining segments intermediate said predetermined spaced segments is that of said inward inoperative position, secondly, by the provision of timed control segment retracting means for causing each of said predetermined spaced segments to move radially inwards from its normal outward position to the inward inoperative position as each such segment approaches the printing zone between said drum and said counterpressure roller and to move radially outwards again to its normal outward position as such segment departs from said printing zone and, thirdly, said preselection means include timed segment shift means arranged to cause each of those segments which are selected to be operative to effect printing to be moved into said outward operative position in turn as they each approach the immediate vicinity of said printing zone and to be withdrawn again in turn immediately they leave such printing zone, said preselection means overriding said timed control segment retracting means in respect of any of said predetermined spaced segments which are selected to effect printing.

11. A rotary duplicating or printing machine which includes a rotatable printing drum arranged to carry a master image thereon with its text lines or other similar items disposed so as to be parallel with the axis of the drum, said printing drum having an arcuate region thereof which underlies said master image subdivided into a plurality of separate segments of equal circumferential width and each of which is individually displaceable in a radial direction between an outward printing position and an inward non-printing position which is nearer to the drum axis than said printing position, a co-operating counterpressure roller parallel with said drum and preselection means for effecting the individual positioning of each of said segments in either its outward printing position or its inward inoperative position in accordance with the required pattern of item selection from said master image characterised in that, firstly, the normal position of each of said plurality of separate segments is that of said outward printing position, secondly, by the provision of timed control segment retracting means for causing each segment in turn to move radially inwards from its normal outward position to its inward inoperative position as such segment approaches the printing zone between said drum and said counterpressure roller and to move outwards again to said outward position as such segment departs from said printing zone and, thirdly, said preselection means includes timed control segment shift means arranged to cause each of those segments which are selected to effect printing to reverse its inward movement as it approaches said printing zone and to re-

turn to its outward printing position while passing through said printing zone.

12. A rotary duplicating or printing machine according to claim 10 in which said timed control segment retracting means comprises a stationary cam surface within said drum and cam follower means on each of said predetermined spaced segments, said cam follower means engaging said cam surface to control the radial movement of said predetermined segments except when overriden by said preselection means.

13. A rotary duplicating or printing machine according to claim 11 in which said timed control segment retracting means comprises a stationary cam surface within said drum and cam follower means on each of said predetermined spaced segments, said cam follower means engaging said cam surface to control the radial movement of said predetermined segments except when overriden by said preselection means.

14. For a hectographic duplicating or like printing machine, a rotatable printing drum which includes a first solid part-cylindrical peripheral wall part having a constant radius from the drum axis and a second part-cylindrical peripheral wall part extending between opposite ends of said first wall part and comprising a plurality of separate axially directed printing segments of equal circumferential width, sheet clamping means in said first wall part for retaining the forward edge of an image-bearing master sheet to be disposed around and supported by said second wall part of said printing drum, a radially disposed web portion extending inwardly from each of said separate printing segments, axially spaced radially slotted guide plates rotatable with said printing drum for supporting said web portions of said printing segments in a manner permitting both axial and radial displacement thereof, gapped regions in the inward facing edge of each of said web portions at axially spaced positions thereof, fixed position abutment surfaces within said drum at positions in alignment with said gapped regions, spring means associated with each of said printing segments for urging said printing segments inwardly to a position where their respective peripheral outer surfaces are at a radius from the axis of said drum less than that of said first wall part, and means for effecting axial displacement of any chosen one of said printing segments to bring said gapped regions out of alignment with said abutment surfaces thereby to move the associated web portion and its attached printing segment radially outwards to a position where the outwardly facing peripheral surface of said printing segment lies at a radius from the drum axis equal to said first wall part.

15. For a hectographic duplicating or like printing machine, a rotatable printing drum which includes a first solid part-cylindrical peripheral wall part having a constant radius from the drum axis and a second part-cylindrical peripheral wall part extending between opposite ends of said first wall part and comprising a plurality of separate axially directed printing segments of equal circumferential width, sheet clamping means in said first wall part for retaining the forward edge of an image-bearing master sheet to be disposed around and supported by said second wall part of said printing drum, a radially disposed inwardly directed web portion extending inwardly from each of said separate printing segments, axially spaced radially slotted guide plates rotatable with said printing drum for supporting said web portions of said printing segments in a manner permitting both axial and radial displacement thereof, a plurality of notches in each of said web portions at axially spaced positions therein, a plurality of fixed position abutment members within said drum in alignment with said notches, a plurality of fixed position cam discs each having a single depressed cam surface region also located within said drum, cam follower rollers in axial alignment with said cam discs on predetermined spaced apart ones of said printing segments spring means associated with each of said printing segments for urging said printing segments inwardly to a position where their respective peripheral outer surfaces are at a radius from the axis of said drum less than that of said first wall part, and means for effecting axial displacement of any chosen one of said printing segments to place said notches in the web portion thereof out of alignment with said opposing abutment members thereby to move the associated web portion and its attached printing segment radially outwards to a position where the outwardly facing peripheral surface of said printing segment lies at a radius from the drum axis equal to said first wall part.

16. For a hectographic duplicating or like printing machine, a rotatable printing drum which includes a first solid part-cylindrical peripheral wall part having a constant radius from the drum axis and a second part-cylindrical peripheral wall part extending between opposite ends of said first wall part and comprising a plurality of separate axially directed printing segments of equal circumferential width, sheet clamping means in said first wall part for retaining the forward edge of an image-bearing master sheet to be disposed around and supported by said second wall part of said printing drum, a radially disposed web portion extending inwardly from each of said separate printing segments, axially spaced radially slotted guide plates rotatable with said printing drum for supporting said web portions of said printing segments in a manner permitting both axial and radial displacement thereof, a plurality of fixed position cam discs each having a single depressed cam surface region located within said drum, cam follower rollers in axial alignment with said cam discs on each of said printing segments, said rollers engaging said cam surfaces of said discs to maintain said segments in an outward position where the peripheral surface thereof lies at a radius from the drum axis equal to said first wall part except when passing said depressed region, a plurality of notches in each of said web portions at axially spaced positions thereof, a plurality of fixed position abutment members within said drum in alignment with said notches, spring means associated with each of said printing segments for urging said printing segments inwardly towards a position where their respective peripheral outer surfaces are at a radius from the axis of said drum less than that of said first wall part, and means for effecting axial displacement of any chosen plurality of said printing segments to bring said notches in the web portions of such displaced segments out of alignment with said abutment surfaces thereby to prevent inward movement of each of said chosen plurality of printing segments when the cam follower rollers thereon pass said depressed regions of said cam discs.

References Cited in the file of this patent

UNITED STATES PATENTS

469,931	Briggs	Mar. 1, 1892
867,868	Beals	Oct. 8, 1907
1,196,729	Barroll	Aug. 29, 1916
1,744,770	Jahn	Jan. 28, 1930
2,012,670	Mack	Aug. 27, 1935
2,421,823	Allen et al.	June 10, 1947