

April 21, 1953

J. B. CAMP
ELECTRONIC COUNTER

2,635,809

Filed Aug. 11, 1950

3 Sheets-Sheet 1

FIG. 1.

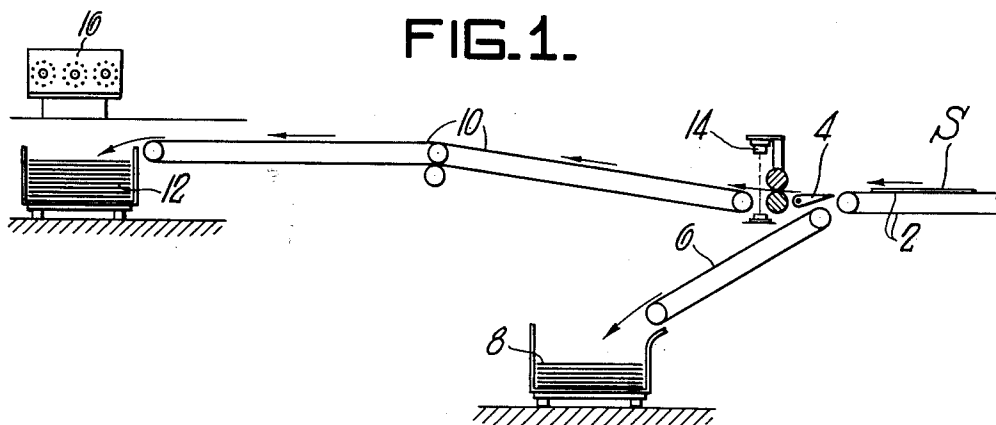
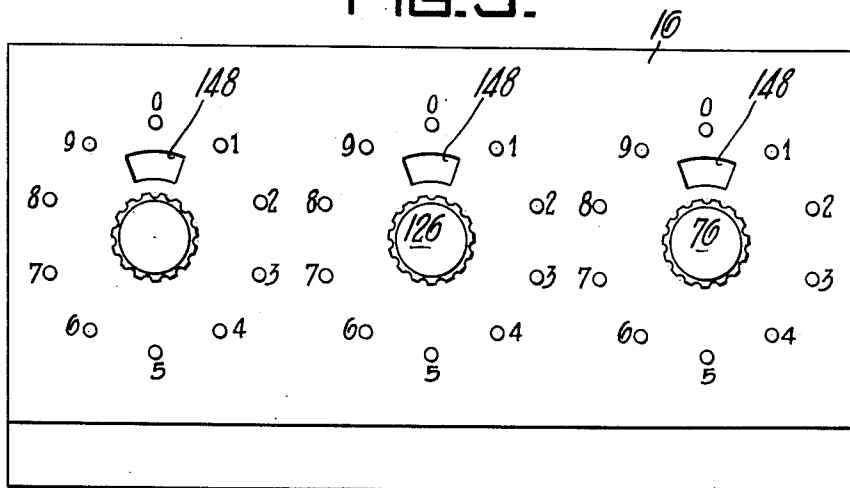


FIG. 3.



Inventor:
JAMES B. CAMP,
by: *Donald G. Dalton*
his Attorney.

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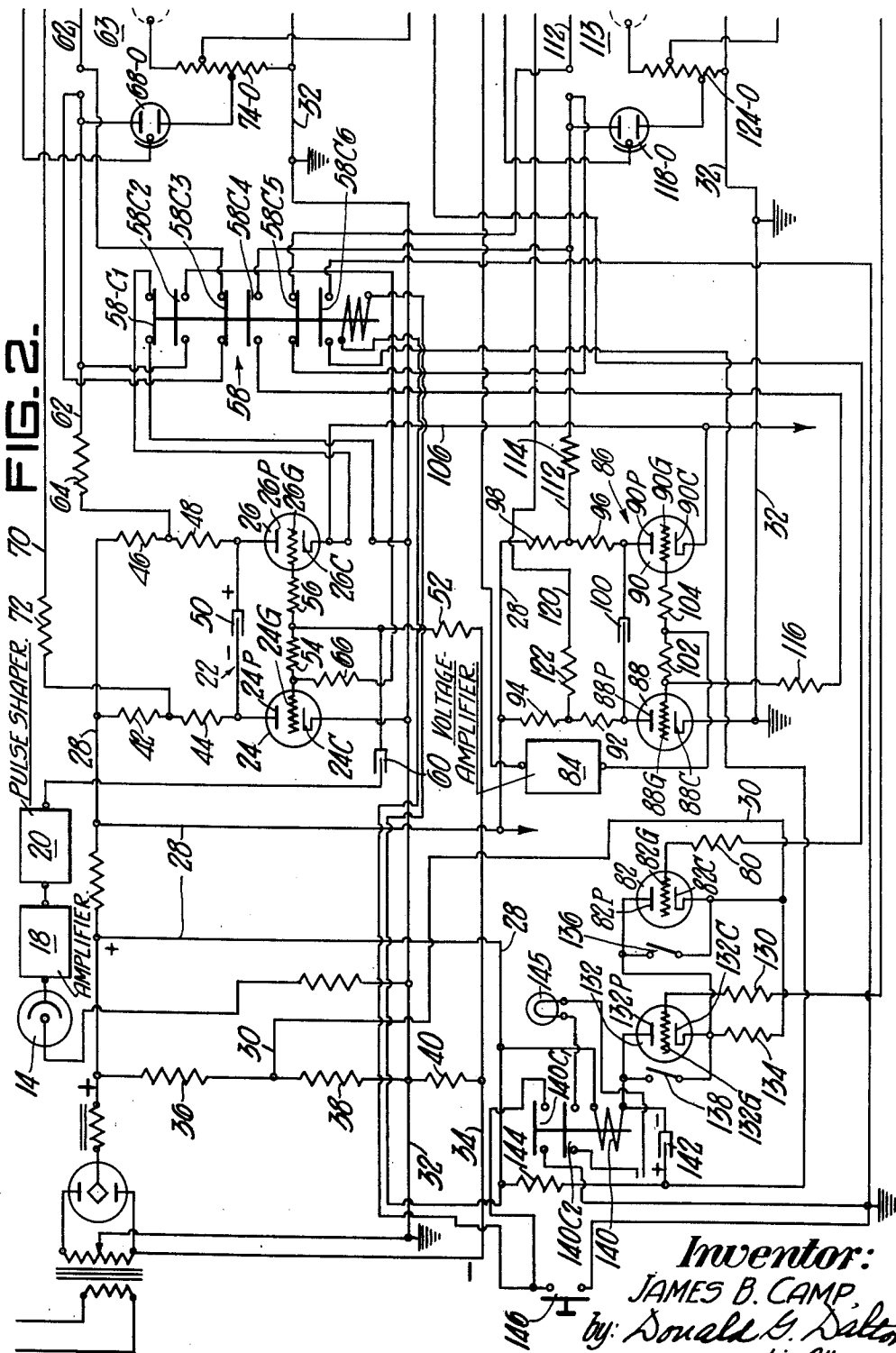
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3 Sheets-Sheet 2



Inventor:
JAMES B. CAMP,
by: *Donald G. Dalton*
his Attorney.

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3 Sheets-Sheet 3

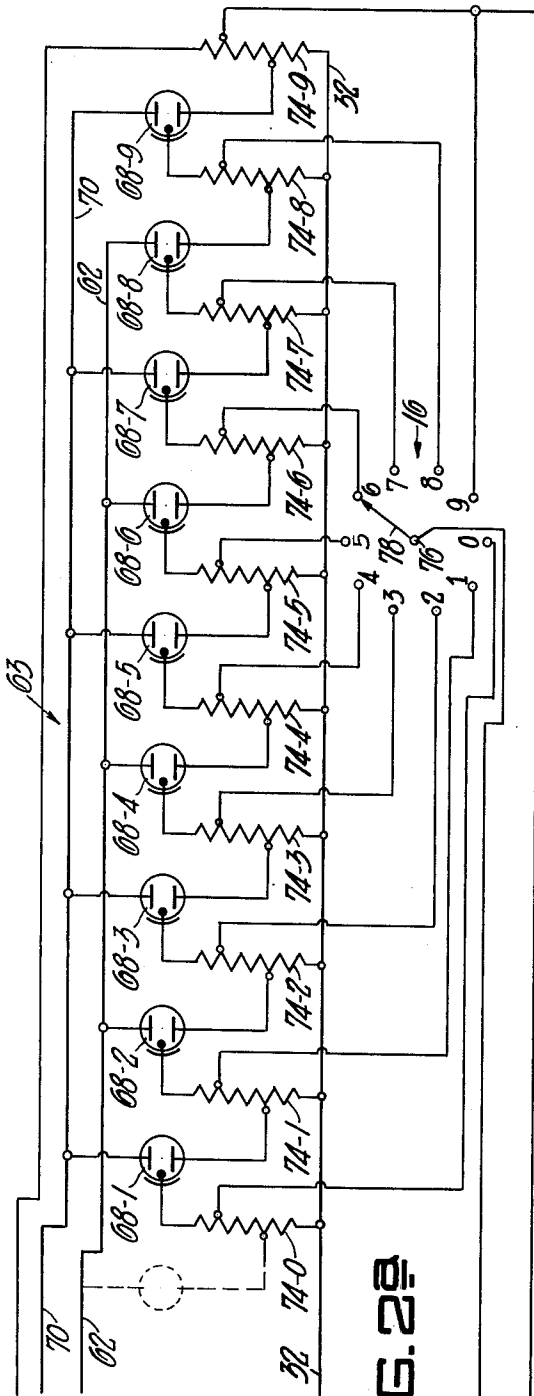
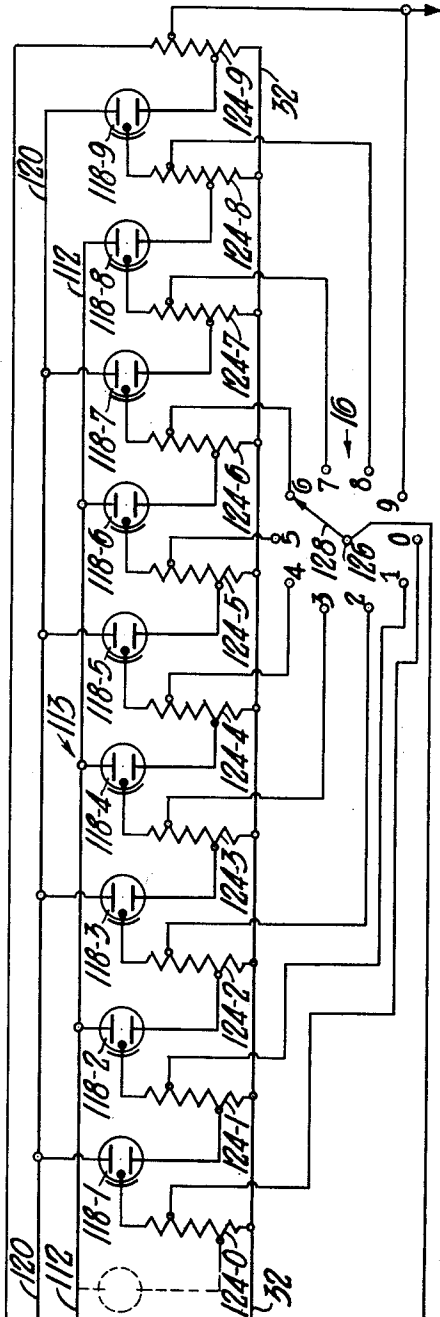


FIG. 2a



Inventor:
JAMES B. CAMP,
by: *Donald G. Dalton*
his Attorney.

UNITED STATES PATENT OFFICE

2,635,809

ELECTRONIC COUNTER

James B. Camp, Fairfield, Ala., assignor to United States Steel Corporation, a corporation of New Jersey

Application August 11, 1950, Serial No. 178,973

4 Claims. (Cl. 235—92)

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This invention relates to an electronic counter and more particularly to a counter for counting sheets of tin plate as they move along a conveyor. When so counting sheets of tin plate it is necessary to count a predetermined number of sheets to make a bundle. A sheet counter suitable for such purpose is disclosed in my co-pending application, Serial No. 1,230, filed January 8, 1948, now Patent No. 2,567,422. This counter has proved to be highly successful in use but some of the moving parts therein become worn and have to be replaced from time to time. To the best of my knowledge, other counters in use have not proved to be entirely satisfactory.

It is therefore an object of my invention to provide a counter without mechanical parts which is able to count sheets moving at high and variable speeds.

Another object is to provide such apparatus which has a relatively small number of parts.

These and other objects will be more apparent after referring to the following specification and attached drawings, in which:

Figure 1 is a schematic view of the counter installed in a sheet classifier;

Figures 2 and 2a, when taken together, disclose a schematic wiring diagram of my invention; and

Figure 3 is a front elevation of the box containing the counter.

Referring more particularly to Figure 1 of the drawings, the reference numeral 2 indicates a conveyor along which the sheets S travel on their way from a shear. At the end of the conveyor 2 is a flap gate 4 which directs the sheets S either to the conveyor 5 which leads to a mender piler 8 or to the inspection conveyor 10 which leads to a prime piler 12. An electric eye 14 is located in the path of travel of the sheets S to the prime piler 12. As the sheet passes under the electric eye 14 light thereto is cut off and the number of sheets on indicating unit 16 is increased by one in a manner to be described hereinafter. The electrical impulse from the photoelectric cell 14 may be applied to a voltage amplifier 18 which amplifies it to a value sufficiently high to enable it to operate the counter. This impulse varies in shape depending upon the speed at which the sheet passes under the photoelectric cell and therefore the pulse from the voltage amplifier 18 is impressed upon a pulse shaper 20 which, regardless of the shape of the pulse received, will deliver a pulse of uniform shape. This pulse is delivered to an electronic switch 22 which includes two electronic tubes 24 and 26. These tubes are provided with a grid,

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plate and cathode and are of the type in which conduction therethrough is started by means of the bias on the grid and in which conduction is interrupted by removing the plate voltage. D. C. voltage for the counter is applied from any suitable source to lines 28, 30, 32 and 34. The value of the voltage supplied to these lines is determined by means of the voltage dividers 36, 38 and 40. Lines 28 and 30 have a positive potential, line 32 is at ground potential, the line 34 has a negative potential. Line 28 is connected to plate 24P through resistances 42 and 44 and to plate 26P through resistances 46 and 48. The plates 24P and 26P are connected through a capacitor 50. A negative bias is applied to the grid 24G from the wire 34 through limiting resistors 52 and 54. A similar negative bias is applied to the grid 26G from the line 34 through limiting resistors 52 and 56. Cathode 24C is connected to ground 32. Cathode 26C is connected to ground 32 through the normally closed contacts 58C1 of a reset relay 58. The pulse from the pulse shaper 20 is applied to the grids 24G and 26G through a capacitor 60 which permits passage of the impulse but prevents passage of the direct current.

A bus 62 for a unit indicator circuit 63 is connected to the electronic switch 22 between the resistors 46 and 48. A resistor 64 is located in the bus 62 adjacent the connection to the switch 22. The grid 24G is connected to the bus 62 through a limiting resistor 66 and the normally open contacts 58C2 of the relay 58. A bank of neon glow tubes 68—0 to 68—9 are arranged, preferably in a circle, for indicating the units counted. For convenience of illustration the tubes are shown arranged in a line in Figure 2a. Each of the tubes 68 is provided with an anode, cathode and grid. As shown, the tubes have an external grid but tubes with an internal grid can also be used. The tubes are such that a greater potential is required to ionize the tubes than is required to keep them ionized. The bus 62 is connected to the anodes of the even numbered tubes 68—0, 68—2, 68—4, 68—6 and 68—8. A normally closed contact 58C3 is connected in the bus 62 between the anodes of tubes 68—0 and 68—2. A bus 70 is connected to the electronic switch 22 between resistor 42 and 44. The anodes of the odd numbered tubes 68—1, 68—3, 68—5, 68—7 and 68—9 are connected to the bus 70. A resistor 72 is provided in the bus 70 adjacent the connection to the switch 22. The cathodes of the tubes 68—0 to 68—9 are connected to ground return auto-transformers 74—0 to 74—9, respectively. Any suitable inductor

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can be used in place of the auto-transformers. The grids of tubes 68—1, 68—2, 68—3, 68—4, 68—5, 68—6, 68—7, 68—8, 68—9 and 68—0 are connected to auto-transformers 74—0, 74—1, 74—2, 74—3, 74—4, 74—5, 74—6, 74—7, 74—8 and 74—9, respectively. One end of each of the auto-transformers 74—0 to 74—9 is connected to the ground 32. A selector switch 76 is provided with ten contacts marked 0 to 9, inclusive, which contacts are connected to auto-transformers 74—0 to 74—9, respectively. The switch 76 has an operating arm 78 which is connected through resistor 80 to the grid 82G of a gas filled tube 92.

The auto-transformer 74—9 also has a tap leading to a voltage amplifier 84, which, in turn is connected to an electronic switch 86 which is similar to switch 22. Switch 86 has two tubes 88 and 90 of the same type as tubes 24 and 26. Plate 88P is connected to line 28 through resistors 92 and 94 and plate 90P is connected to line 28 through resistors 96 and 98. The plates 88P and 90P are connected through a capacitor 100. The impulse from voltage amplifier 84 is connected to grid 88G through resistor 102 and to grid 90G through resistor 104. Cathode 88C is connected to ground 32. Cathode 90C is connected to cathode 26C through line 106 which is connected to ground through normally closed contactor 58C1. A bus 112 for a tens indicator circuit 113 is connected to the electronic switch 86 between the resistors 96 and 98. A resistor 114 is located in the bus adjacent the connection to the switch. The grid 88G is connected to the bus 112 through a limiting resistor 116 and the normally open contacts 58C4 of the relay 58. A second bank of neon glow tubes 118—0 to 118—9 identical with tubes 68—0 to 68—9 are arranged preferably in a circle for indicating tens counted. For convenience of illustration the tubes are shown arranged in a line in Figure 2^a. The bus 112 is connected to the anodes of the even numbered tubes 118—0, 118—2, 118—4, 118—6 and 118—8. A normally closed contact 58C5 is connected in the bus 112 between the anodes of tubes 118—0 and 118—2. A bus 120 is connected to the switch 86 between resistors 92 and 94. The anodes of the odd numbered tubes 118—1, 118—3, 118—5, 118—7, and 118—9 are connected to the bus 120. A resistor 122 is provided in the bus 120 adjacent the connection to the switch 86. The cathodes of tubes 118—0 to 118—9 are connected to ground return auto-transformers 124—0 to 124—9, respectively. The grids of tubes 118—1, 118—2, 118—3, 118—4, 118—5, 118—6, 118—7, 118—8, 118—9 and 118—0 are connected to auto-transformers 124—0, 124—1, 124—2, 124—3, 124—4, 124—5, 124—6, 124—7, 124—8 and 124—9, respectively. One end of each of the auto-transformers 124—0 to 124—9 is connected to the ground 32. A selector switch 126 is provided with ten contacts marked 0 to 9, inclusive, which contacts are connected to auto-transformers 124—0 to 124—9, respectively. Switch 126 has an operating arm 128 which is connected through a resistor 130 to the grid 132G of a gas filled tube 132.

Cathode 82C is connected to line 30. Cathode 132C is connected to line 30 and to cathode 82C through a resistor 134. Plate 32P is connected to cathode 132C. Cathode 82C is connected to plate 32P through a switch 136 which is closed only when the arm 78 of switch 76 is on its zero position. The switches 76 and 136 may be mounted on a common shaft so that they will operate together in this manner. In like manner cathode 132C is connected to plate 132P through a switch

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138 which is closed only when arm 128 of switch 126 is on zero position. Switches 126 and 138 may also be mounted on a common shaft so that they will operate together. Plate 132P is connected to wire 28 through the operating coil of a relay 140. Connected to the wire 28 in parallel with the coil 140 are a capacitor 142 and a charging resistor 144. The normally open contact 140C1 of relay 140 is connected in series with the coil of relay 58. A second set of normally open contacts 140C2 may be provided for controlling a light, bell or other equipment 145 when relay 140 is energized. A normally open reset switch 146 is connected in parallel with the contact 140C1. The capacitor 142 and resistor 144 are connected to ground through a normally open contact 58C6.

Additional indicator circuits, similar to circuits 63 and 113 may be provided to indicate hundreds, thousands, etc. An electronic switch is provided for each additional circuit with the parts thereof being connected to wires 58 and 106 and to the tap from auto-transformer 124—9 as indicated by the arrows. Figure 3 shows a front view of the indicating unit 16 in which means are provided for counting to 999. The tubes in each bank are arranged in a circle and numbered from 0 to 9 as shown. The pointers 78 and 128 as well as the pointer for the hundreds unit are arranged on a numbered dial with the preset number appearing through windows 148 in the wall of indicating unit 16.

The operation of the device is as follows:

Assuming that direct current is being applied to the system as shown, there will be sufficient negative bias from the line 34 on the grids 24G and 26G to prevent the tubes 24 and 26 from conducting. To prepare the system for counting, the reset switch 146 is closed, thus energizing the coil of relay 58. This momentarily opens contact 58C1 thus preventing flow of current through the tube 26 and at the same time closes contact 58C2 which will decrease the negative bias on grids 24G and 26G to a point sufficient to start tube 24 conducting. Tube 26 cannot conduct because its cathode circuit is open. Since tube 26 is not conducting, sufficient potential is supplied to bus 62 to cause the tubes 68 to conduct. However, contact 58C3 of relay 58 will also be open so that the initial potential on bus 62 is only applicable to tube 68—0. As soon as this tube starts conducting there will be a voltage drop across resistor 64 which reduces the voltage at the anode of the even numbered tubes to a value sufficient to sustain ionization, but not sufficient to cause ionization. Therefore, when relay 58 is deenergized and contact 58C3 closes the other even numbered tubes cannot ionize but the zero tube will remain light. In like manner only zero tubes are made light in all other banks. When tube 24 is conducting, its plate voltage is less than the voltage on plate 26P because of the drop in potential through resistors 42 and 44. Therefore, capacitor 50 is charged with a potential having the polarity shown in Figure 2. Also, when tube 24 is conducting, it draws current through resistor 42 and reduces the potential on the bus 70 and therefore the potential on the anodes of the odd numbered tubes to a point below that necessary to sustain ionization. When the first sheet S passes under the photoelectric cell 14 a positive charge is impressed on the grids 24G and 26G through the capacitor 60. This reduces the negative bias on grid 26G to a point where tube 26 will start conducting. When this happens the potential on plate 26P will decrease because of current flow-

ing through resistors 46 and 48 until the potential is equal to that on plate 24P. The capacitor 50 will then discharge electrons from the negative to the positive side in order to neutralize the charge. This flow of electrons causes a voltage drop across resistors 42 and 44 which reduces the potential of plate 24P sufficiently to stop tube 24 from conducting. When this occurs, the capacitor 50 will recharge with a polarity opposite to that shown. When tube 26 conducts it draws current through resistance 46 to reduce the potential on bus 62 to a point below that necessary to sustain ionization of the even numbered tubes. Since tube 24 is not conducting, the voltage on bus 70 is sufficient to sustain ionization of the odd numbered tubes. Tube 68—0 will be deionized and will stop drawing current through the auto-transformer 74. This induces a large voltage in the winding of the transformer of such polarity as to oppose the change in current. This voltage is applied to the grid of tube 68—1 and in combination with the sudden increased anode voltage will cause tube 68—1 to ionize. Tube 68—1 will draw enough current through resistor 72 to reduce the voltage available at its anode to a value sufficient to sustain ionization, but insufficient to cause ionization so that none of the other odd numbered tubes will ionize. While all of the odd numbered tubes had the same anode potential as tube 68—1 only tube 68—1 received the inductive kick on its grid which permitted it to ionize before the other odd numbered tubes had an opportunity to do so. Once tube 68—1 ionizes it draws enough current through resistor 72 to prevent the other odd numbered tubes from ionizing. When a second sheet S passes under the electric eye 14, conduction is switched back to tube 24 by reducing the potential on grid 24G to cause the tube 24 to fire, which in turn, causes the capacitor 50 to stop tube 26 from firing. When tube 24 fires the potential on the anodes of the odd numbered tubes is reduced to a point where they cannot remain ionized. When tube 68—1 deionizes it gives an inductive kick to the grid of tube 68—2. This causes tube 68—2 to ionize immediately, thus drawing current through resistor 64 and dropping the potential on the anodes of the even numbered tubes to a value insufficient to cause ionization of any of the other even numbered tubes. This operation repeats itself until tube 68—9 is ionized.

When the tenth sheet S passes under the photoelectric tube 14, tube 68—0 will ionize due to the inductive kick from auto-transformer 74—9. Voltage from transformer 74—9 will also be fed to amplifier 84 where it is amplified and inverted and used to trigger electronic switch 86. This causes tube 118—1 to ionize in the same manner as explained above. When the twentieth sheet passes under the photoelectric eye 14 another pulse from auto-transformer 74—9 is impressed on switch 86, thus deionizing tube 118—1 and ionizing tube 118—2.

If desired, an additional bank of neon tubes identical with the units and tens banks may be provided by connecting the line 106 to the cathode of a tube similar to tube 90 of an electronic switch (similar to switches 22 and 86) and by connecting a tap from the auto-transformer 124—9 to a voltage amplifier similar to amplifier 84. Each additional bank will work in the same manner as the tens bank.

In some instances, such as in counting sheets of tin plate to make a bundle, it is desired to return the counter to zero after a predetermined number of sheets have been counted. Assuming

that sixty-six sheets are to be counted, the pointer 78 will be placed on contact 6 of the switch 76 and the pointer 128 will be placed on contact 6 of the switch 126. When the sixth sheet is counted, a positive pulse is applied across ground return auto-transformer 74—5. This pulse is applied to the grid 82G. However, tube 82 will not conduct since it does not have any plate potential until tube 132 conducts. When the sixtieth sheet is counted, a pulse is applied to grid 132G and since there is potential on plate 132P, tube 132 will conduct. However, its cathode return is through resistor 134 which has a high resistance so that it limits the plate potential of tube 132. As a result, tube 132 will not draw enough current to energize the coil of relay 140. When the sixty-sixth sheet is counted, a pulse is applied to grid 82G and since there is potential on plate 82P, tube 82 will start conducting. The cathode return of tube 132 will then have a very low impedance path through tube 82 to the ground and the conduction through tube 132 will be sufficient to cause the coil of relay 140 to energize. Energization of relay 140 closes contact 140C1, thus energizing the coil of relay 58, which in turn, resets the counter to zero. At the same time, contact 140C2 closes, thus turning on a light, sounding a bell or performing other actions. Energization of relay 58 closes contact 58C6 so that the previously positive left side of capacitor 142 will be at ground potential and the capacitor 142 will be recharged to a new value with opposite polarity. The recharging action will cause a voltage drop of such polarity as to reduce the plate potential of tube 132 below the value necessary to sustain ionization, thus cutting off tubes 132 and 82. If nine or less objects are to be counted, the switch 138 will be closed since the pointer 128 is on zero. In this case the tube 132 will be by-passed and tube 82 will be energized the first time that a pulse is applied to its grid. In like manner, if the pointer 128 is set to zero, switch 136 will be closed and the coil of relay 140 will be energized as soon as tube 132 conducts.

For each additional bank of neon tubes, additional gas filled tubes similar to tubes 132 and 82 are inserted between tubes 82 and 132 with a high resistor similar to resistor 134 inserted in the cathode circuit.

While one embodiment of my invention has been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. Apparatus for counting moving objects comprising a group of glow tubes, each of said tubes having a grid, anode and cathode, an electronic switch, means actuated by each of said moving objects for supplying an electrical impulse to said electronic switch, a first bus connected to said electronic switch, a second bus connected to said electronic switch, current being supplied to one of said buses by alternate impulses and to the other of said buses by the remaining impulses, connections between the first bus and a first electrode of alternate glow tubes, connections between the second bus and a first electrode of the remaining glow tubes, the first electrodes in both of said connections being of the same polarity, a resistor in the first of said buses adjacent its connections to the electronic switch, a normally closed contact in said first bus between the first and second connections from

said first bus to said tubes, said contact being momentarily opened when the counter is started in operation, an inductor for each of said glow tubes normally connected to ground, a tap between each of said inductors and the second electrode of its adjacent glow tube, and a tap between each of said inductors and the grid of the next succeeding glow tube, the last named tap from the last of said inductors being connected to the grid of the first of the group of glow tubes.

2. Apparatus for counting moving objects according to claim 1 including a second group of glow tubes similar to the tubes of the first group, a second electronic switch, a tap connecting the last inductor of the first group of glow tubes to the second electronic switch, a third bus connected to the second electronic switch, connections between the third bus and an electrode of alternate glow tubes of the second group, connections between the fourth bus and an electrode of the remaining glow tubes of the second group, a resistor in each of said third and fourth buses adjacent their connections to the second electronic switch, a normally closed contact in said third bus between the first and second connections, said contact being momentarily opened when the counter is started in operation, an inductor for each of said glow tubes of the second group connected to ground, a tap between each of said last named inductors and the other electrode of its adjacent glow tube, and a tap between each of said last named inductors and the grid of the next succeeding glow tube, the last named tap from the last of said inductors being connected to the grid of the first of the second group of glow tubes.

3. Apparatus for counting a predetermined number of objects comprising a group of glow tubes, each of said tubes having a grid, anode and cathode, an electronic switch, means actuated by each of said moving objects for supplying an electrical impulse to said electronic switch, a first bus connected to said electronic switch, a second bus connected to said electronic switch, current being supplied to one of said buses by alternate impulses and to the other of said buses by the remaining impulses, connections between the first bus and a first electrode of alternate glow tubes, connections between the second bus and a first electrode of the remaining glow tubes, the first electrodes in both of said connections being of the same polarity, a resistor in the first of said buses adjacent its connections to the electronic switch, a normally closed contact in said first bus between the first and second connections from said first bus to said tubes, said contact being momentarily opened when the counter is started in operation, an inductor for each of said glow tubes normally connected to ground, a tap between each of said inductors and the second electrode of its adjacent glow tube, a tap between each of said inductors and the grid of the next succeeding glow tube, the last named tap from the last of said inductors being connected to the grid of the first of the group of glow tubes, a second group of glow tubes similar to the tubes of the first group, a second electronic switch, a tap connecting the last inductor of the first group of glow tubes to the second electronic switch, a third bus connected to the second electronic switch, a fourth bus connected to the second electronic switch, connections between the third bus and an electrode of alternate glow tubes of the second group, connections between the fourth bus and an electrode of the remaining glow tubes of the second group, a resistor in each of said third and fourth buses adjacent their connections to the second electronic switch, a normally closed contact in said third bus between the first and second connections, said contact being momentarily opened when the counter is started in operation, an inductor for each of said glow tubes of the second group connected to ground, a tap between each of said last named inductors and the other electrode of its adjacent glow tube, a tap between each of said last named inductors and the grid of the

tween the fourth bus and an electrode of the remaining glow tubes of the second group, a resistor in each of said third and fourth buses adjacent their connections to the second electronic switch, a normally closed contact in said third bus between the first and second connections, said contact being momentarily opened when the counter is started in operation, an inductor for each of said glow tubes of the second group connected to ground, a tap between each of said last named inductors and the other electrode of its adjacent glow tube, a tap between each of said last named inductors and the grid of the next succeeding glow tube, the last named tap from the last of said inductors being connected to the grid of the first of the second group of glow tubes, a pair of selector switches one for each of said groups of glow tubes, each of said switches including an operating arm and a plurality of contacts equal in number to the tubes in the associated group, a tap connecting each of said contacts to one of said inductors, each of said operating arms being positioned on one of its associated contacts, a relay coil for operating said normally open contacts, means for energizing said relay coil when the predetermined number of objects are counted, and means connecting said operating arms to said last named means.

4. Apparatus for counting a predetermined number of objects comprising a group of glow tubes, each of said tubes having a grid, anode and cathode, an electronic switch, means actuated by each of said moving objects for supplying an electrical impulse to said electronic switch, a first bus connected to said electronic switch, a second bus connected to said electronic switch, connections between the first bus and an electrode of alternate glow tubes, connections between the second bus and an electrode of the remaining glow tubes, a resistor in each of said buses adjacent their connections to the electronic switch, a normally closed contact in said first bus between the first and second connections, said contact being momentarily opened when the counter is started in operation, an inductor for each of said glow tubes connected to ground, a tap between each of said inductors and the other electrode of its adjacent glow tube, a tap between each of said inductors and the grid of the next succeeding glow tube, the last named tap from the last of said inductors being connected to the grid of the first of the group of glow tubes, a second group of glow tubes similar to the tubes of the first group, a second electronic switch, a tap connecting the last inductor of the first group of glow tubes to the second electronic switch, a third bus connected to the second electronic switch, a fourth bus connected to the second electronic switch, connections between the third bus and an electrode of alternate glow tubes of the second group, connections between the fourth bus and an electrode of the remaining glow tubes of the second group, a resistor in each of said third and fourth buses adjacent their connections to the second electronic switch, a normally closed contact in said third bus between the first and second connections, said contact being momentarily opened when the counter is started in operation, an inductor for each of said glow tubes of the second group connected to ground, a tap between each of said last named inductors and the other electrode of its adjacent glow tube, a tap between each of said last named inductors and the grid of the

next succeeding glow tube, the last named tap from the last of said inductors being connected to the grid of the first of the second group of glow tubes, a pair of selector switches one for each of said groups of glow tubes, each of said switches including an operating arm and a plurality of contacts equal in number to the tubes in the associated group, a tap connecting each of said contacts to one of said inductors, each of said operating arms being positioned on one of its associated contacts, a relay coil for operating said normally open contacts, a pair of tubes each having a cathode, grid and plate, a connection between the grid of the first of said pair of tubes and the operating arm of the selector switch for the first group of glow tubes, a connection between the grid of the second of said pair of tubes and the operating arm of the selector switch for the second group of glow tubes, a connection between the plate of the first tube and the cathode of the second tube, a connection between the plate and cathode of the first tube, a switch in said last named connections, said last named switch being closed only when the arm of the first selector switch is on zero, a connection between the cathodes of said tubes, a

resistor in said connection, a connection between the plate and cathode of the second tube, a switch in said last named connection, said last named switch being closed only when the arm of the second selector switch is on zero, a D. C. power source, a connection between the D. C. power source and the plate of the second tube, and a relay coil in said last named connection for operating said normally open contacts, said relay coil being energized when the predetermined number of objects have been counted.

JAMES B. CAMP.

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