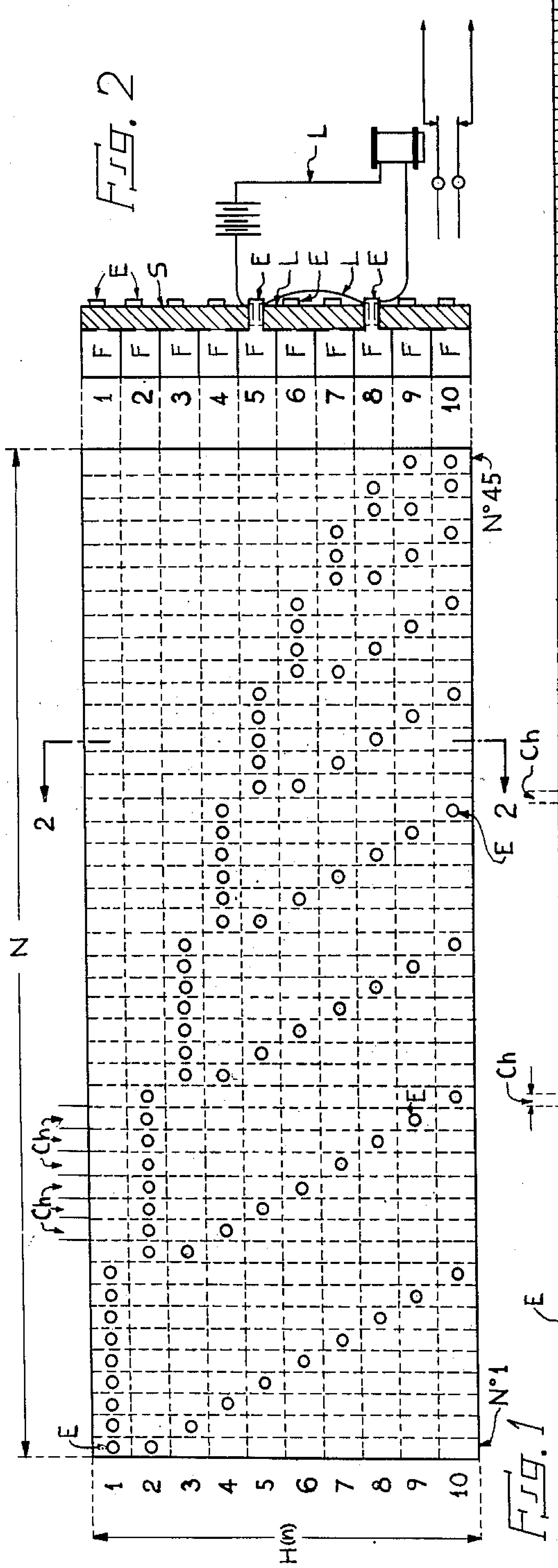
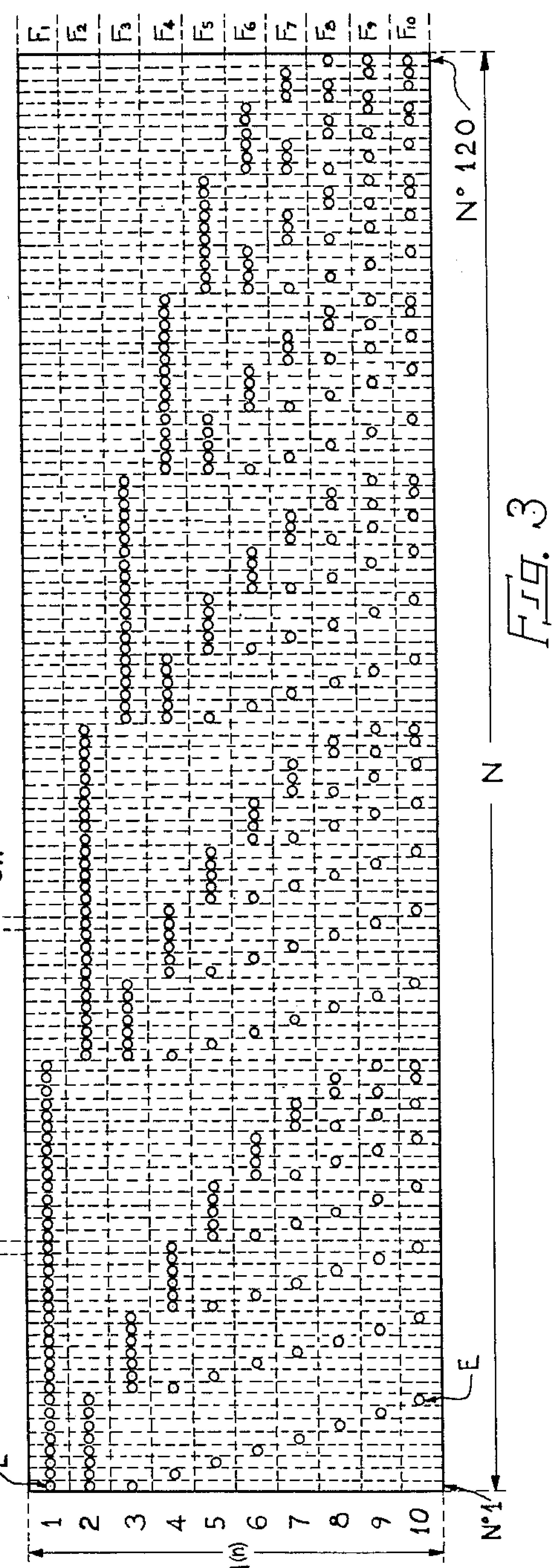
Jan. 6, 1953 J. URTEAGA 2,624,787

PHOTOELECTRIC SELECTOR OF ELECTRIC CIRCUITS

Filed Dec. 31, 1949 3 Sheets-Sheet 1





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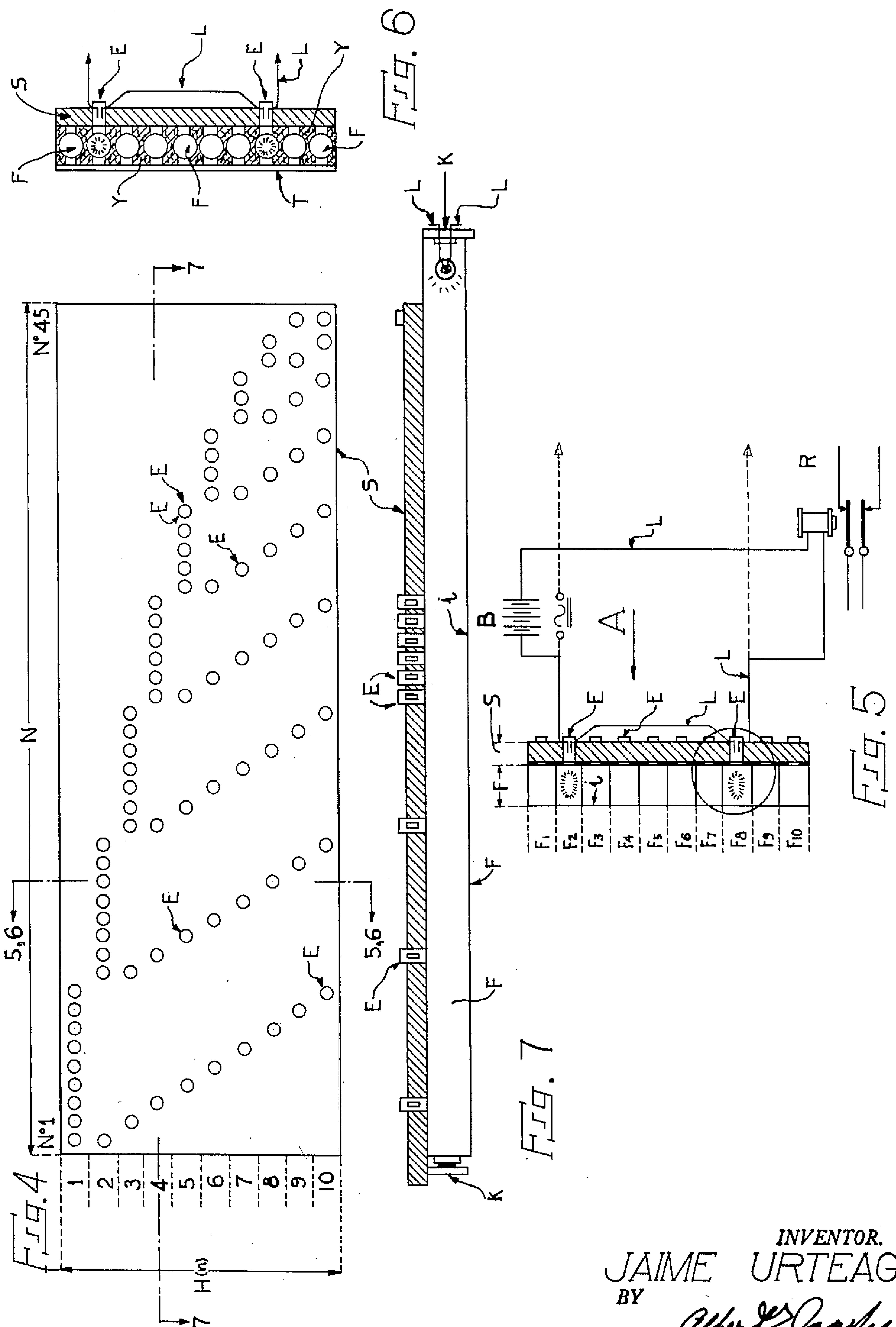
Filed Dec. 31, 1949 3 Sheets-Sheet 2



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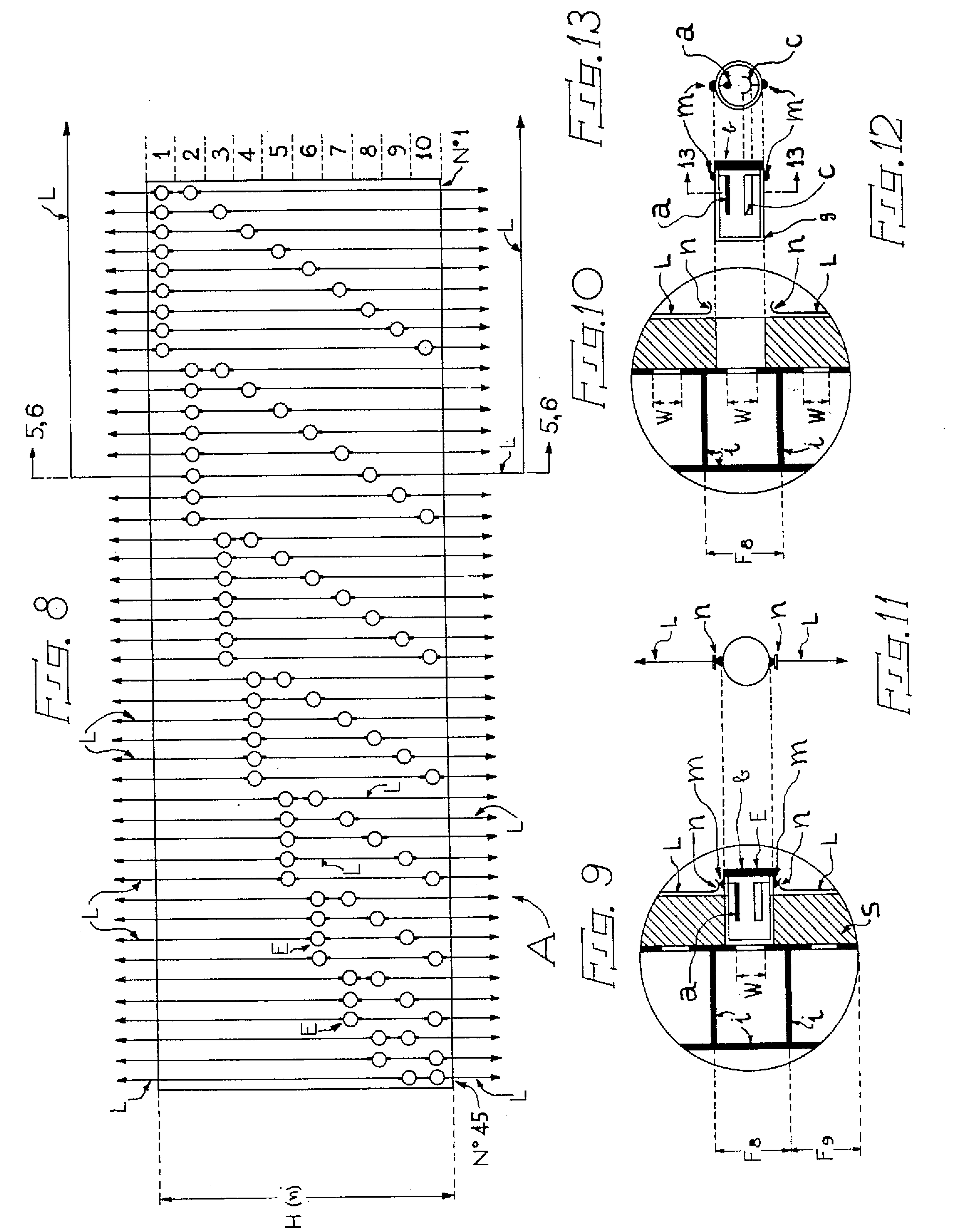
Filed Dec. 31, 1949 3 Sheets-Sheet 3



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PHOTOELECTRIC SELECTOR OF ELECTRIC CIRCUITS

Jaime Urteaga, Santiago, Chile

Application December 31, 1949, Serial No. 136,259

3 Claims. (Cl. 175—321)

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My invention relates to a multiple photo-electric element selector, and the object of the invention is to provide a practical selector, of many circuits, each of which is composed of two, three, four, or more photo-electric elements, so that whenever the complete chain of these elements is activated by the appropriate combination of ray sources, the corresponding circuit is closed, and will in turn complete the circuit of the particular motor, relay or other apparatus to be put in function.

Another object of the invention is to provide a selector for message transmission, such as telephony or telegraphy and automatic far-distance control of such equipment as planes, ships, tanks, etc., and speaking in general a selector which provides a simple selection of one or several circuits from a group of circuits.

The principal advantages of this selector over existing selectors are the following:

First, total absence of any moving parts; second, extreme light weight; third, compactness of design; fourth, ease, simplicity and low cost of maintenance; fifth, ease of replacement of any defective parts; sixth, trouble-free operation even in very polluted atmosphere; seventh, possibility of operation with either direct or alternating current; eighth, possibility of adopting shape of selector to the object in which it will be placed, since it may be constructed in either circular or flat rectangular shape; ninth, possibility of closing circuits of varying resistance, by varying intensity of activating rays; tenth, silent functioning; eleventh, cheapness of design; twelfth, necessity for less maintenance of personnel.

In the drawings in which like characters of reference designate corresponding parts throughout the views:

Figure 1 represents a schematic front view of the distribution of the photo-electric elements in a 10 light-source flat panel type selector, in which each chain counts with two elements.

Figure 2 represents the cross-sectional view of the same selector of Figure 1 along lines 1—1, showing at the same time the external relay connections.

Figure 3 represents the schematic front view of the distribution of the photo-electric elements in a 10 light-source flat panel type selector, in which each chain counts with three elements.

Figure 4 represents the front view of a 10 light-source flat panel type selector in which each chain counts with two elements, with these light-sources removed in order to show the panel perforations holding the photo-electric elements.

Figure 5 represents the vertical cross-sectional view of the same selector of Figure 4 along lines **3—3**. In this view the light-sources consist of rectangular box-like shaped light-reflecting cases or shields. At the same time the external relay wiring is shown.

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Figure 6 represents the same vertical cross-sectional view along lines **3—3** of Figure 4, but here light-, neon-, or fluorescent-tubes are shown as light sources.

Figure 7 represents the horizontal cross-sectional view along lines **2—2** of Figure 4.

Figure 8 represents the rear views of the same selector of Figure 4, looking in direction of arrow "A," shown in Figure 5.

Figure 9 represents the enlarged view of the encircled area of Figure 5, with the photo-electric element in its socket.

Figure 10 represents the same enlarged view, with the photo-electric element withdrawn from its socket.

Figure 11 represents the enlarged rear-view of the photo-electric element and its holding socket.

Figure 12 represents the enlarged longitudinal cross-sectional view of the phototube.

Figure 13 represents the enlarged cross-sectional view along lines **5—5** of the same phototube shown in Figure 12.

In these figures the letter E designates the photo-electric elements; the letter F, the light sources or reflector sources; the letter L, the wiring conductors; the letter S the selector panel; the letter H, the available height of light sources; the letter K, the light source holder; the letter R, the auxiliary relay, which is actuated by the chain elements; the letter B, is the battery which operates the relay R when the chain is closed; the letter *a* is the anode electrode of the photo-tube; the letter *c* is the cathode electrode of the phototube; the letter *m* is one of the two contacts of the photo-electric element-socket; the letter *n* is one of the two contacts of the counter-socket holding the photo-electric element; the letter *i* is the reflecting side of the light reflector cases or shields; the letter *w* is the window in the reflector cases or shields, through which the reflected light rays fall on the photo-electric element; the letter *g* is the glass or plastic cover of the phototubes; the letter *e* is the electrode of the photo-voltaic or photoconductive element; the letter N is the available width of chain circuits; the letter Y is the padding betwen light-, neon- or fluorescent-tubes; the letter T is the strip which holds the aforementioned padding in place; the letters *ch* are the chains of which each selector is composed; the numbers 1, 2, 3 etc. or F1, F2, F3 etc. are the numbering of the light-sources; the numbers (No. 1), (No. 2), (No. 3) etc. are the numbering of the chains.

The selector to which this application refers, consists of two main elements, (A) the various circuits or chains *ch* to be closed as desired, which in turn are composed of two or more photo-electric elements E, several of which connected in series make up a chain *ch*, which when activated by a light-source F, become either conductive or generate their own potential, hence closing the selected circuit or element chain *ch*.

(A) The photo-electric elements can consist of:

(1) Photo-voltaic cells, which are light-sensitive, and which generate a voltage or potential, when exposed to visible or other radiation.

(2) Photoconductive cells, which are also light-sensitive, and of which the resistance varies with the illumination intensity, projected on the cell.

(3) Photo-electric tube, also called phototube, in which an electron emission is produced directly, by radiation falling on the cathode electrode. This latter radiation may be light, and ultraviolet or infrared radiations.

(B) The radiation sources may consist of:

(*a*) Rectangular reflector cases or shields which with direct or alternating current, are illuminated inside by a light-source such as a bulb on one or both ends of the case or shield.

(*b*) Light-tubes, which are vacuum or gas-filled tubes provided with a filament which lights when either direct or alternating current of the correct voltage is applied.

(*c*) Neon-tubes, which are gas-filled tubes, provided with electrodes on each end which light the tube, through flashing from one electrode to the other when the correct voltage alternating current is applied.

(*d*) Fluorescent-tubes, which in principle are rather similar to neon-tubes, but which do not diffuse direct lighting as do the neon-tubes, since the flashing illuminates the fluorescent coating on the inside of the tube. These tubes also operate on the correct voltage of an alternating current.

(*e*) Infrared light sources.

(*f*) Ultraviolet light sources.

(*g*) X-ray light sources.

The last three light-sources, are rather of technical than practical interest. The different combinations of circuit selections are obtained by the varying relative locations of the photo-electric elements, making up each chain. With two elements in each chain, double selection is obtained, with three elements in each chain triple selection is obtained, with four elements quadruple selection, etc., etc.

The selector will be constructed from a panel of either flat or circular form, say, of some ¾″ thickness, which can be either of wood, or some other insulating material, such as plastic, ebonite, or similar material.

In this panel, holes will be drilled or cast along longitudinal and transverse rows, the longitudinal rows having greater numbers of holes than the transverse rows. Each hole will be furnished with a counter-socket complete with the terminals *n*, which latter will be permanently wired in series with the other terminals *n* of the remaining counter-sockets of the particular chain *ch*. Into these counter-sockets the photo-electric elements will be plugged, their contacts *m* making direct contact with the terminals *n* of the counter-sockets, so that it will be extremely easy to interchange any defective photo-electric element. Since the reflector cases, the light-, neon- or fluorescent tubes will be located as close as possible to these holes in the panel, these very holes will furnish a shield against any stray radiation hitting adjacent upper or lower cells. The light-sources will be placed at right angles to the axis of the chains of elements, so as to enable the right selection to be made by lighting the right combination of light-sources, as will be explained in detail further on.

If tubes are employed some padding Y between tubes and panel will have to be furnished to avoid any possibility of stray rays hitting adjacent upper or lower cells, which are not supposed to be activated. A chain of elements which composes a circuit may be composed of a minimum of two cells, which would provide the simplest case of selection.

If *n* represents the total number of light-sources which can be installed in the height of the panel then the following formula represents the total number N of circuit or chain combinations possible:

$$N_{(2)} \text{ is equal to } \frac{(n-1)\times n}{2}$$

or as illustrated in Figure 1 where there is provision for 10 light-sources in the height of the selector:

$$N_{(2)} \text{ is equal to } \frac{(10-1)\times 10}{2} \text{ is equal to } \frac{90}{2} \text{ equal to } 45.$$

which consists of the following combinations:

(1–2) (2–3) (3–4) (4–5) (5–6) (6–7) (7–8) (8–9) (9–10)
(1–3) (2–4) (3–5) (4–6) (5–7) (6–8) (7–9) (8–10)
(1–4) (2–5) (3–6) (4–7) (5–8) (6–9) (7–10)
(1–5) (2–6) (3–7) (4–8) (5–9) (6–10)
(1–6) (2–7) (3–8) (4–9) (5–10)
(1–7) (2–8) (3–9) (4–10)
(1–8) (2–9) (3–10)
(1–9) (2–10)
(1–10) giving a total of 45 combinations.

The same example of 10 light-source height has also been worked out for a selector with three elements in each chain in Figure 3. This gives the following combinations for the No. "1" group:

(1–2–3) (1–3–4) (1–4–5) (1–5–6) (1–6–7) (1–7–8) (1–8–9) (1–9–10)
(1–2–4) (1–3–5) (1–4–6) (1–5–7) (1–6–8) (1–7–9) (1–8–10)
(1–2–5) (1–3–6) (1–4–7) (1–5–8) (1–6–9) (1–7–10)
(1–2–6) (1–3–7) (1–4–8) (1–5–9) (1–6–10)
(1–2–7) (1–3–8) (1–4–9) (1–5–10)
(1–2–8) (1–3–9) (1–4–10)
(1–2–9) (1–3–10)
(1–2–10)

This sequence of the group "1" is covered by the formula $\frac{(n-2)\times(n-1)}{2}$ or a total of $\frac{8\times 9}{2}$ equal to 36 combinations.

Next comes the following sequences of combinations for the No. "2" group:

(2–3–4) (2–4–5) (2–5–6) (2–6–7) (2–7–8) (2–8–9) (2–9–10)
(2–3–5) (2–4–6) (2–5–7) (2–6–8) (2–7–9) (2–8–10)
(2–3–6) (2–4–7) (2–5–8) (2–6–9) (2–7–10)
(2–3–7) (2–4–8) (2–5–9) (2–6–10)
(2–3–8) (2–4–9) (2–5–10)
(2–3–9) (2–4–10)
(2–3–10)

This sequence of the group "2" is covered by the formula $\frac{(n-3)\times(n-2)}{2}$ or $\frac{56}{2}$ or equal to 28 combinations.

Next comes the following sequence of combinations for the No. "3" group:

(3–4–5) (3–5–6) (3–6–7) (3–7–8) (3–8–9) (3–9–10)
(3–4–6) (3–5–7) (3–6–8) (3–7–9) (3–8–10)
(3–4–7) (3–5–8) (3–6–9) (3–7–10)
(3–4–8) (3–5–9) (3–6–10)
(3–4–9) (3–5–10)
(3–4–10)

This sequence of the group "3" is covered by the formula $\frac{(n-4)\times(n-3)}{2}$ or $\frac{42}{2}$ or equal to 21 combinations.

Next comes the following sequence of combinations for the No. "4" group:

(4–5–6) (4–6–7) (4–7–8) (4–8–9) (4–9–10)
(4–5–7) (4–6–8) (4–7–9) (4–8–10)
(4–5–8) (4–6–9) (4–7–10)
(4–5–9) (4–6–10)
(4–5–10)

This sequence of the group "4" is covered by the formula $\frac{(n-5)\times(n-4)}{2}$ or equal to $\frac{30}{2}$ or 15 combinations.

Next comes the following sequence of combinations for the No. "5" group:

(5–6–7) (5–7–8) (5–8–9) (5–9–10)
(5–6–8) (5–7–9) (5–8–10)
(5–6–9) (5–7–10)
(5–6–10)

This sequence of the group "5" is covered by the formula $\frac{(n-6)\times(n-5)}{2}$ or equal to $\frac{20}{2}$ or 10 combinations.

Next comes the following sequence for the combination for the No. "6" group:

(6–7–8) (6–8–9) (6–9–10)
(6–7–9) (6–8–10)
(6–7–10)

This sequence of the group "6" is covered by the formula $\frac{(n-7)\times(n-6)}{2}$ or equal to $\frac{12}{2}$ or 6 combinations.

Next comes the following sequence for the combination for the No. "7" group:

(7–8–9) (7–9–10)
(7–8–10)

This sequence of the group "7" is covered by the formula $\frac{(n-8)\times(n-7)}{2}$ equal to $\frac{6}{2}$ or 3 combinations.

Finally remains the combination for the No. "8" group:

(8–9–10)

The formula of which is $\frac{(n-9)\times(n-8)}{2}$ or $\frac{2}{2}$ or 1 combination.

Therefore the total number of combinations of a selector, with an available height of 10 light-sources and containing 3 elements per chain is: 36 plus 28 plus 21 plus 15 plus 10 plus 6 plus 3 plus 1 giving a total of 120 combinations for triple selection as compared to 45 combinations for single selection composed of two elements per chain.

The partial formulae of groups 1 to 8 may be summarized in the following formula:

$$N_{(3)}=(n-2)^2+(n-2)^2-(n-2)$$

$$N_{(3)}=(10-2)^2+(10-2)^2-(10-2)=120 \text{ combinations}$$

Therefore as may be readily appreciated quadruple selection will boost up the number of combinations still more, and would take up too much space to be giving the detailed enumeration of combinations of the various sequences, and therefore, it must suffice to state that the total number of combinations possible is 210 for a selector with 10 light-sources.

From Figures 1 and 3 it may be readily appreciated that on none of the vertical lines or chains there will be encountered twice the same combination so that if for example light-sources 1 and 2 (Fig. 1) or 1, 2 and 3 (Fig. 3) are lit, only photoelectric elements in the row 1 and 2 or 1, 2 and 3 will be activated and only the chains No. 1 completed (Figs. 1 and 3). The same holds true for any other combination be it simple, triple or multiple selection, and the principle of selection is based hereon.

It is immaterial whether in the flat or circular type panel selectors the chains and light-sources are mounted horizontally or vertically, as long as they are mounted at right angles one to the other, since only the shape of the selector will be affected and not the functioning.

The Figure 1 represents a schematic outside front view of a 2 element per chain flat panel type selector, equipped with 10 light-sources for obtaining the different circuit selections. Here as in Figures 4 and 8 we have a graphical demonstration how a total of 45 combinations are obtainable with a selector of this specification.

Figure 2 shows the same selector in vertical sectional view along lines **1—1**. This selector is equipped with the rectangular shaped reflector cases F as mentioned under light-sources *a*, column 3, lines 24–27.

Figure 3 represents the schematic outside front view of a 3 element per chain flat panel type selector, equipped with 10 light-sources for obtaining 120 different combinations of circuits as is shown graphically herewith.

In Figures 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13 the various outside and sectional views of a 2 element per chain flat panel type selector, equipped with 10 light-sources and phototubes as photo-electric elements are shown.

Figure 4 is the front view of the panel with the light-sources removed in order to show the relative positions of the panel drillings or holes, containing the phototubes E.

Figures 5 and 6 show the vertical sectional view along lines **3—3** of Figure 4. In Figure 5 the rectangular shaped reflector cases are shown as light-sources as well as the external wiring of the auxiliary relay R and the battery B. This relay R is operated by the battery B when the circuit passing through the phototube elements E opposite light-source F2 and F8 is completed, when these elements are activated by the respective light-sources. An alternative circuit is marked by the dotted lines.

In Figure 6 light-, neon- or fluorescent tubes are shown as light-sources one tube separated from the other by means of pads Y, in order to prevent any stray light from falling on adjacent photo-electric elements in the upper or lower row.

From Figures 4, 5 and 6 a good picture of the method of selection may be formed, by assuming that light-sources F2 and F8 are lit in order to activate the respective elements of the chain corresponding hereto which in Figure 4 lies along line 3—3. A careful scrutiny of the remaining chains will reveal, that there exists no other combination of elements, which will activate another chain if light-sources F2 and F8 are lit, herewith giving a graphical demonstration of the method of selection.

Figure 7 is the horizontal sectional view of the same selector along lines 2—2. The light-source which corresponds to F4 in this instance is a reflector case, supported on flanges K, illuminated by a bulb placed at one end in the inside of the case. From this figure may be seen that whenever a light-source is lighted, a number of photoelectric elements are activated, (9 in the case of a 10 light-source 2 elements per chain selector and 36 in the case of a 10 light-source 3 elements per chain selector.) However this does not affect the principle of selection since in order to close a chain all the elements contained therein must be activated, and as shown above, there only exists one particular chain, which corresponds to a certain selection of light-source combinations.

From Figures 4, 5, 6 and 7 the mounting at right angles of light-sources and chains may be noted.

Figure 8 represents the rear view along arrow A of Figure 5 of the panel showing the series wiring connections L of the elements E making up the chains or circuits.

Figure 9 represents the enlarged view of the encircled area of light-source F8 and its corresponding phototube of the cross-sectional view of Figure 5, showing in more detail the transparent window *w*, through which the light-rays fall on the phototube E, of the reflecting surfaces *i* of the reflector casing F8, which at the same time acts as a shield preventing stray rays from activating adjacent cells in the upper or lower rows. In this Figure 9 the phototube E is shown in its position in the counter-socket of the panel-drilling or hole, showing how a positive contact is made between the prongs *m* of the phototube and the terminals *n* of the counter-socket in the panel-drilling.

Figure 10 represents the same enlarged view as Figure 9, but with the phototube E removed from its socket.

Figure 11 represents the rear outside view of the phototube and its counter-socket, showing how the conductors L are fixed permanently to the counter-socket contacts *n*.

Figure 12 represents the enlarged longitudinal sectional view of the phototube E, showing in detail the glass or plastic cover *g*, the base *b*, the anode electrode *a*, the cathode electrode *c* and the tube socket contacts or prongs *m*.

Figure 13 is the cross-sectional view of the same tube along lines 5—5 of Figure 12 showing the cross-sectional views of the anode electrode *a* and the cathode electrode *c*.

I claim:

1. A selector of the character described including a source of current, a plurality of electric conductor circuits, each one with a plurality of light sensitive elements forming selector chain circuits, said light sensitive elements being disposed in a panel in longitudinal and transverse rows, said longitudinal rows having greater numbers of elements than said transverse rows, and a plurality of light sources which are of elongated form, each light source being located adjacent a longitudinal row, separate chain circuits connecting all the elements in each transverse row in series with a sensitive relay for completing the selected chain circuit, and said chain circuits being activated by a preselected combination of a plurality of light sources.

2. A selector of the character described including a source of current, a plurality of electric conductor circuits, each one with a plurality of light sensitive elements forming selector chain circuits, said light sensitive elements being disposed in a panel in longitudinal and transverse rows, said longitudinal rows having greater numbers of elements than said transverse rows, and a plurality of light sources which are of elongated form, each light source being located adjacent a longitudinal row, separate chain circuits connecting all the elements in each transverse row in series with a sensitive relay for completing the selected chain circuit, each transverse row containing two light sensitive elements, and said chain circuits being activated by a preselected combination of two light sources.

3. A selector of the character described including a source of current, a plurality of electric conductor circuits, each one with a plurality of light sensitive elements forming selector chain circuits, said light sensitive elements being disposed in a panel in longitudinal and transverse rows, said longitudinal rows having greater numbers of elements than said transverse rows, and a plurality of light sources which are of elongated form, each light source being located adjacent a longitudinal row, separate chain circuits connecting all the elements in each transverse row in series with a sensitive relay for completing the selected chain circuit, each transverse row containing three light sensitive elements, and said chain circuits being activated by a preselected combination of three light sources.

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