Nov. 11, 1952 M. AUDIER ET AL 2,617,593

COUNTING AND GROUPING DEVICE

Filed Feb. 12, 1945 3 Sheets-Sheet 1

Fig. 1

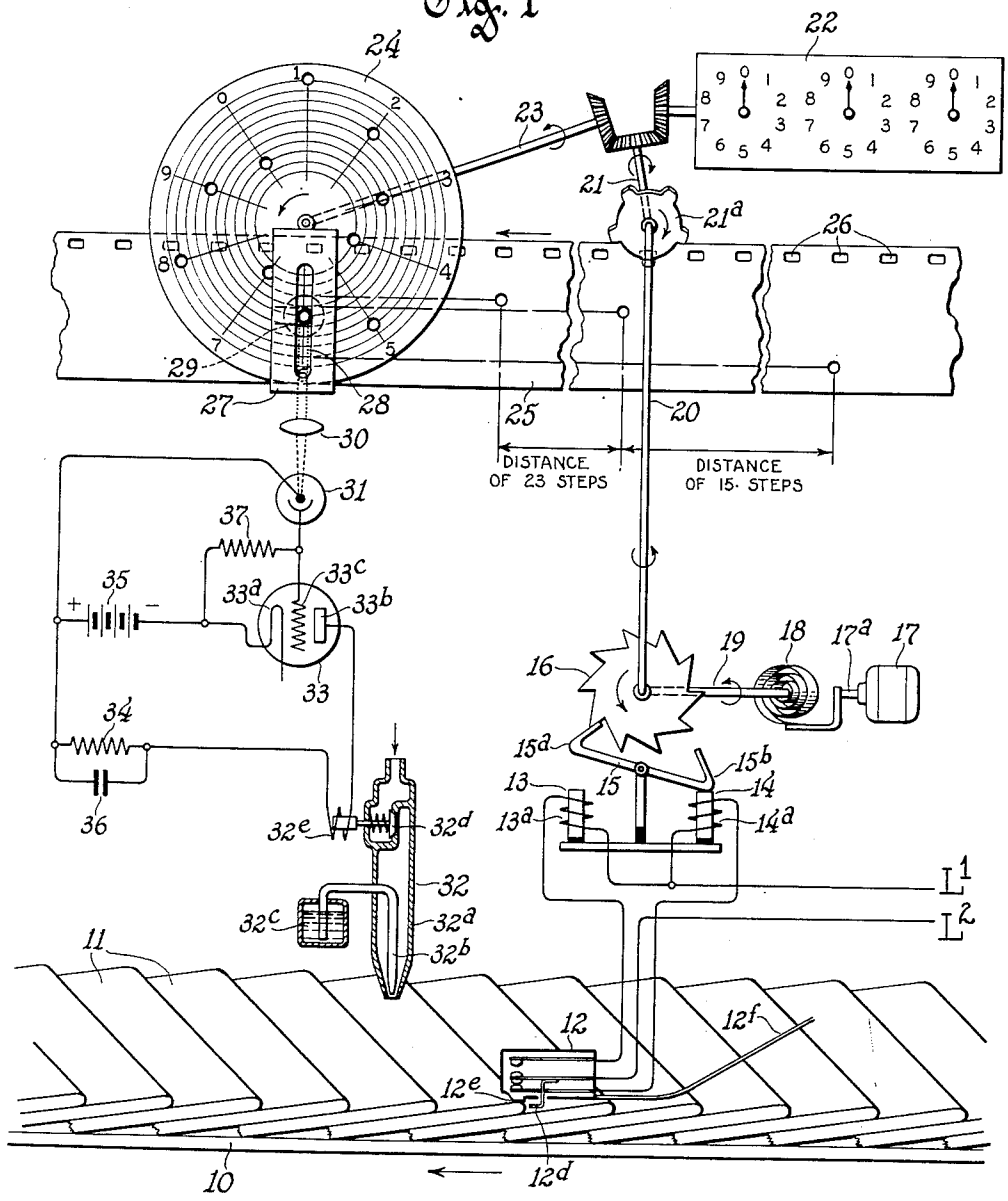

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Fig. 2

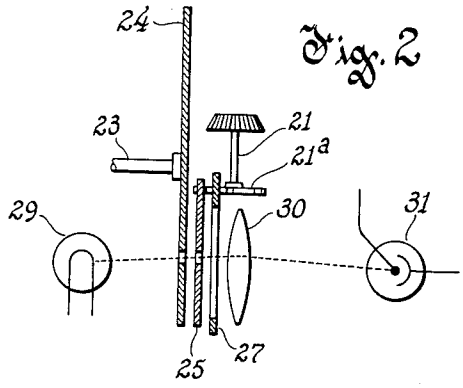


Fig. 3

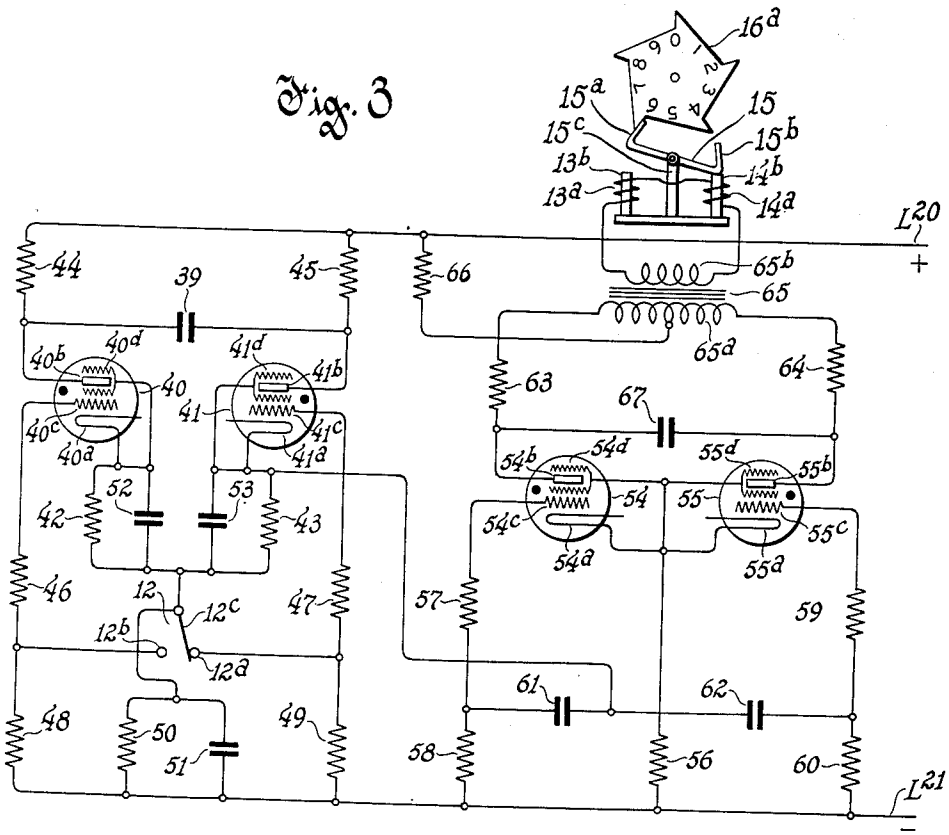
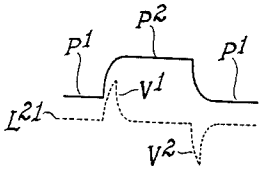


Fig. 4



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COUNTING AND GROUPING DEVICE

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Fig. 5

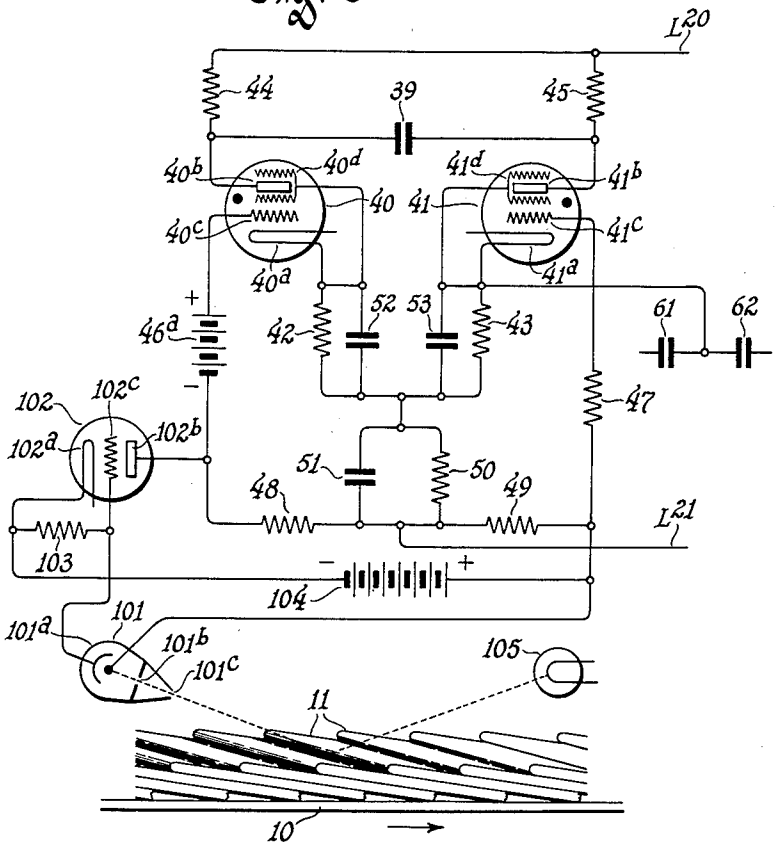


Fig. 6

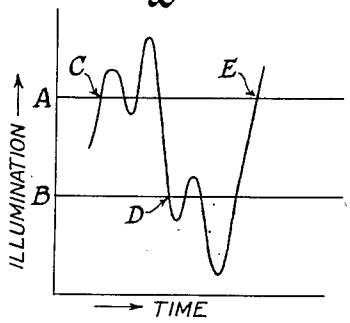
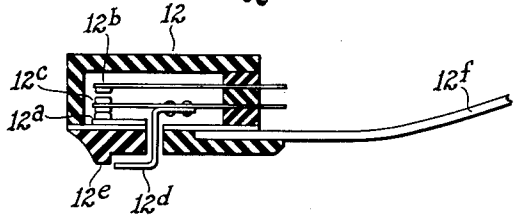


Fig. 7



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UNITED STATES PATENT OFFICE

2,617,593

COUNTING AND GROUPING DEVICE

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Application February 12, 1945, Serial No. 577,481

3 Claims. (Cl. 235—132)

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The invention relates to improvements in counting and grouping devices, and, while not limited thereto, is particularly applicable to the counting and grouping of newspapers as they are carried on a belt conveyor from the press to a receiving station.

In the production of newspapers, it is customary to provide a counter for totalizing the papers produced by the press adjacent to the belt which carries the folded newspapers to a delivery station. The counter is customarily actuated by a lever or the like so that upon the passage of a paper the lever is oscillated to move the counter forward by one number. It has also been proposed to connect with said counter, a device which is actuated each time a certain desired number of papers has passed the counter to displace the last of said number of papers, so that the total number of papers between two displaced papers represents a standard lot of, say, twenty-five or fifty papers, which may then be taken off the belt at the receiving station to be bundled into standard packages.

Newspapers are delivered to various distributors in individual bundles, each bundle containing a different number of newspapers, depending upon the requirement of the respective distributor. To expedite the delivery of papers and to reduce the amount of work of preparing them for shipment, it is desirable to provide means which automatically group the desired number of papers for the respective bundles, and an object of the present invention is to provide means for such grouping.

The devices, which have been used heretofore for counting the total number of papers produced, are inaccurate because their time of response is too great in relation to the speed with which the papers pass by the counting device. Hence the speed of the press and the speed of delivery of papers from the press had often to be limited by the speed of registration of the available counting devices.

An object of the present invention is to provide for a greatly increased speed of response of the counting device, so that the press and the delivery belt can be operated at their maximum speed without affecting the accuracy of the paper count.

The accompanying drawing is illustrative of certain embodiments of the invention.

In the drawing,

Figure 1 represents diagrammatically a counting device incorporating the invention, while

Fig. 2 is a detail of certain parts of Fig. 1.

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Fig. 3 is a modification of certain parts of the system shown in Fig. 1.

Fig. 4 is a diagram of certain voltage variations in the system illustrated in Fig. 3.

Fig. 5 is a modification of the systems shown in Figs. 1 to 3.

Fig. 6 is a graph of the action of the system in Fig. 5.

Fig. 7 is a detail drawing of the control switch for the system shown in Figs. 1 to 3.

Referring to Figs. 1, 2 and 7, the same illustrate a conveyor belt 10 of any suitable conventional type which moves in the direction of the arrow and on which a series of folded newspapers 11, are disposed in shiplap fashion, so that they move with the belt with the fold trailing the body of the paper. Above the belt, so as to clear the passing papers, is arranged a single-pole, double-throw switch 12, which is shown in detail in Fig. 7.

As shown in Fig. 7, the switch 12 comprises a housing in which are insulatedly mounted a lower stationary contact 12^a, a yieldingly supported upper stationary contact 12^b, and an intermediate movable contact 12^c, which is biased to engage the contact 12^a. The movable contact 12^c is provided with a contact shoe 12^d, which projects outside of the casing. The casing is provided at its forward end with a downward projection 12^e of such length, that normally the shoe 12^d extends slightly below the projection 12^e. The switch as a whole is supported on the frame of the conveyor by a leaf spring 12^f, which normally forces the shoe 12^d and the projection 12^e into contact with the papers passing thereunder in such a way that the contact 12^c engages upper contact 12^b. At the moment when the trailing edge of a newspaper leaves the shoe 12^d, while the projection 12^e is still in contact with said edge, the shoe 12^d moves downwardly, thereby causing contact 12^c to disengage contact 12^b and engage contact 12^a, as shown in detail in Fig. 7. A moment later the projection 12^e also drops down on the next paper, thereby causing disengagement of contact 12^c from contact 12^a and engagement of the former with contact 12^b.

The switch 12 controls the current supplied from a suitable source L^1, L^2 to a pair of electromagnets 13 and 14, having energizing windings 13^a and 14^a, respectively. Each one of the electromagnets 13 and 14 is arranged adjacent to an arm 15^a, and 15^b, respectively, of a double ended pawl 15, which is mounted in cooperative relation to a ratchet wheel 16. The ratchet wheel

is provided with ten teeth and the arrangement is such that for each complete oscillation of the ratchet 15, the ratchet wheel rotates through an angle equivalent to the distance between successive teeth in a counter-clockwise direction. The ratchet wheel 16 is driven by a torque motor 17 of any suitable type through a tension spring 18, one end of which is connected to the shaft 17a of the torque motor, while the other end is connected to the shaft 19 of the ratchet wheel 16. When the ratchet wheel is standing still the spring 18 is tensioned in accordance with the maximum torque exerted by the motor 17, and when the wheel is released upon oscillation of the ratchet 15, the spring 18 causes a quicker oscillation and movement of the ratchet wheel to its new position. The introduction of the spring between the motor and the ratchet wheel 16, greatly reduces the time lag which otherwise would be high on account of the inertia of the rotating part of the torque motor 17. Coupled to the shaft 19 in any suitable manner so as to rotate in synchronism therewith and at the same speed, is a shaft 20 which has attached thereto a cogwheel 21a, provided with five equidistant cogs in its circumference. The shaft 20 is further provided with an extension 21, which through a suitable positive gearing drives a conventional counting device 22, provided with a number of dials. One revolution of the pointer of the right-hand dial corresponds to ten revolutions of the ratchet wheel 16; the pointer of the center dial makes one revolution for every one hundred revolutions of said wheel 16, etc. There is also connected to the shaft 21, by gearing or in any other suitable manner, a shaft 23 which rotates at the same speed as the shaft 20. The shaft 23 carries a disc 24 of sheet metal or other opaque material and is provided with ten holes numbered 1 to 9 and 0, the holes being arranged around the disc at equal angular intervals from each other in the natural order, 1 to 9, followed by 0, and at distances from the center decreasing in equal decrements in the following order: 1, 8, 5, 2, 9, 6, 3, 0, 7 and 4.

Arranged in parallel with and adjacent to the disc 24 is a strip 25 of opaque material. This strip is of a width somewhat greater than the radial distance between the holes 1 and 4 on the disc 24 and its one edge is provided with a series of holes 26. The cogwheel 21a is mounted adjacent to the strip 25, so that the cogs successively engage the successive holes 26 of the strip to move the latter in the direction of the arrow. Thus when the ratchet wheel 16 rotates through an angle corresponding to one tooth, the strip 25 moves one-half of the distance between holes 26.

On the side of the disc 24 opposite to that on which the strip 25 is mounted is a mask 27 of opaque material. This mask is provided with a narrow slot 28, of a width slightly larger than the diameter of the holes in the disc 24. A light source 29 (see Fig. 2) is mounted opposite to the mask 27, so that light rays from the source 29 may pass through the slot 28 and through any hole in the disc which may be in alignment with the slot. The strip 25 is provided with holes so located that they selectively are in alignment with corresponding holes in the disc 24, when the respective hole in the strip is in the common plane of the slot 28 and the light source. Opposite the side of the strip 25 is mounted a condensing lens 30 (see Fig. 2), so arranged that when a hole in the disc 24 matches with a hole in the strip 25, a light ray from the source 29 impinges upon the lens 30 which focuses said ray upon a photoelectric tube 31, to thereby vary its illumination with a resulting variation of its impedance.

Adjacent to the conveyor belt 10 and in substantial transverse alignment with the switch 12 is mounted a spraygun 32, which is adapted when actuated to spray a small quantity of a colored liquid on one of the passing papers. As illustrated in the drawing, the spraygun comprises an outer conduit 32a, and an inner conduit 32b. The ends of the two conduits are concentric and in close proximity to each other to form a nozzle. The inner conduit is connected to a suitable liquid container 32c, while the outer container is connected to a suitable source of compressed air, and the admission of such air is controlled by a normally closed valve 32d, which in turn is actuated by an electromagnetic winding 32e. When the winding 32e is energized air pressure is admitted to the spraygun. The air issuing from the nozzle produces a partial vacuum which sucks the colored liquid into the air stream with which it mixes to be deposited on the paper.

The illustration of the spraygun is merely diagrammatic, its construction being no part of this invention and any suitable electrically operable means for spraying a colored liquid on the paper or of marking it otherwise may be employed. The winding 32e has one of its terminals connected to the anode 33b, of an electron tube 33, which is also provided with a cathode 33a and a control electrode 33c. The second terminal of the winding 32e is connected through a resistor 34, to the positive terminal of a direct current power supply, such as a storage battery 35. The resistor 34 is paralleled by a condenser 36. The cathode 33a is connected to the negative terminal of the source 35. The control electrode 33c is connected to one terminal of the photoelectric device 31 and is also connected through a resistor 37, to the negative terminal of the source 35. The second terminal of the photoelectric device 31 is connected to the positive terminal of the source 35.

The operation of the spraying device is as follows: When counting is to begin, the hole in the disc 24 and the first hole in the strip 25, corresponding to the numeral 0, are aligned with each other and with the light source 29, and the photoelectric cell 31. Assuming that the counting of newspapers is to start with 0 and that the first bundle should contain twenty-three newspapers, the ribbon 25 is then provided with a hole which as indicated in the drawing will match the hole 0 in the disc when the hole in the ribbon is opposite the slot 28. A second hole is punched in the ribbon which is so located that it will match the hole corresponding to the numeral 3 in the disc, the lateral spacing from the first hole in the ribbon being such that the disc 24 makes 2.3 revolutions between the matching of the first and the second hole. If it is further desired that the second bundle should contain fifteen papers, a third hole in the strip 25 is spaced from the second hole by a distance corresponding to 1.5 revolutions of the disc 24 and a corresponding travel of the strip 25.

When no light from the source 29 impinges upon the photoelectric cell 31, the potential of the control electrode 33c is such that the tube 33 conducts little current so that the coil 32e is not sufficiently energized and the valve 32d is closed and no colored fluid issues from the spraygun 32.

When light impinges upon the photoelectric cell 31 the control electrode 33c becomes more positive thereby rendering the tube 33 more conducting. In the interval during which the photoelectric cell 31 is not illuminated the current flowing through the tube and through the coil 32e, while insufficient to produce a pull which will open the valve 32d, is sufficient to charge the condenser 36 to a minimum potential so that if the impedance of the tube 33 is decreased upon illumination of the photocell 31, the condenser charges at a high rate through coil 32e to pull the valve 32d open, and thereby cause colored fluid to be discharged on the paper. However, as soon as the condenser 36 is fully charged its current rapidly drops to a value which permits the valve 32d to close again, so that the spraygun delivers color fluid only for a very brief interval, the length of the interval being determined by the constants of the circuit already described.

As the magnet 14 is normally energized the ratchet arm 15a is in the position shown, where it makes contact with a tooth of the ratchet wheel 16. The ratchet wheel is thus prevented from rotation. As soon as the paper starts moving past the switch 12, the circuit between the contacts 12a and 12c is broken by the raising of the shoe 12d. This causes deenergization of the magnet 14, resulting in the release of the arm 15b of the ratchet 15. At substantially the same instant the contact 12c engages the contact 12b thereby energizing the magnet 13 to attract the ratchet arm 15a which releases the ratchet wheel from the arm 15a to permit rotation of the wheel and moving the ratchet arm 15b into engagement with a tooth of the ratchet wheel thus permitting the wheel 16 to move one-twentieth of a revolution. As soon as the paper has passed the switch 12, the magnet 13 is again deenergized and the magnet 14 is energized thereby moving the arm 15b out of engagement with a tooth of the ratchet wheel 16 and again moving the arm 15a into the path of another tooth of the ratchet wheel 16, permitting the ratchet wheel to move another one-twentieth of a revolution and thus completing one step of the escapement. As successive papers continue to pass under the switch 12, the ratchet wheel continues to rotate, the driving power being supplied by the torque motor 17 through the spring 18, as has already been described. Rotation of the ratchet wheel 16 causes rotation of the cogwheel 21a, the disc 24 and the counter 22 in synchronism with the ratchet wheel. Rotation of the cogwheel 21a moves the strip 25 with a step by step motion in the direction of the arrow until after twenty-three operations of the switch 12, the ratchet wheel 16 and the cogwheel 21a, the disc 24 has rotated 2.3 revolutions. At that moment the second hole punched in the strip 25 matches the hole corresponding to the numeral 3 in the disc 24 and a ray of light from the source 29 impinges upon the photocelectric cell 31, thereby energizing again the coil 32e to spray colored liquid on the paper which at that moment is under the spray gun 32. Thus the total number of papers from the first to and including the marked paper is twenty-three, and they may be removed together as a bundle. The apparatus continues to function as described until the third hole in the strip 25 matches the hole in the disc 24 corresponding to numeral 8, which occurs after an additional fifteen oscillations of the ratchet 16. Thereupon another paper is marked in the manner described and the bundle of papers between the first and inclusive of the second marked paper is fifteen. Thus by proper punching, the strip 25 may be arranged so that the interval between any two marked papers corresponds to any desired number.

In addition to marking the papers so as to divide them into individual groups, it is also desirable to count the total number of papers delivered. This is accomplished by the counter 22 in the usual manner, as will be obvious.

Fig. 3 is an improvement of the circuit for controlling the solenoids 13 and 14 of Fig. 1 and is especially for extremely high speeds. In the circuit shown in Fig. 1, the contacts of the control switch 12 must carry the entire energizing current for the coils 13a and 14a, and under certain conditions may be subject to considerable arcing. Furthermore, while the movable parts of switch 12 are light they have some inertia and, especially under high speed operating conditions, may be subject to chattering, thus possibly causing inaccuracies in counting. The interval during which the coil 14a is energized depends upon the duration of engagement between the contacts 12a and 12b, and if the speed is high the period of closure of the energizing circuit for the coil 14a may be insufficient. The ratchet must make one complete oscillation for each passing paper.

The diagram (Fig. 3) illustrates a means whereby the operation of the device is improved for high speed installations. Instead of energizing the coils 13a and 14a directly through a circuit, including the contacts of the switch 12b, an amplifying circuit is interposed. The ratchet wheel 16a of Fig. 3 is provided with only 5 teeth, instead of 10, as in Fig. 1.

In this modification the pivot of the ratchet 15 is supported by a permanently magnetized bar 15c, which produces poles of one polarity in the arms 15a and 15b of the ratchet 15, while the cores 13b and 14b are of the opposite polarity. The coils 13a and 14a are so connected that the current flowing therein induces magnetic fields in the cores 13b and 14b which tend to make the two pole faces of the cores of opposite polarity relative to each other. Hence the magnetic flux of one pole face is increased and that of the other is weakened and with a current of suitable magnitude is reversed to the same polarity as that of the associated ratchet arm, with the result that said arm is repulsed, while the other arm is attracted. The effect of each core upon the adjacent ratchet arm reverses with reversal of the current in the coils 13a and 14a. The combined effect of the magnets on the two lever arms greatly increases the power available for oscillating the arm and thereby makes the oscillations of the latter more positive. This permits increasing the speed of operation of the ratchet mechanism shown in Fig. 3 over that obtainable with the mechanism shown in Fig. 1. Direct current is supplied from the lines L^{20} and L^{21}. The system includes a pair of electron tubes 40 and 41 having cathodes 40a and 41a, respectively, anodes 40b and 41b, respectively, control electrodes 40c and 41c, and screen grids 40d and 41d, respectively. The cathodes 40a and 41a are each connected in series with resistors 42 and 43, respectively, to the movable contact 12c of the control switch 12. The anodes 40b and 41b are connected through resistors 44 and 45, respectively, to the positive line L^{20}. A condenser 39 is connected between the anodes 40b and 41b. The control grids 40c and 41c are connected through resistors

46 and 47, respectively, to the stationary contacts 12^b and 12^a, respectively. The contacts 12^b and 12^a are further connected through resistors 48 and 49, respectively, to the negative line L^{21}. The movable contact 12^c is connected through a resistor 50 in parallel with a condenser 51, to the line L^{21}. The resistors 42 and 43 are paralleled by condensers 52 and 53, respectively, while the screen grids 40^d and 41^d are connected to the corresponding cathodes 40^a and 41^a, respectively.

The system also includes a pair of gaseous electron tubes 54 and 55, having cathodes 54^a and 55^a, respectively, anodes 54^b and 55^b, respectively, control grids 54^c and 55^c, respectively, and screen grids 54^d and 55^d, respectively. The cathodes 54^a and 55^a are jointly connected to the screen grids 54^d and 55^d, and are further connected through a resistor 56, to the line L^{21}. The control grid 54^c is connected through two series connected resistors 57 and 58, and the control grid 55^c through similar series connected resistors 59 and 60, to line L^{21}. Connected in series with each other between the common terminal of the resistors 57 and 58, and the common terminal of resistors 59 and 60 are two condensers of like capacity 61 and 62. The common terminal of the condensers 61 and 62 is connected to the cathode 41^a. The anodes 54^b and 55^b are connected in series with resistors 63 and 64, respectively, to the end terminals of the center tapped primary winding 65^a of a transformer 65, which is also provided with a secondary winding 65^b. The center tap of winding 65^a is connected through a limiting resistor 66 to the line L^{20}. The secondary winding 65^b and the windings 13^a and 14^a are connected in series to form a closed loop. Connected between the anodes 54^b and 55^b is a condenser 67.

The system as described thus far operates in the following manner: Referring to Figs. 1 and 3, with the conveyor 10 and the switch 12 in the position shown in Fig. 1, the circuit is closed between the contacts 12^a and 12^c. Under these conditions the grid 41^c has a potential which renders the tube 41 conducting and a current flows from line L^{20}, through resistor 45, the tube 41, resistor 43 through the resistor 50 to line L^{21}. The constants of this circuit are chosen so that the voltage drop across the resistor 50 impresses a potential on the grid 40^d with respect to the cathode 40^a which renders the tube 40 non-conducting. When upon motion of the conveyor 10, circuit between the contacts 12^a and 12^c is broken, and circuit is made between the contacts 12^b and 12^c, the grid 40^c has impressed thereon the potential of the cathode 40^a, which causes the tube 40 to become conducting, and due to the current flowing through said tube a potential drop appears across the resistor 44, which lowers the potential of the anode 40^b to charge the condenser 39 in a manner to also lower the potential of the anode 41^b so as to render the tube 41 non-conducting. The purpose of the capacitors 52 and 53 is to delay decrease of the potential of the associated cathodes long enough to allow the corresponding anode potential to decrease sufficiently so as to extinguish the respective tube.

The operation of this part of the circuit shall be further explained in connection with Fig. 4. The tubes 40 and 41 with the condenser 39 constitute a multi-vibrator circuit. In the past it has been customary to employ the potential variation of the anodes of the tubes to afford a controlling effect. In the present system the varying potential of the cathode is used to produce this controlling effect and the effect can thereby be made much more precise. It will be apparent that when the tube 41 is non-conducting while the tube 40 is conducting the potential of the cathode 41^a is somewhat above that of the bus bar L^{21}. The value of the cathode potential is indicated by P^1 in Fig. 4 and depends upon the voltage drop in the resistors 42 and 50, produced by the current passing through the tube 40. If now the tube 41 becomes suddenly conducting the potential of the cathode 41^a increases to the value P^2, such increase taking place almost instantaneously, the only delay being due to the time necessary to charge the small condenser 53. As long as the potential of the cathode 41^a had the value P^1 the potential of the grid 54^c was that of the bus bar L^{21}. The sudden rise of the potential of the cathode 41^a from P^1 to P^2 impresses a transient charge upon the condenser 61, and the potential of the grid 54^c is correspondingly raised temporarily from that of bus bar L^{21} to a more positive value as indicated by the dotted curve V^1. Thereafter the potential P^2 remains constant for an appreciable period so that the potential of the grid 54^c again drops to that of the bus bar L^{21}. During the next period when the tube 41 again becomes non-conducting and the tube 40 becomes conducting the potential of the cathode 41^a drops again from P^2 to P^1, the change being slightly retarded again by the action of the condenser 53. This causes a negative potential V^2 to be impressed upon the grid 54^c but this negative potential is obviously incapable of effecting the conduction of tube 54. It will thus be seen that by this circuit arrangement a transient potential of a relatively high peak value and unilateral polarity is impressed upon the tubes 54 and 55 resulting in a very precise and positive control of said tubes.

The potential change of the cathode 41^a due to the alternate conduction and non-conduction of the tube 41 is thus impressed, as aforedescribed, upon the control grids 54^c and 55^c through the capacitors 61 and 62, respectively. Assuming that the tube 54 is conducting, it is apparent that its grid 54^c is biased negatively by a voltage which is equal to the drop through the resistor 56. When the tube 41 becomes conducting the positive potential of the cathode 41^a increases by an amount which is equal to the drop across the resistor 43. As the cathode 41^a becomes more positive it also makes the grids 54^c and 55^c more positive. As long as the tube 54 is conducting it is not affected by this increase, but as the tube 55 is non-conducting this increase in its grid potential causes the tube to become conducting. Similarly if the tube 55 is conducting, an increase in the potential of the grid 54^c causes the tube 54 to become conducting which in turn through the action of the condenser 67, in a well known manner, extinguishes the tube 55. The alternate conduction of the tubes 54 and 55 causes pulses of current to flow alternately through the two halves of the winding 65^a and this current induces an alternating current in the winding 65^b which flows alternately and in opposite directions through the coils 13^a and 14^a. As the magnetic system operating the ratchet 15 is polarized the alternating current flowing in the coils 13^a and 14^a causes the ratchet to oscillate alternately from one position to the other upon each current

pulse in the winding 65b, thus permitting the ratchet wheel 16a to advance upon each pulse one-half of the tooth pitch. The frequency of oscillations of the ratchet is thus one-half of that shown in Fig. 1. The operation of the balance of the system is the same as described heretofore in connection with Figs. 1 and 2.

Fig. 5 shows a modification of the system illustrated in Fig. 3, only such elements being shown as are necessary for an understanding of the changes required. The resistor 46 of Fig. 3 is replaced by a biasing battery 46a, having its positive terminal connected to the control electrode 40c. Furthermore, the control switch 12 is eliminated and is replaced by a photoelectric cell 101. The photocell 101 has its positive pole connected to the common terminal of the resistors 47 and 49, while its negative terminal is connected to the control electrode 102c of a high vacuum electron tube 102, which is also provided with a cathode 102a and an anode 102b. The anode 102b is connected to the common terminal of the battery 46a and the resistor 48 while the cathode 102a is connected to the negative terminal of the photoelectric cell 101, through a resistor 103. A source of direct current voltage 104 for supplying current to the photocell 101 is connected to the positive terminal of the photocell 101 and to the cathode 102a.

The illumination of the photocell 101 in response to the movement of papers through the recording zone is controlled in the following manner: A light source 105 is mounted above the conveyor belt 10 in such a manner that at the zone of reference the light strikes the papers obliquely, as indicated by the dotted lines. In consequence the trailing edge of each paper casts a deep shadow upon the adjacent surface of the succeeding paper as the papers successively pass through said zone. The photocell 101 is provided with an enclosure 101a which shields it completely from any light, except for a light beam which may pass through small orifices 101b and 101c arranged on the axis of the photocell. The orifice 101b is preferably arranged in a partition mounted within the enclosure transversely to the axis of the photocell while the orifice 101c may be arranged in the wall of the enclosure 101a. The photocell assembly is mounted in such a way that the axis is directed toward the point at which the papers are to be counted. The light beam reflected by the papers and which impinges upon the photocell 101 is normally a maximum. However, when the shadows on the papers pass the axis of the photocell the intensity of the light beam is greatly reduced so as to substantially reduce the conduction of the photocell.

The modified system illustrated in Fig. 5 functions in the following manner: Inasmuch as either the tube 40 or the tube 41 is conducting, the voltage drop across the resistor 50 has a given value the resistor terminal closest to the cathodes 40a and 41a being positive with respect to the resistor terminal connected to line L^{21}. When the photocell 101 is illuminated with maximum intensity the voltage drop through the resistors 48 and 49 is a maximum. In that case the tube 41 is conducting while the negative voltage on the control electrode 40c which is the resultant of the voltage drops through the resistors 50 and 48 and the battery 46a is a maximum.

Normally the light intensity on the photo-tube 101 is maximum so that the control electrode 102c has a maximum positive potential. Hence the conduction of the tube 102 is also a maximum. As a result, a current flows from the source 104, through the resistors 49 and 48, through the tube 102, back to the source 104. The voltage on the grid 40c is equal to the resultant of the voltage drops through the resistors 50 and 48, and the opposing voltage of the battery 46a. If now the intensity of the light beams reflected by the papers and impinging upon the tube 101 is reduced, the positive potential of the control electrode 102c is also reduced, thereby reducing the current passing from the battery 104, through the resistors 48 and 49. The decrease of the voltage drop through the resistor 48 reduces the blocking potential on the grid 40c until a value is attained at which the tube 40 becomes conducting. The initiation of current conduction in the tube 40 causes the interruption of conduction through tube 41, as has been explained in connection with Figure 3, and the potential of grid 41c changes to a value which is equal to the voltage drops through the resistors 50 and 49. If the intensity of the light impinging upon the photo-tube 101 again increases, the voltage drop through the resistors 49 and 48 again increases so as to raise the potential of the grid 40c to a value to again render the tube 40 conducting and the cycle will be repeated. It will be observed that upon initiation of conduction of these tubes 40 or 41 the condensers 52 and 53 and their coacting resistors 42 and 43 momentarily depress the potential of the cathodes of the respective tubes to insure positive action of the circuit. The varying potential of the cathode 41a causes alternate conduction of the tubes 54 and 55 as heretofore explained.

Fig. 6 illustrates the response of the system to the variations of the intensity of illumination of the photocell in Fig. 5. It is well understood that the illumination of the photocell by the light source is subject to modifications by unwanted external light and by variations of the reflective quality of the paper. Furthermore, there may be other factors besides the movement of the objects through the light beam impinging upon the photocell, which tend to vary the alternate conduction of the tubes 40 and 41 in response to the movement of the objects. These influences would cause unwanted response of the tubes 40 and 41 and would lead to faulty indications. By proportioning the circuit, particularly the resistors 48, 49, and the voltage sources 46a and 104, the circuit may be arranged so that after being non-conducting the tube 41 does not become conducting again until the intensity of illumination of the photocell 101 passes from a value lower than A in Fig. 6, to a higher value as indicated by the arrow C. The aforedescribed response is not affected to any substantial degree by fluctuations of the voltage supply. After the tube 41 has thus become conducting, the current of the photocell may vary, as indicated by the curve, either above or below the value A, and the tube 40 will not become conducting to extinguish the tube 41 until the illumination drops below the value B as indicated by the arrow D in Fig. 6 whereupon the tube 40 becomes and remains conducting even though the illumination of the photo-tube varies below or above said value B, except if it should increase again to the value A. In the latter event the tube 41 again becomes conducting as indicated by the arrow E. It will also be noticed that any minor variation in voltage of the source 104 will not substantially affect the relation of the voltage drops in the resistors 48 and 49, and thus the response of tubes 40 and 41 is substantially unaffected by such variations in voltage. It will

also be seen that the circuit may be designed for any desired sensitivity to variations in illumination of the photo-tube, such sensitivity being substantially unaffected by variations of the voltage supplied to the photocell circuit.

We claim:

1. In a system for grouping, by marking, articles moved in succession through a given zone, in combination, a rotatable disc provided with a plurality of apertures arranged at regular angular intervals and at different distances from the center of said disc, a program ribbon provided with a plurality of apertures arranged to co-act, upon movement of said ribbon, successively with certain of said first named apertures for permitting passage of a beam of light through the co-acting apertures, a counting mechanism comprising means constantly tending to move said disc and said ribbon, said counting mechanism further comprising means responsive to movement of each article through said given zone to control said first mentioned means for operation intermittently in equal steps and in synchronism with the movement of the articles, a photo-cell responsive to illumination by said beam of light, and means responsive to control by said photo-cell for marking the articles completing the predetermined groups.

2. In a system for grouping, by marking, articles moved in succession through a given zone, in combination, a rotatable disc provided with a plurality of apertures arranged at regular angular intervals and at different distances from the center of said disc, a program ribbon provided with a plurality of apertures arranged to co-act, upon movement of said ribbon, successively as desired, with certain of said first named apertures to permit passage of a beam of light through the co-acting apertures, a counting mechanism comprising control means responsive to movement through a given zone of a series of articles to be grouped, an escapement including an oscillatable member, a co-acting ratchet wheel and means for rotating said ratchet, electromagnetic means responsive to said control means for operating said oscillatable member, driving connections from said ratchet wheel to said disc and to said ribbon for moving them in synchronism with movement of the articles, a photo-cell responsive to illumination by said beam of light, and means responsive to control by said photo-cell for marking the articles completing the predetermined groups.

3. In a system for grouping, by marking, articles moved in succession through a given zone, in combination, a rotatable disc provided with apertures arranged at regular angular intervals and at different distances from the center of said disc, a program ribbon provided with a number of apertures arranged to co-act, upon movement of said ribbon, successively with certain of said first named apertures for permitting passage of a beam of light through the co-acting apertures, a first photo-cell responsive to illumination by the beam of light, means responsive to control by said first photo-cell for marking the articles completing the predetermined groups, a pair of electron tubes, means to direct a beam of light on the moving articles for reflection thereby and for variation by each article in passing through a given zone, of the intensity of the reflected light, a second photo-cell subjected to the reflected light and responsive to variations in its intensity, means for initiating conduction of one of said pair of tubes upon illumination of said second photo-cell increasing to a given relatively high value and for initiating conduction of the other of said pair of tubes upon the illumination decreasing to a given relatively low value, said means including means for rendering the first mentioned tube non-conducting upon the other tube becoming conducting and vice versa, an escapement including an oscillatable member, a co-acting ratchet wheel and means for rotating said ratchet wheel, electromagnetic means responsive to the conduction of said tubes for operating said oscillatable member, and driving connections from said ratchet wheel to said disc and said ribbon.

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