Sept. 27, 1938. D. C. COX 2,131,095

MEANS FOR SORTING HOMOGENEOUS ARTICLES

Filed Feb. 15, 1934 3 Sheets-Sheet 1

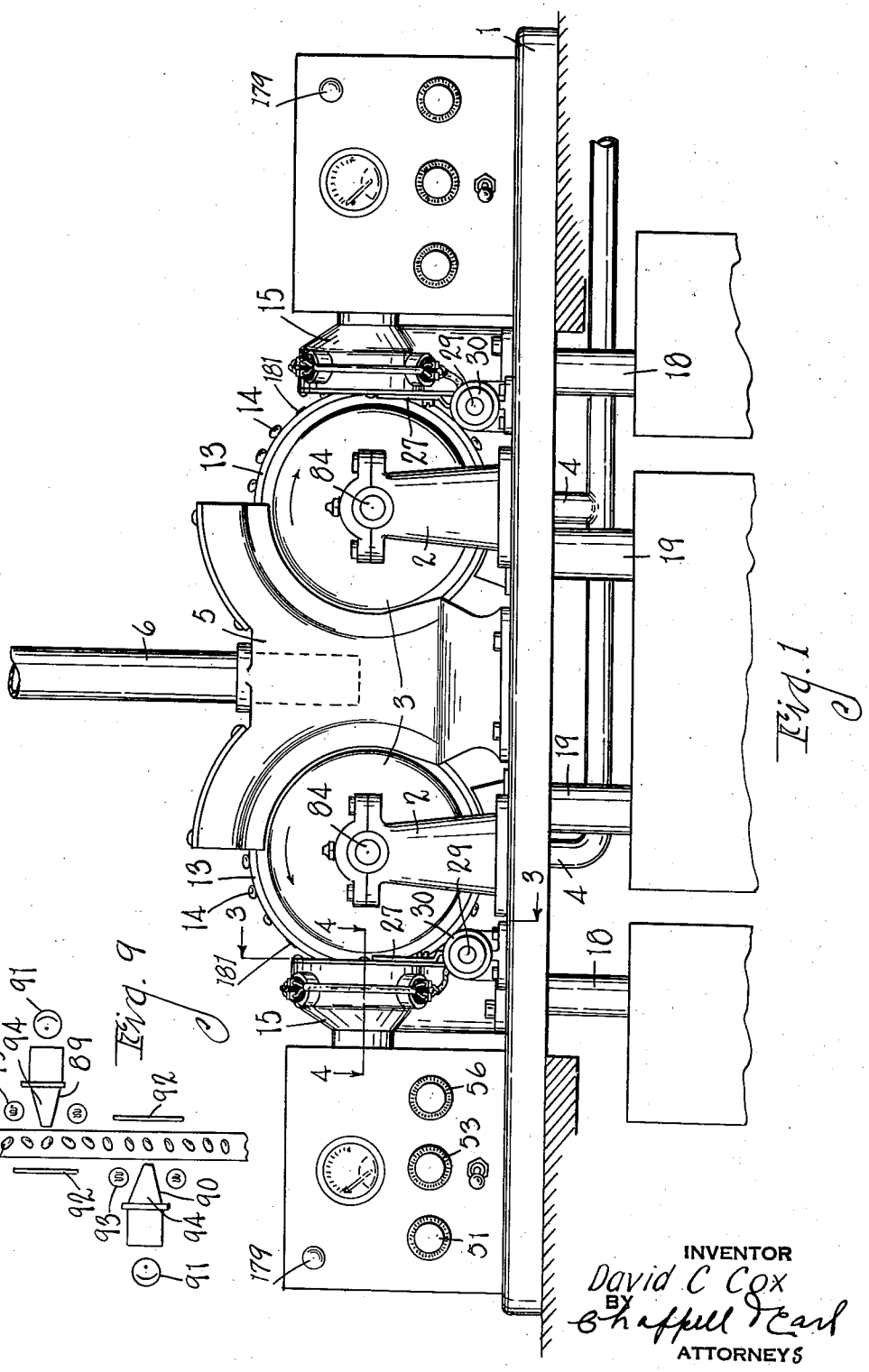


Fig. 1

Fig. 9

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MEANS FOR SORTING HOMOGENEOUS ARTICLES

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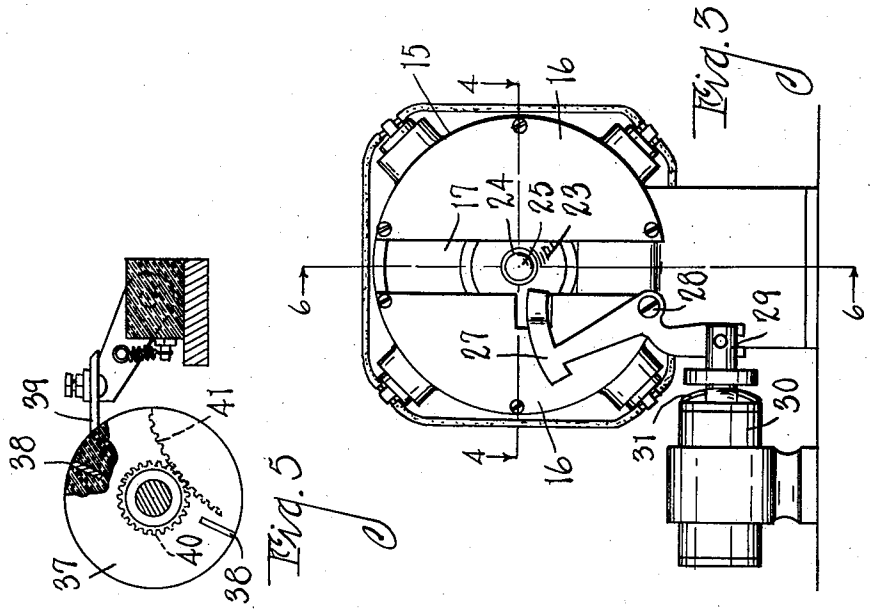


Fig. 3

Fig. 5

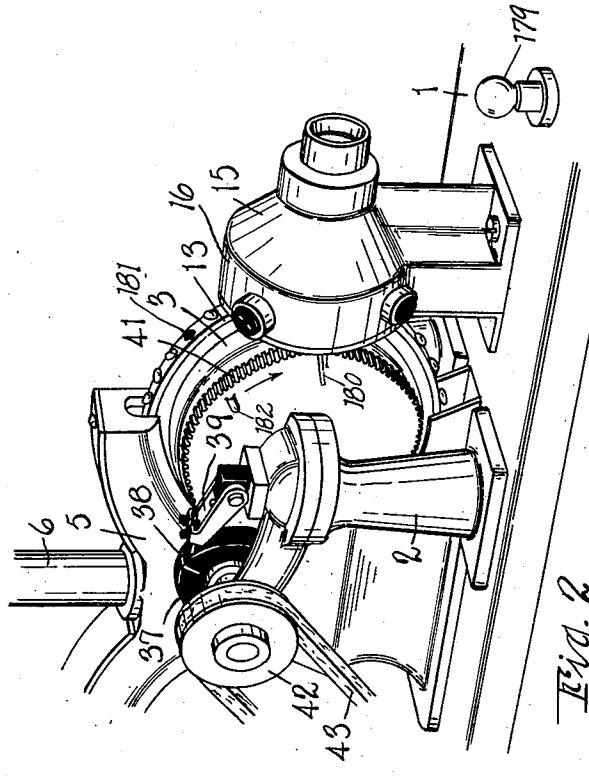


Fig. 2

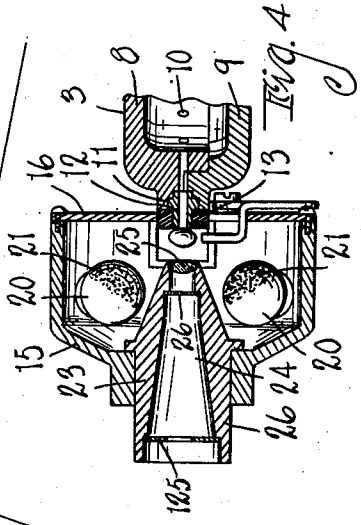


Fig. 4

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MEANS FOR SORTING HOMOGENEOUS ARTICLES

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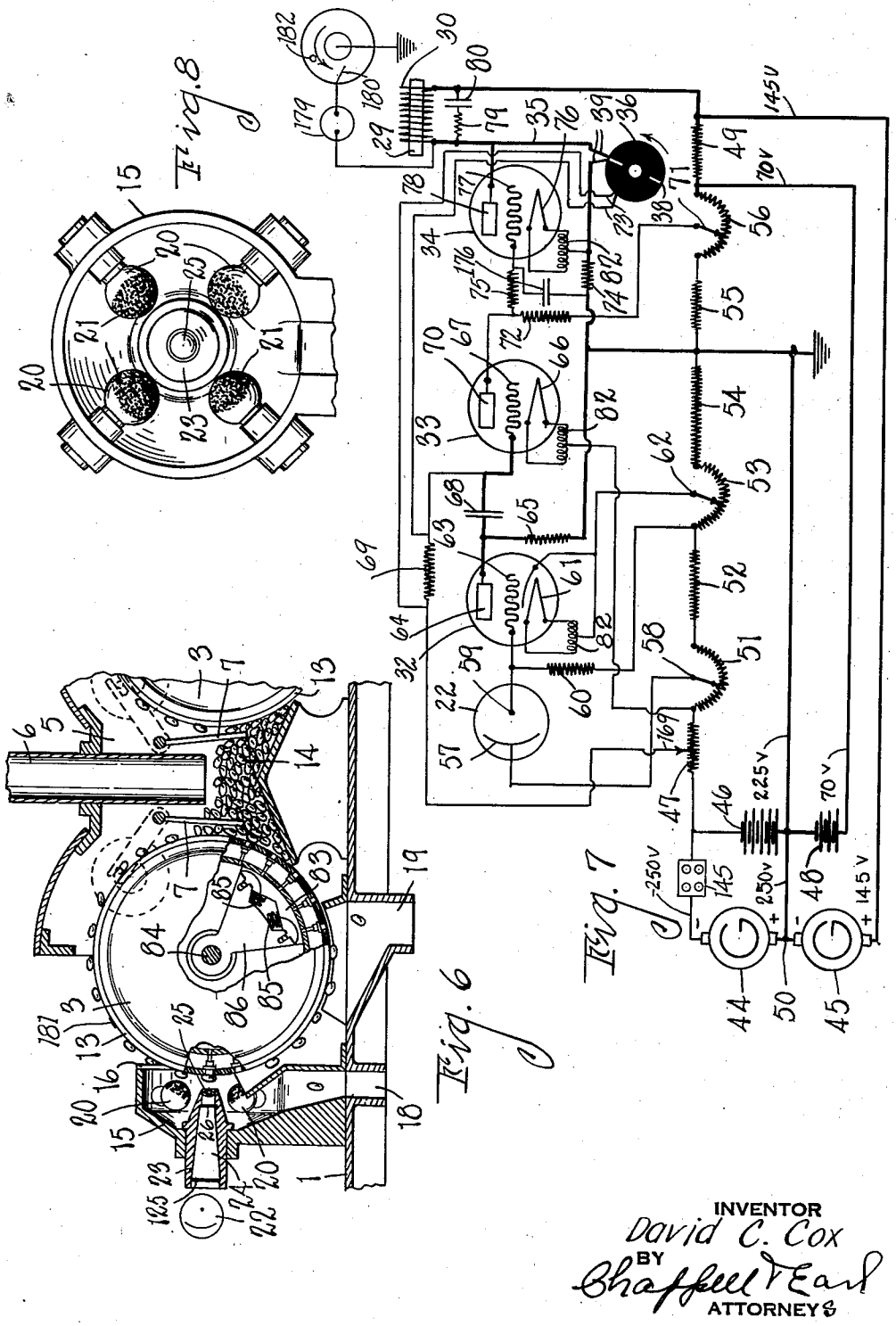


Fig. 8

Fig. 7

Fig. 6

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UNITED STATES PATENT OFFICE

2,131,095

MEANS FOR SORTING HOMOGENEOUS ARTICLES

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Application February 15, 1934, Serial No. 711,374

23 Claims. (Cl. 209—111)

The main objects of this invention are:

First, to provide an improved means for sorting homogeneous articles, such as beans, at high speed with great accuracy.

Second, to provide a sorting apparatus of this character having means associated therewith for minimizing the effect of variations of light from the primary light source.

Third, to provide improved means for interrupting the ionization of a grid controlled gaseous discharge tube without opening the plate circuit thereof so that the sorting mechanism is free to operate in response to an impulse from the photoelectric cell.

Fourth, to provide an improved optical system for preventing the photoelectric cell from responding to shadows and for increasing the accuracy and efficiency of the sorting mechanism.

Fifth, to provide electrical apparatus of this character having the discharge tappet outside of the view of the photoelectric cell so as not to influence the operation of the latter and providing means to delay the operation of said hammer or tappet until the discolored article is in proper position to be struck thereby.

Sixth, to provide means for viewing opposite sides of the articles to be sorted by individual photoelectric cells which are provided with color reference backgrounds.

Seventh, to provide an optical system for the light reflected from the articles on the photoelectric cell to increase the sensitivity of the latter.

Eighth, to provide an optical system having a filter for increasing the sensitivity of the photoelectric cell to the color of the articles to be sorted.

Ninth, to provide apparatus having the above desirable features and characteristics and which is simple and economical in its parts and very efficient in operation.

Objects relating to details and economies of my invention will appear from the description to follow. The invention is defined and pointed out in the claims.

A structure which is a preferred embodiment of my invention is illustrated in the accompanying drawings, in which:

Fig. 1 is a fragmentary side elevation of a machine embodying the features of my invention.

Fig. 2 is a fragmentary perspective view.

Fig. 3 is a front elevation of the lamp housing showing the operative relation of the selector mechanism thereto.

Fig. 4 is an enlarged fragmentary section on a line corresponding to line 4—4 of Figs. 1 and 3.

Fig. 5 is an enlarged fragmentary view showing details of the interrupter switch for short circuiting the plate and filament of the power tube to interrupt the ionization thereof.

Fig. 6 is a fragmentary view mainly in vertical section on a line corresponding to line 6—6 of Fig. 3.

Fig. 7 is a diagrammatic view of the electrical apparatus.

Fig. 8 is a fragmentary view in elevation of the interior of the lamp housing showing the special arrangement of the frosting on the lamps for diffusing the light within the housing to prevent the operation of the photoelectric cell by shadows.

Fig. 9 is a diagrammatic view of a modification.

The structure illustrated in the drawings comprises a base 1 of suitable dimensions to support the operating parts. On this base are pedestals 2 supporting the drum-like conveyors 3 which have suitable hollow journals communicating with the suction pipes 4. The conveyors are associated with a single hopper 5 which has openings in its opposite end walls to receive the peripheries of the pair of conveyors. The feed spout 6 depends centrally into the hopper and an agitator 7 is provided on each side of the spout in operative relation to the conveyor.

In the embodiment illustrated, each conveyor is made up of a pair of sections 8 and 9, see Fig. 4, having a shouldered joint, the section 8 having a series of radial bores or suction passages 10 therein which terminate in shouldered seats 11 for the tips 12. These tips project through a rim 13 which is of a pre-selected uniform color to suit the normal color of the articles to be sorted. The rim is of hard surfaced material such as pyroxylin which permits a ready cleaning and provides a smooth, durable and uniformly colored surface.

The feed spout 6 projects into the hopper 5 the desired distance to determine the normal level of the articles 14 therein, such as beans, to be sorted. The hopper is open at its sides to receive the conveyors so that a portion of the periphery of each conveyor sweeps upwardly through the hopper in supporting relation to the contents thereof so that the articles are picked up by the suction orifices. The agitator 7 acts to bring the articles into proper relation to be picked up by the conveyor.

A lamp housing 15 is associated with each conveyor opposite the hopper, each housing being preferably of general cylindrical shape and provided with a face plate 16 having a slot 17 therein into which a portion of the periphery of the conveyor projects so that the articles on the conveyor are successively carried into the housing. The housing has a discharge passage 18 with a chute 19 for the rejected articles leading therefrom. The lamps 20 are arranged in uniformly spaced radial relation in the housing, there being

a pair of lamps on each side of the vertical plane of the conveyor.

In order to diffuse the light from the lamps within the housing and prevent spotting, I frost that portion of each lamp nearest the selecting station, the frosting being indicated at 21. If desired, completely frosted lamps may be used for this purpose or frosted shields separate from the lamps may be used. The purpose of the frosting is to diffuse the light so as to prevent the operation of the sorting mechanism in response to shadows.

A color or light sensitive element such as a selenium or photoelectric cell 22 is disposed to focus on the articles as they are carried successively through the lamp housing by the conveyor. The tapered focusing tube or funnel 23 is disposed centrally of the lamp housing and projects into close proximity to the path of the articles on the conveyor, the tube having a conical light passage 24 for directing the light reflected from the articles as they move through the selecting station to the photoelectric cell. Within the conical light passage 24, I mount a condensing lens 25 for concentrating the reflected light on the photoelectric cell, and a color filter 26. The filter may consist of a 50% copper nitrate solution and is adapted to remove red light and increase the sensitivity of the photoelectric cell to yellow and brown articles, in this case beans.

The condensing lens 25 is a double convex lens and is mounted at the small end of the cone 24. The lens is about ⅜ inch in diameter and ⅝ inch from the center of the average bean. At the opposite end of the cone, there is disposed a diaphragm or disk 125 with a ⅝ inch central round aperture for framing the average bean. This is quite important from the commercial standpoint because if the diaphragm be too large, small dark beans will be retained due to the intense light ring of background which is visible. This diaphragm is placed where the image of the bean comes to a focus. The image, sharp at this point, becomes quite blurred by the time it strikes the phototube 22.

The photoelectric cell controls the electrically actuated selector means which in the embodiment illustrated consists of a pivoted hammer or tappet 27 pivoted at 28, its lower end being connected to the armature 29 of the solenoid or electromagnet 30. A spring 31 acts to retract the armature.

As illustrated by Fig. 7, the output of the photoelectric cell 22 is amplified by a first stage vacuum tube amplifier 32, generally called a heater type triode and technically known as an unipotential cathode triode, and a second stage vacuum tube amplifier 33, preferably a filament type triode. The output of the second stage amplifier is adapted to control the grid controlled gaseous discharge tube 34, preferably a mercury vapor ionization tube. The electromagnet 30 is disposed in the plate circuit of the ionizing power tube as illustrated and is adapted to actuate its armature 29 when the tube is ionized. For interrupting the ionization of the power tube without opening the plate circuit of the grid controlled gaseous discharge tube, I provide a shunt circuit 35 across the plate and filament thereof and in this circuit dispose a normally open circuit closing switch 36 for short circuiting the plate and filament periodically and in synchronism with the movement of the articles being sorted through the selecting station. The plate and filament of the grid controlled gaseous discharge tube are short circuited for approximately .005 second while the tube de-ionizes. Thus, the circuit of the electromagnet is active at all times and the armature will function in response to an impulse regardless of the condition of the short circuiting switch 36. This is a decided improvement over plate circuit interrupters of the type used in the prior art for de-ionizing tubes.

In the embodiment of my invention illustrated by the drawings, I have shown the short circuiting switch 36 in the form of a commutator consisting of a rotor 37 of insulating material having narrow contacts or blades 38 of conducting material at diametrically opposite sides thereof. The brushes coacting with the commutator are indicated at 39, 39 (see Fig. 5). The rotor 37 is driven in synchronism with the conveyor, the commutator or its shaft having a gear 40 meshing with the gear 41 on the conveyor. The commutator shaft is provided with a pulley 42 which is driven by an electric motor (not shown) through the belt 43.

Referring particularly to Fig. 7, my improved electrical apparatus is energized by means of a 250-volt direct current generator 44 and a 145-volt direct current generator 45 connected in series circuit relation as indicated. A 225-volt battery 46 is connected to the terminals of the generator 44 through the bank 145 of ballast lamps. The latter stabilize the voltage and are of especial importance in preventing generator hum from getting into the machines. A 70-volt battery 48 and a 12,000-ohm resistor 49 are connected to the terminals of the 145-volt generator 45. I float the storage batteries on the generators in this manner for the purpose of removing objectionable hums in the apparatus, such as plate voltage hum from the generator commutators, plate voltage hum from asymmetry of the generators, plate voltage hum from a voltage regulator and compound hum due to interference and reinforcement of two commutators on the direct current generators. Such hums, ripples and flutters in the plate circuits of the amplifying tubes cause the apparatus to function only fractionally on pale beans or light colored articles. Thus, by floating the batteries on the generators I provide for the removal or sorting of all pale beans or light colored articles. Further, I obviate the use of a voltage regulator by this arrangement.

The positive terminal of the 250-volt generator 44 is connected to the negative terminal of the 145-volt generator 45 at 50. A first 400-ohm potentiometer 47, a 1000-ohm potentiometer 51, a 1200-ohm resistor 52, a second 400-ohm potentiometer 53, and a 3500-ohm resistor 54 are connected in series circuit relation and to the terminals of the 225-volt battery 46 with the first 400-ohm potentiometer 47 connected to the negative terminal of the battery and the 3500-ohm resistor 54 connected to the positive terminal of the battery. A 600-ohm resistor 55 and a 2000-ohm potentiometer 56 are connected to the 70-volt battery 48 with the resistor connected to the negative terminal of the battery and the potentiometer connected to the positive terminal thereof. The potentiometers and resistors provide a potentiometer circuit for energizing the various elements of the control circuit. The maximum line voltage resulting from my improved arrangement is only 225 volts. This reduces the hazard due to high voltage found in prior apparatus.

The negative electrode 57 of the photoelectric cell 22 is connected to the variable terminal 58

of the 1000-ohm potentiometer 51 and the positive electrode 59 is connected to the positive terminal of the 1200-ohm resistor 52 by a circuit including the 30-megohm resister 60. Thus, by varying the voltage applied to the photo-tube by means of the movable contact 58 of the potentiometer 51, the natural differences between individual photo-tubes may be essentially compensated.

The filament 61 of the first stage vacuum tube amplifier 32 is connected to the variable terminal 62 of the second 400-ohm potentiometer 53. The grid 63 of such amplifier is connected to the positive terminal 59 of the photoelectric cell. The plate 64 is connected to the positive terminal of the 3500-ohm resistor 54 by a circuit including the 50,000-ohm resistor 65. The operation of the first stage amplifier may thus be conveniently controlled by manipulating the movable contact 62 of the potentiometer 53.

The filament 66 of the second stage vacuum tube amplifier is connected to the negative terminal of the potentiometer 51. The second stage amplifier grid 67 is connected to the first stage amplifier plate 64 by a circuit including the .1-microfarad condenser 68, such grid being also connected to the variable contact 169 of the potentiometer 47 by a circuit including the 250,000-ohm resistor 69. The circuit connecting the second stage amplifier plate 70 to the variable terminal 71 of the potentiometer 56 includes the 50,000-ohm resistor 72. The second stage vacuum tube amplifier 33 is conveniently controlled by manipulating the movable contact 71 of the potentiometer 56.

From the above description, taken in connection with Fig. 7, it will be observed that the first and second stage amplifiers are connected by a capacity coupling. This is a very valuable and important feature of my hook-up inasmuch as the apparatus is made sensitive to the rate of change of light intensity instead of absolute light intensity as in prior control circuits. The condenser 68 provides a capacity in the circuit which gives a certain elasticity thereto, the condenser acting to absorb slow changes in potential due to corresponding variations in the primary light source without affecting the operation of the device, a leakage path being provided for equalizing or discharging the condenser due to such slow changes. However, in the event of a rapid change, as, for example, when a discolored bean or article passes the view of the photo-electric cell, such impulses are readily transmitted by the condenser and result in the actuation of the discharge hammer. Thus, the system is made impervious to changes in extraneous light or variations in the lamp voltage.

The photo-tube is provided with a voltage control to overcome variations in individual photo-tubes in the system. It is connected by a resistance coupling to the grid of the first amplifier. The capacity coupling is used between the first and second amplifiers to present slow changes in the low-level part of the amplifier from changing the status of the high-level part. The most noticeable effect of this is to permit small variations in the intensity of the light falling upon the objects being sorted without an exaggerated effect (due to amplification) upon the setting and behavior of the machine.

The grid 67 of the amplifier is connected through the resistor 69 to the grid return line, but from time to time such resistor is short circuited by the two brushes 73, 73 acting in conjunction with the synchronized commutator 36. Contact is made for a brief time, approximately .004 second, the time being regulated so that the short circuit occurs while the photo-cell is looking at a part of the bare, clear, unshadowed rim of the sorting wheel. The condenser is thus neutralized or conditioned between each article to be sorted. The machine may be said to be in equilibrium before judging each article, the accumulated charge on the condenser due to slight variations being discharged periodically.

The filament 76 of the grid controlled gaseous discharge tube is connected to ground or the negative terminal of resistor 55 through the 75-ohm resistor 74 while the grid 77 of such tube is connected to the second stage amplifier plate 70 through the 100,000-ohm resistor 75, the grid 77 being connected to the ground side of the resistor 74 through the .01 microfared condenser 176. The plate 78 is connected to the positive terminal of the 145-volt generator 45 by a circuit which includes the electromagnet 30. A 350-ohm resistor 79 and 4-microfarad condenser 80 are connected across the terminals of the electromagnet 30 to prevent sparking at the switch 36 due to self-induction of the electromagnet, and to eliminate the tendency of the grid controlled gaseous discharge tube to be relighted by the excessive voltage which otherwise occurs upon suddenly de-energizing the magnet. As pointed out above, the plate 78 and filament 76 of the power tube are short circuited periodically between successive article inspections to de-ionize the tube if such condition exists, resulting in the restoration of the armature and discharging hammer by the spring 31.

The 75-ohm resistor 74 between the center tap of the grid controlled gaseous discharge tube filament transformer winding 82 and the plate return or ground acts so that when the tube is not lighted the circuit is not affected, but as soon as the tube lights it makes the filament about 25 volts positive with respect to the grid and effectively prevents premature relighting of the tube. The inductive surge from the magnet as it is being released tends to relight the tube simply by applying an excessive voltage to its plate. If the grid has not returned to its normally negative condition, the short circuiting switch will not extinguish it. The presence of the 75-ohm resistor gives a positive break under all circumstances. Thus, the plate current of the grid controlled gaseous discharge tube immediately conditions the grid controlled gaseous discharge tube itself for ready interruption.

The resistor 75 and condenser 176 constitute a resistor-condenser hook-up for the grid 77 of the grid controlled gaseous discharge tube. I have discovered that surges in the second amplifier plate line, if rising suddenly, would light the grid controlled gaseous discharge tube while still below its normal point of discharge. The steep wave-fronts encountered in very rapid sorting are effectively prevented from causing a half-light or premature discharge of the grid controlled gaseous discharge tube by the cushioning or integrating effect of such resistor-condenser hook-up.

I connect a signal lamp 179, such as a "neon" lamp, between the plate of the grid controlled gaseous discharge tube and the brush 180. A test spot 181 is provided on the rim of the sorting wheel. When the test spot comes into the field of the photo-cell, the brush is momentarily engaged by the small cam or contact 182 on the

side of the large gear 41 which drives the wheel. Before the commutator segment connects to release the magnet, this contact 182 leaves the brush 180. In this manner, the "neon" lamp gets only about 18 volts (the tube drop) if the grid controlled gaseous discharge tube is lighted, but gets the full 125 volts if the grid controlled gaseous discharge tube fails to light. The signal lamp is then normally out, but if for any reason whatever the machine fails to operate the magnet while the test spot is in the field of the phototube, the signal lamp will light intermittently. By calibrating the test spots, it is possible for the operator to make a rapid setting of a machine by feeling for the position where the test spot is barely missed and then turning the control dial a predetermined degree.

The brushes 39, 39 and 73, 73 of the commutator 36 are arranged so that the latter make contact with a segment exactly between beans where the field is clearest and best illuminated. The magnet brushes 39, 39 are set about ¼ cycle in advance of the condenser neutralizing brushes and serve to release the magnet after it has had time to eject a cull.

An interrupter or circuit breaker has been used in the plate circuit of the power tube to de-ionize the latter. Such interrupters are subject to the disadvantage of not always maintaining or not certainly maintaining the circuit connection while the tappet or hammer is in actuated position or the position in which it kicks a rejected article from the conveyor. My improved arrangement leaves the magnet circuit connected at all times, the only break being in the tube itself. The "kick" is interrupted and the hammer is allowed to return by short circuiting the grid controlled gaseous discharge tube filament and plate for a fraction of a second while the tube de-ionizes. The counter-electromotive force of the electromagnet prevents the hammer from fluttering. The electromagnet functions in response to an impulse at any time regardless of the position of the short circuiting switch. Further, any defect or failure of the switch leaves the hammer in position to kick when necessary, but then the hammer will not return, but will scrape off all of the articles from the conveyor. Therefore, no failure of the short circuiting switch can possibly damage the delivered articles.

As best illustrated by Fig. 3, the hammer 27 is positioned so that it does not appear in the viewing field of the photoelectric cell at any time. This prevents the operation of the hammer from affecting the base illumination intensity and the subsequent operation of the photoelectric cell. The actuation of the hammer is delayed slightly in response to operation of the photoelectric cell in order to provide sufficient time for the conveyor to present colored articles ejected to the kick-off. For the purpose of so delaying the hammer operation, I utilize condensers 68 and/or 176. By apportioning the capacities of either or both of these condensers, the extent to which the latter cushion impulses originating in the photoelectric cell and consequently provide a time delay may be regulated. Of course, the speed of the conveyor travel is a factor in the reckoning of the desired time delay. However, knowing such speed and the delay desired, the condenser values may be readily calculated. For example, for the condenser 68 having the value specified, in combination with a resistor 69 of given value, the time constant is one-fortieth of a second. Similarly, for a condenser 176 of the value specified in conjunction with a resistor 75 of given value, the time constant is computed as .001 second.

Referring again to the circuit diagram of the apparatus, Fig. 7, the filaments of the amplifying tubes and power tube are energized by a common source of alternating current (not shown) through the transformer secondaries 82 connected to the terminals of the filaments. Further, the filaments illustrated are adapted to heat a separate cathode not shown but quite common to tubes of this type.

With my improved arrangement the conveyors are continuously driven at a relatively fast peripheral speed and at the same time the action of the sorting mechanism is sufficiently rapid to remove the discolored articles therefrom. The discolored articles are discharged from the conveyor by the hammer 27 and fall into the chute 18. The properly colored articles are carried along until the suction orifices reach the valve 83 which is mounted within the conveyor on the spindle 84 disposed axially thereof. Springs 85 carried by the valve support 86 urge the valve yieldingly against the inner periphery of the conveyor so that the orifices are successively brought into operative relation to the valve, and as soon as the suction is released, the beans fall into the discharge chute 19.

Referring to the modification illustrated by Fig. 9 of the drawings, there is illustrated a conveyor 87 for moving a continuous series of articles 88 to be sorted past a pair of selecting stations 89 and 90. A photoelectric cell 91 is arranged at each station to view opposite sides of the articles, a color reference background 92 being associated with each of the photoelectric cells on the side of the conveyor opposite thereto. The lamps 93 are provided at each station for illuminating the articles and the color reference background so that the reflected light is directed to the photoelectric cells by the lens means 94. The photoelectric cells control means (not shown) for discharging discolored articles which vary a predetermined degree from the color of the reference background. Thus, should the conveyor 87 become soiled, the operation of the photoelectric cells is not affected, and further, the color reference backgrounds may be changed as desired for articles of different colors. For example, if the articles to be sorted are blue, the reference background of the proper shade of blue may be selected and the photoelectric cells adjusted so as not to operate except in response to a color variation from the reference background. This arrangement enables the background to be so remote from the article under observation as to essentially prevent shadows from the latter reducing the brightness of such background.

The essence of my hook-up as distinguished from that of the prior art hinges upon sorting by difference, as set forth. The capacity coupling between the first and second stages of amplification is the method which I prefer to use. Transformer coupling at the same point can be used if desired, but it is not as effective. I believe that what is called inductive coupling might also be used. The circuits which will operate in this manner are grouped under the heading of alternating current amplifiers as distinguished from direct current amplifiers. There are distinct practical reasons, the size of units involved, etc., the number of variations besides the variations in illumination, which are compensated, which have influenced me to adopt the particular one described.

The machine sorts very accurately and rapidly by virtue of my improvements listed above. In some respects my apparatus is like that disclosed by the application of Martin C. Hanson for Letters Patent, Serial No. 593,145, filed February 15, 1932, and owned by the assignee of the present invention, but my apparatus is capable of sorting more articles and with greater accuracy than that disclosed by Hanson, because my apparatus is responsive to the speed of color changes, rather than to the degree of illumination alone. Thus, my method obviates the trouble heretofore caused by changes in the general illumination of the system, such as by clouds or by voltage changes on the illuminating lamps. In general, my apparatus is not affected by such changes, because the hook-up is responsive only to the rate of change of light intensity affecting the "electric eye."

Many cases of sorting occur in which it is desirable to remove the articles which appear brighter than the others in the light which reaches the photo-tube. For example, in sorting lima beans it is necessary to remove white beans and retain the green beans. My method and apparatus can be readily modified to sort in this manner. The tripping impulse is arranged to trip when the field is brightened rapidly, while the background is made green dark enough to retain beans of the same tint or darker. In this case, a red-sensitive photo-tube, such as a selenium cell, is used with red lamps or a red filter. The light actually reaching the photo-tube is or contains color absorbed by dark articles. In the circuit shown by Fig. 7, the trip is reversed by merely reversing the positive and negative electrode connections and then the photo-tube potentiometer is moved up on the voltage divider so that resistor 60 is connected to its negative terminal.

The trip may be reversed in other ways, inasmuch as the impulse reverses with each amplifier added with either capacity or resistance coupling. A single stage amplifier whose plate or coupling condenser goes directly to the grid controlled gaseous discharge tube, instead of to a second amplifier, reverses the trip without reversing the connections to the photo-tube. The first tube might be connected to the grid controlled gaseous discharge tube exactly as the second tube is shown in the drawings (without condenser). The differential effect might then be introduced by a capacity coupling between the photo-tube and the first grid tube. Thus, it is quite possible to have a one stage amplifier (not interpreting the grid controlled gaseous discharge tube function as amplification) either of direct or reverse trip and still remain within the scope of the differential amplifier.

The present circuit is used on account of the limited amount of light which can be received from the small articles being sorted. Other circuits for obtaining differential sorting will occur to those skilled in the art, and for this reason it is to be understood that the circuit I show in the drawings is not to be construed as a restriction, but as an example.

I have illustrated and described my improvements in embodiments which I have found very practical. I have not attempted to illustrate or describe other embodiments or adaptations, as it is believed this disclosure will enable those skilled in the art to embody or adapt my improvements as may be desired.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Electrical apparatus comprising in combination, a photoelectric cell arranged to view a continuous series of constantly moving spaced articles, control circuits for said photoelectric cell, a first stage amplifier operatively associated with said photoelectric cell, control circuits for said amplifier, a second stage amplifier operatively associated with said first stage amplifier, means including a grid-controlled gaseous discharge tube operatively associated with said second stage amplifier for discharging discolored articles from said series in response to the operation of said photoelectric cell, means for making said discharge means responsive only to a rapid rate of change of light intensity affecting said photoelectric cell and comprising a resistance in the plate circuit of the first stage amplifier, and a capacity coupling the plate of the first stage amplifier with the grid of the second stage amplifier, and means synchronized with the movement of said articles for conditioning said capacity and for short circuiting the plate and filament of said gaseous discharge tube at regular intervals.

2. Electrical apparatus comprising in combination, a photoelectric cell arranged to view a continuous series of constantly moving spaced articles, control circuits for said photoelectric cell, a first stage amplifier operatively associated with said photoelectric cell, control circuits for said amplifier, a second stage amplifier operatively associated with said first stage amplifier, means including a gaseous discharge tube operatively associated with said second stage amplifier for discharging discolored articles from said series in response to the operation of said photoelectric cell, a coupling between the first and second stage amplifiers operable in response to steep wavefronts only, and means synchronized with the movement of said articles for conditioning said coupling at regular intervals.

3. Electrical apparatus comprising a grid controlled gaseous discharge tube having a filament, grid and plate, control circuits therefor, a source of electromotive force and an electromagnet in the plate circuit, and means for interrupting the ionization of said grid controlled gaseous discharge tube without opening said plate circuit, said means comprising a shunt circuit connected to said filament and plate, and normally open circuit closing means in said shunt circuit for periodically short circuiting the filament and plate for approximately .005 second while the tube deionizes.

4. Electrical apparatus comprising a grid controlled gaseous discharge tube having a filament, grid and plate, control circuits therefor, a source of electromotive force and an electromagnet in the plate circuit, and means for interrupting the ionization of said grid controlled gaseous discharge tube comprising a shunt circuit connected to said filament and plate, and normally open circuit closing means in said shunt circuit for short circuiting the filament and plate.

5. Electrical apparatus comprising a grid controlled gaseous discharge tube having a filament, grid and plate, control circuits therefor, a source of electromotive force in the plate circuit, and means for short circuiting the filament and plate for approximately .005 second while the tube deionizes.

6. Electrical apparatus comprising a grid controlled gaseous discharge tube having a filament and plate, control circuits therefor, a source of

electromotive force and a relay in the plate circuit, a shunt circuit connected to said filament and plate, and normally open circuit closing means in said shunt circuit for periodically short circuiting the filament and plate.

7. Electrical apparatus comprising in combination, a 250-volt direct current generator, a 225-volt battery connected to the terminals of said generator, a 145-volt direct current generator, a 70-volt battery and a 1600-ohm resistor connected to the terminals of said 145-volt generator, means connecting the positive terminal of said 250-volt generator to the negative terminal of said 145-volt generator, a first 400-ohm potentiometer, a 1000-ohm potentiometer, a 1200-ohm resistor, a second 400-ohm potentiometer and a 3500-ohm resistor connected in series circuit relation and to the terminals of said 225-volt battery with the second 400-ohm potentiometer connected to the negative terminal of the battery, a 600-ohm resistor and a 2000-ohm potentiometer connected in series circuit relation to said 70-volt battery with the resistor connected to the negative terminal of the battery and the potentiometer connected to the positive terminal of the battery, a photoelectric cell having positive and negative electrodes, means connecting said negative electrode to the variable terminal of said 1000-ohm potentiometer, means including a 30-megohm resistor connecting said positive electrode to the positive terminal of said 1200-ohm resistor, a first stage vacuum tube amplifier having a filament, grid and plate, means connecting said filament to the variable terminal of said second 400-ohm potentiometer, means connecting said grid to the positive electrode of said photoelectric cell, means including a 50,000-ohm resistor connecting said plate to the positive terminal of said 3500-ohm resistor, a second stage vacuum tube amplifier having a filament, grid and plate, means connecting said second stage amplifier filament to the negative terminal of said 1000-ohm potentiometer, means including a .1-microfarad condenser connecting said second stage amplifier grid to said first stage amplifier plate, means including a 250,000-ohm resistor connecting said second stage amplifier grid to the variable terminal of said first 400-ohm potentiometer, means including a 50,000-ohm resistor connecting said second stage amplifier plate to the variable terminal of said 2000-ohm potentiometer, a grid controlled gaseous discharge tube having a filament, grid and plate, means including a 75-ohm resistor connecting said power tube filament to the negative terminal of said 600-ohm resistor, means including a 100,000-ohm resistor connecting said grid controlled gaseous discharge tube grid to said second stage amplifier plate, means including a .01-microfarad condenser connecting said grid controlled gaseous discharge tube filament to the negative terminal of said 600-ohm resistor, means including a normally open circuit closing switch connecting said grid controlled gaseous discharge tube filament to said grid controlled gaseous discharge tube plate for periodically short circuiting the grid controlled gaseous discharge tube filament and plate to interrupt the ionization of said grid controlled gaseous discharge tube, an electromagnet having a spring retracted armature, means including said electromagnet connecting said grid controlled gaseous discharge tube plate to the positive terminal of said 145-volt generator, a common source of alternating current operatively connected to said filaments for heating the same, and means including said circuit closing switch for periodically short circuiting said 250,000-ohm resistor to condition said .1-microfarad condenser.

8. Electrical apparatus comprising in combination, a first direct current generator, a first battery connected to the terminals of said generator, a second direct current generator, a battery and a resistor connected to the terminals of said second generator, means connecting the positive terminal of said first generator to the negative terminal of said second generator, a first potentiometer, a second potentiometer, a resistor, a third potentiometer and a resistor connected in series circuit relation and to the terminals of said first battery with the first potentiometer connected to the negative terminal of the battery, a resistor and a fourth potentiometer connected to said second battery with the resistor connected to the negative terminal of the battery and the potentiometer connected to the positive terminal of the battery, a photoelectric cell having positive and negative electrodes, means connecting said negative electrode to the variable terminal of said second potentiometer, means including a resistor connecting said positive electrode to the negative terminal of said third potentiometer, a first stage vacuum tube amplifier having a filament, grid and plate, means connecting said filament to the variable terminal of said third potentiometer, means connecting said grid to the positive electrode of said photoelectric cell, means including a resistor connecting said plate to the positive terminal of said first battery, a second stage vacuum tube amplifier having a filament, grid and plate, means connecting said second stage amplifier filament to the negative terminal of said second potentiometer, means including a condenser connecting said second stage amplifier grid to said first stage amplifier plate, means including a conditioning resistor connecting said second stage amplifier grid to the variable terminal of said first potentiometer, means including a resistor connecting said second stage amplifier plate to the variable terminal of said fourth potentiometer, a grid controlled gaseous discharge tube having a filament, grid and plate, means including a resistor connecting said grid controlled gaseous discharge tube filament to the negative terminal of said second battery, means including a resistor connecting said grid controlled gaseous discharge tube grid to said second stage amplifier plate, means including a condenser connecting said grid controlled gaseous discharge tube amplifier grid to the negative terminal of said second battery, means including a normally open circuit closing switch connecting said power tube filament to said grid controlled gaseous discharge tube plate for periodically short circuiting the grid controlled gaseous discharge tube filament and plate to interrupt the ionization of said grid controlled gaseous discharge tube, an electromagnet having a spring retracted armature, means including said electromagnet connecting said grid controlled gaseous discharge tube plate to the positive terminal of said second generator, a common source of current operatively connected to said filaments for heating the same, and means including said circuit closing switch for periodically short circuiting said conditioning resistor.

9. Electrical apparatus comprising in combination, a first direct current generator, a first battery connected to the terminals of said generator, a second direct current generator, a battery and a resistor connected to the terminals of said sec-

ond generator, means connecting the positive terminal of said first generator to the negative terminal of said second generator, a first potentiometer, a second potentiometer, a resistor, a third potentiometer and a resistor connected in series circuit relation and to the terminals of said first battery with the first potentiometer connected to the negative terminal of the battery, a resistor and a fourth potentiometer connected to said second battery with the resistor connected to the negative terminal of the battery and the potentiometer connected to the positive terminal of the battery, a photoelectric cell having positive and negative electrodes, means connecting said negative electrode to the variable terminal of said second potentiometer, means including a resistor connecting said positive electrode to the negative terminal of said third potentiometer, a first stage vacuum tube amplifier having a filament, grid and plate, means connecting said filament to the variable terminal of said third potentiometer, means connecting said grid to the positive electrode of said photoelectric cell, means including a resistor connecting said plate to the positive terminal of said first battery, a second stage vacuum tube amplifier having a filament, grid and plate, means connecting said second stage amplifier filament to the negative terminal of said second potentiometer, means including a condenser connecting said second stage amplifier grid to said first stage amplifier plate, means including a conditioning resistor connecting said second stage amplifier grid to the variable terminal of said first potentiometer, means including a resistor connecting said second stage amplifier plate to the variable terminal of said fourth potentiometer, a grid controlled gaseous discharge tube having a filament, grid and plate, means including a resistor connecting said grid controlled gaseous discharge tube filament to the negative terminal of said second battery, means including a resistor connecting said grid controlled gaseous discharge tube grid to said second stage amplifier plate, means including a condenser connecting said grid controlled gaseous discharge tube amplifier grid to the negative terminal of said second battery, means including a normally open circuit closing switch connecting said grid controlled gaseous discharge tube filament to said power tube plate for short circuiting the grid controlled gaseous discharge tube filament and plate to interrupt the ionization of said grid controlled gaseous discharge tube, and means for periodically short circuiting said conditioning resistor.

10. Electrical apparatus comprising a conveyor adapted to carry a series of articles to be sorted past a selecting station and having a test spot and a contact movable therewith, a photoelectric cell adapted to be influenced by the articles passing said selecting station, a first amplifier having its grid operatively associated with said photoelectric cell, a second amplifier havin its grid connected to the plate of said first amplifier through a condenser, said plate being connected to its potential source through a resistor, means for periodically conditioning said condenser between the arrival and departure of the articles at said selecting station, a grid controlled gaseous discharge tube having its grid connected to the plate of said second amplifier through a resistor, the plate being connected to its potential source through a resistor and the grid being connected to ground through a condenser, sorting means at said selecting station controlled by said grid controlled gaseous discharge tube, means for periodically de-ionizing said grid controlled gaseous discharge tube between the arrival and departure of the articles at said selecting station, a stationary brush adapted to be momentarily engaged by said contact when the test spot is at the selecting station, and a signal lamp connected between the plate of said grid controlled gaseous discharge tube and said brush for indicating that the apparatus is not properly functioning each time the test spot passes the selecting station.

11. Electrical apparatus comprising a conveyor adapted to carry a series of articles to be sorted past a selecting station, a photoelectric cell adapted to be influenced by the articles passing said selecting station, a first amplifier having its grid operatively associated with said photoelectric cell, a second amplifier having its grid connected to the plate of said first amplifier through a condenser, said plate being connected to its potential source through a resistor, means for periodically conditioning said condenser between the arrival and departure of the articles at said selecting station, a grid controlled gaseous discharge tube having its grid connected to the plate of said second amplifier through a resistor, the plate being connected to its potential source through a resistor and the grid being connected to ground through a condenser, sorting means at said selecting station controlled by said grid controlled gaseous discharge tube, and means for periodically de-ionizing said grid controlled gaseous discharge tube between the arrival and departure of the articles at said selecting station.

12. Electrical apparatus comprising a conveyor adapted to carry a series of articles to be sorted past a selecting station, a photoelectric cell adapted to be influenced by the articles passing said selecting station, a first amplifier having its grid operatively associated with said photoelectric cell, a second amplifier having its grid connected to the plate of said first amplifier through a condenser, said plate being connected to its potential source through a resistor, means for periodically conditioning said condenser between the arrival and departure of the articles at said selecting station, a grid controlled gaseous discharge tube, sorting means at said selecting station controlled by said grid controlled gaseous discharge tube, and means for periodically de-ionizing said grid controlled gaseous discharge tube between the arrival and departure of the articles at said selecting station.

13. Electrical apparatus comprising a conveyor adapted to carry a series of articles to be sorted past a selecting station, a photoelectric cell adapted to be influenced by the articles passing said selecting station, an amplifier, a grid controlled gaseous discharge tube having its grid connected to the plate of said amplifier through a resistor, the plate being connected to its potential source through a resistor and the grid being connected to ground through a condenser, sorting means at said selecting station controlled by said grid controlled gaseous discharge tube, and means acting in synchronism with said conveyor for periodically de-ionizing said grid controlled gaseous discharge tube between the arrival and departure of the articles at said selecting station.

14. Electrical apparatus comprising in combination, a photoelectric cell, an amplifier operatively associated with said photoelectric cell, a grid controlled gaseous discharge tube operatively associated with said amplifier, an electro-

magnet in the plate circuit of said grid controlled gaseous discharge tube, a source of electromotive force in the plate circuit of said grid controlled gaseous discharge tube for maintaining the ionization current therein when established and energizing said electromagnet, a shunt circuit in parallel with the plate circuit of said grid controlled gaseous discharge tube, a normally open switch in said shunt circuit, and means for periodically closing said switch to deionize said grid controlled gaseous discharge tube without opening said plate circuit.

15. Electrical apparatus comprising in combination, a photoelectric cell arranged to view a continuous series of constantly moving spaced articles, a shade having a light passage for directing the light reflected from the articles to the photoelectric cell, a lamp housing surrounding said shade, lamps within said housing for illuminating the articles as they enter the viewing field of said photoelectric cell, and means for diffusing the light of said lamps to prevent the operation of said photoelectric cell by shadows, said means comprising frosting on the side of the lamp globes nearest the viewing position of the articles.

16. Electrical apparatus comprising in combination, a photoelectric cell arranged to view a continuous series of constantly moving spaced articles, a shade having a light passage for directing the light reflected from the articles to the photoelectric cell, a lamp housing surrounding said shade, lamps within said housing for illuminating the articles as they enter the viewing field of said photoelectric cell, and means for diffusing the light of said lamps to prevent the operation of said photoelectric cell by shadows, said means comprising frosting on the lamp globes.

17. Electrical apparatus comprising in combination, a photoelectric cell arranged to view a continuous series of constantly moving spaced articles, a shade having a light passage for directing the light reflected from the articles to the photoelectric cell, a lamp housing surrounding said shade, lamps within said housing for illuminating the articles as they enter the viewing field of said photoelectric cell, and means for diffusing the light of said lamps to prevent the operation of said photoelectric cell by shadows.

18. Electrical apparatus comprising in combination, a continuously moving conveyor for moving a series of articles in single file past an inspecting station, a photoelectric cell at said station for viewing each article as it passes the same, an amplifying circuit connected to said photoelectric cell for amplifying impulses originating in said cell, and means controlled by said photoelectric cell for discharging the discolored articles and comprising a hammer adapted to strike the article from the conveyor when actuated in response to the operation of the photoelectric cell, said hammer being arranged to operate outside of the view of said photoelectric cell so as not to influence the latter, and means in said circuit acting to delay the operation of the hammer until articles to be discharged thereby are moved adjacent thereto by said conveyor.

19. Electrical apparatus comprising in combination a photo-tube arranged to view a continuous series of constantly moving spaced articles, a first stage alternating current amplifier operatively associated with said photo-tube, a second stage alternating current amplifier operatively associated with said first stage amplifier, a grid controlled gaseous discharge tube operatively associated with said second stage amplifier, discharge means operatively associated with said grid controlled gaseous discharge tube for discharging discolored articles from said series in response to the operation of the photo-tube, said alternating current amplifiers acting to make said discharge means responsive only to a rapid rate of change of light intensity affecting said photo-tube rather than the absolute light intensity, and means synchronized with the movement of said articles for short circuiting the plate and filament of said discharge tube at regular intervals.

20. Electrical apparatus comprising in combination a photo-tube arranged to view a continuous series of constantly moving spaced articles, a grid controlled gaseous discharge tube operatively associated with said photo-tube, discharge means operatively associated with said grid controlled gaseous discharge tube for discharging discolored articles from said series in response to the operation of said photo-tube, an alternating current amplifying circuit between said photo-tube and grid controlled gaseous discharge tube for making said discharge means responsive only to a rapid rate of change of light intensity affecting said photo-tube, and means for periodically conditioning said amplifying circuit to neutralize the effects thereon of changes in light intensity below a predetermined rate.

21. Apparatus for sorting homogeneous articles, such as beans, comprising in combination, electric sorting means including a photoelectric cell arranged to view a constantly moving series of the articles as they move through an illuminated selecting station over a color reference background, an amplifier having a condenser in its grid circuit, and means operating in timed relation to the movement of said articles for restoring said condenser to its normal condition at definite intervals between the arrival and departure of articles at said selecting station.

22. Apparatus for sorting homogeneous moving articles, such as beans, comprising in combination, electric sorting means including a grid controlled gaseous discharge tube having means including a resistor in its filament to ground circuit for conditioning the tube, if ionized, for restoration to its normal unionized condition, and means operating in timed relation to the movement of said articles for periodically restoring said tube to its normal un-ionized condition at definite intervals if ionized, said last named means causing said tube to be short-circuited through said resistor.

23. Apparatus for sorting homogeneous moving articles, comprising in combination electric sorting means including a grid controlled gaseous discharge tube having means for conditioning the tube if ionized for restoration to its normal deionized condition, and means operating in timed relation to the movement of said articles for periodically restoring said tube to its normal deionized condition by short circuiting the tube at definite intervals.

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