

Aug. 3, 1943.

R. B. JOHNSON

2,325,958

PRINTING MECHANISM

Filed Dec. 27, 1940

7 Sheets-Sheet 1

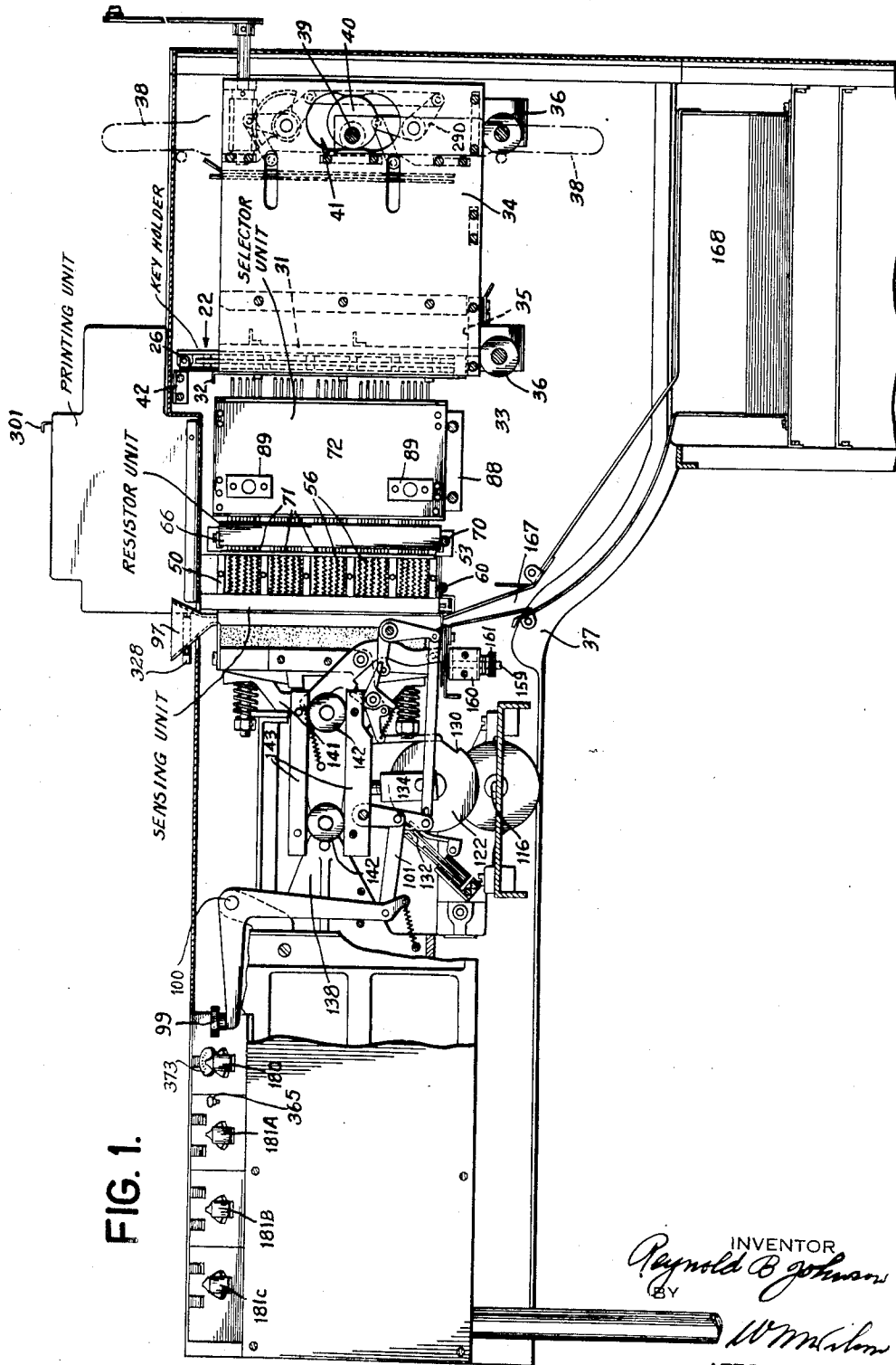


FIG. 1.

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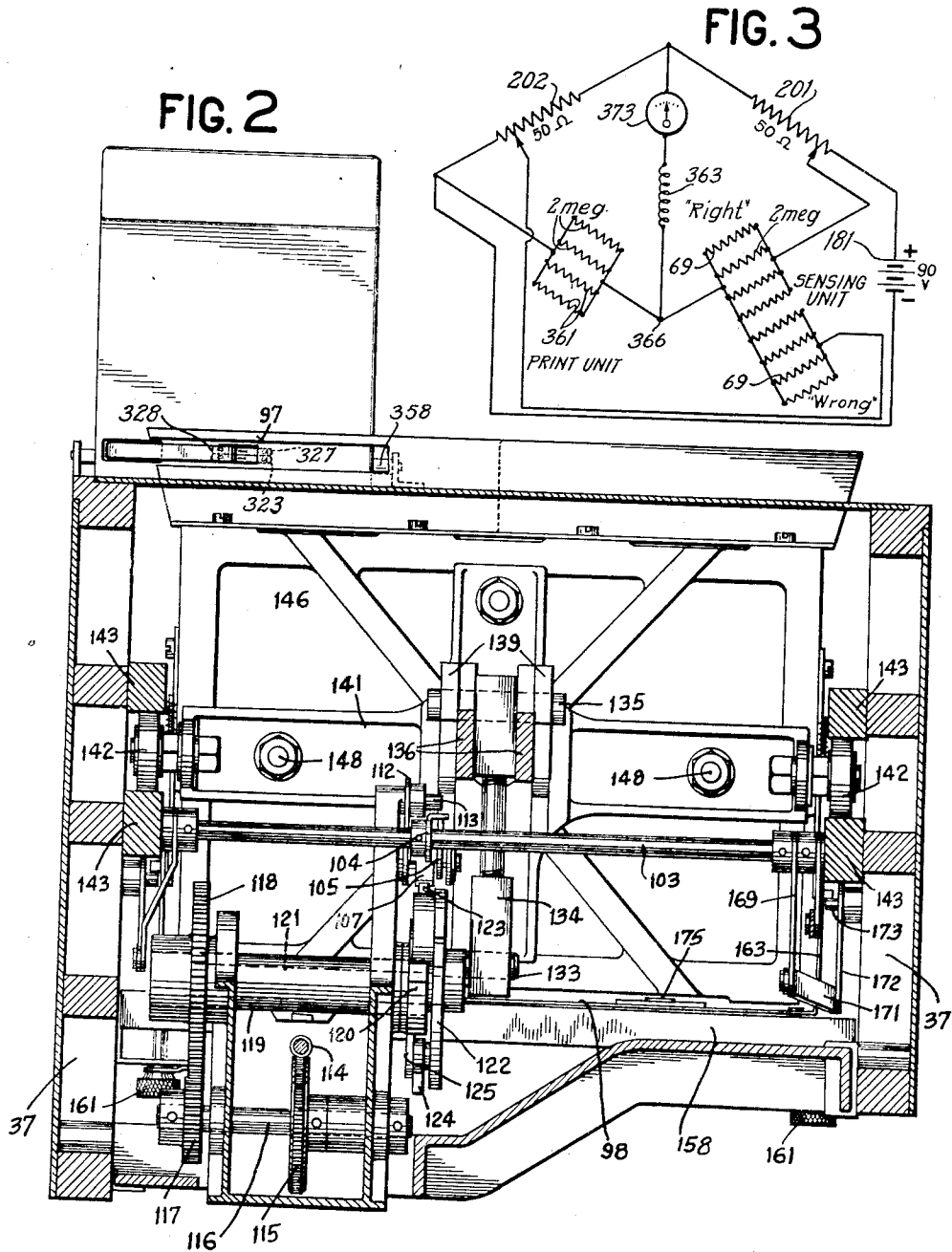
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PRINTING MECHANISM

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7 Sheets-Sheet 2



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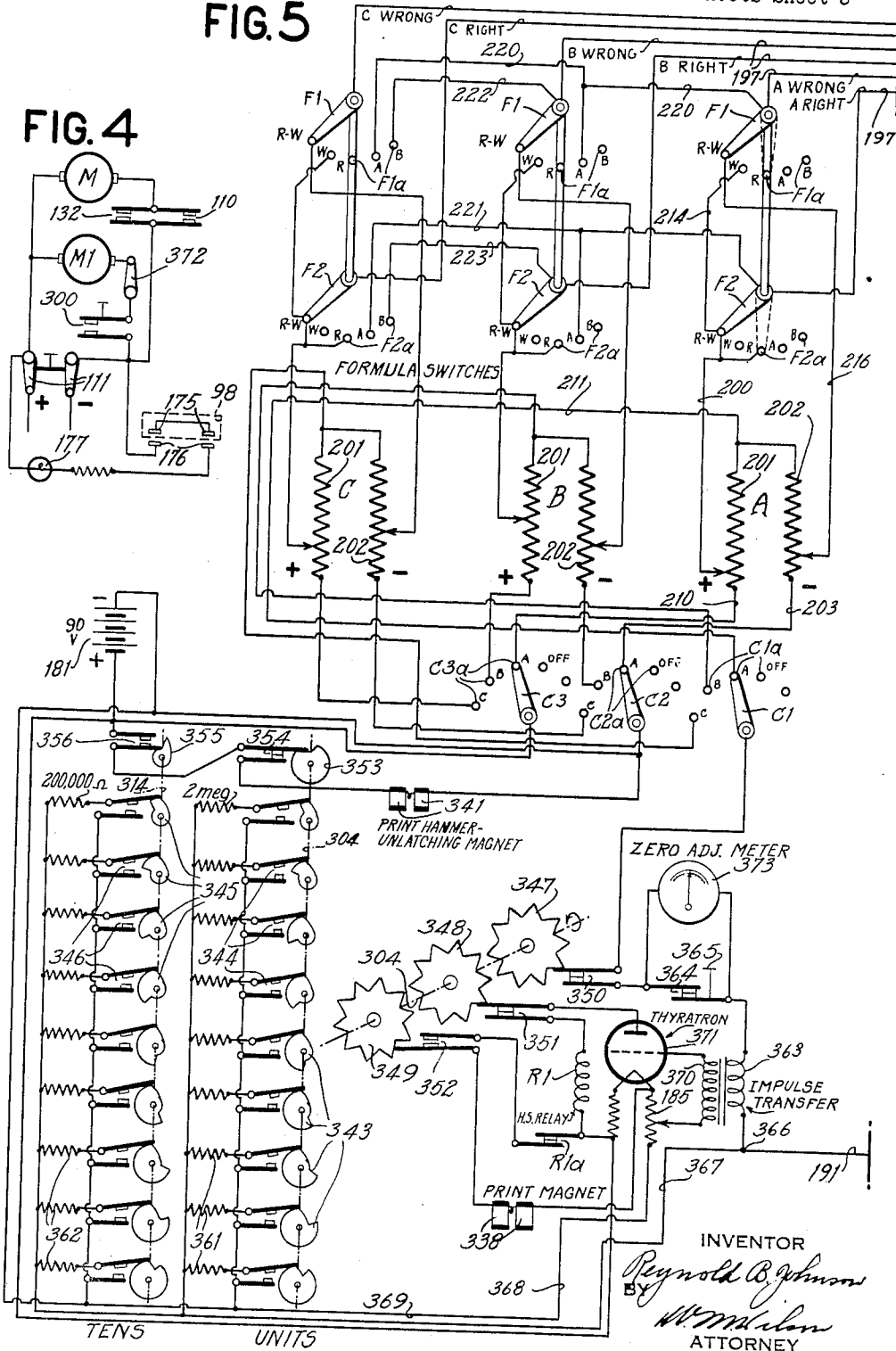
PRINTING MECHANISM

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7 Sheets-Sheet 3

FIG. 5

FIG. 4



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7 Sheets-Sheet 4

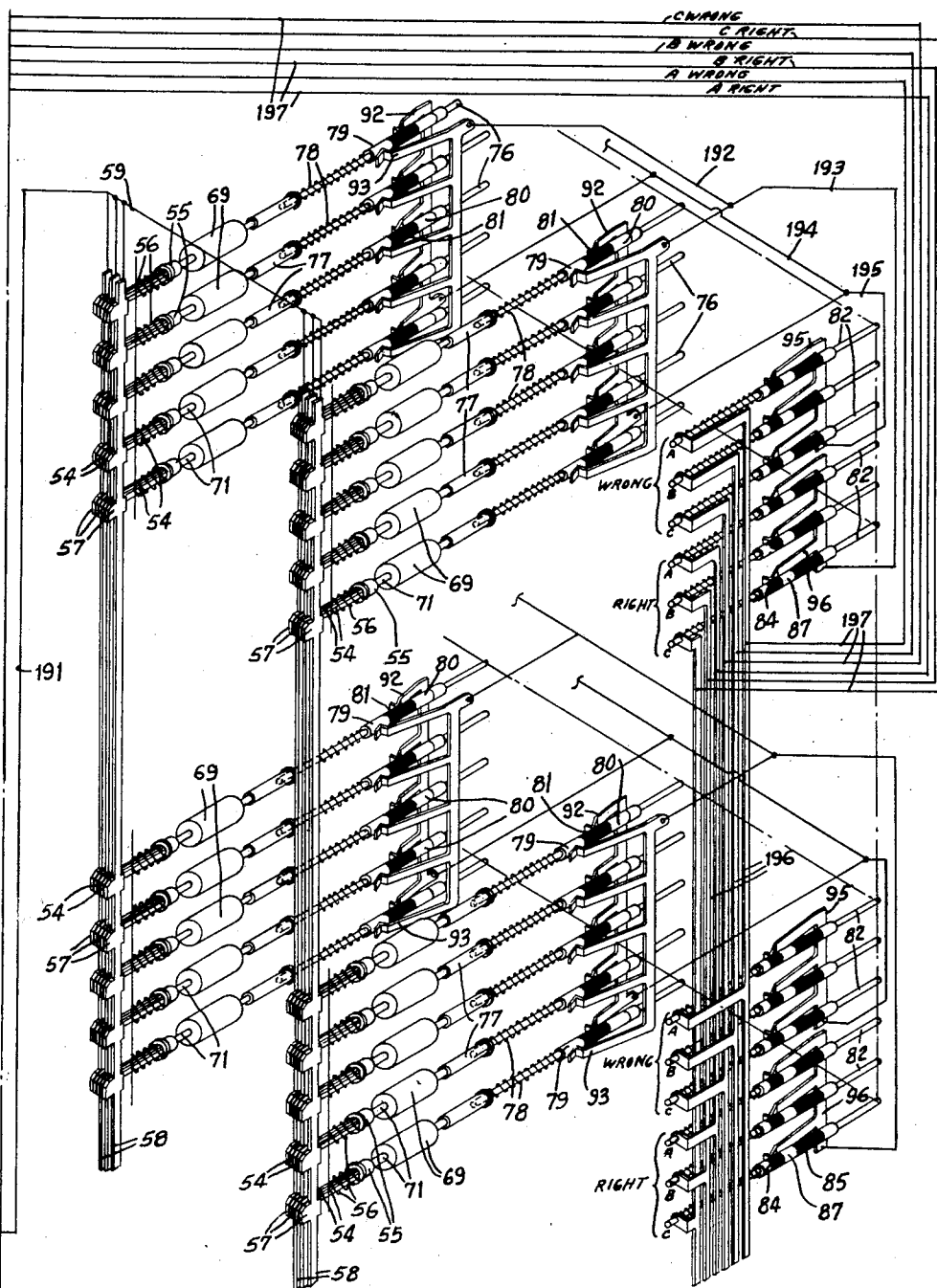


FIG. 5a.

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7 Sheets-Sheet 5

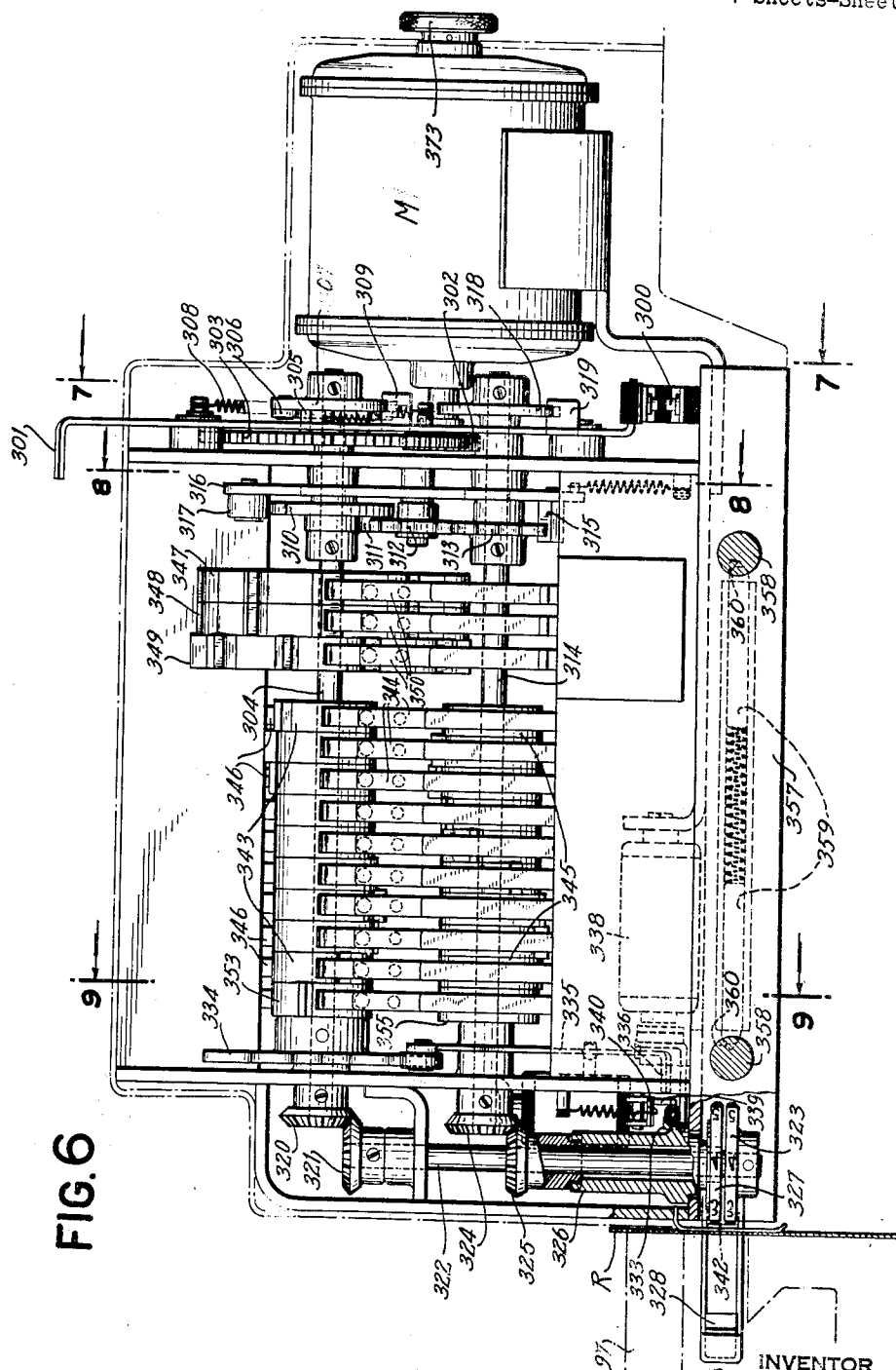


FIG. 6

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7 Sheets-Sheet 6

FIG. 9

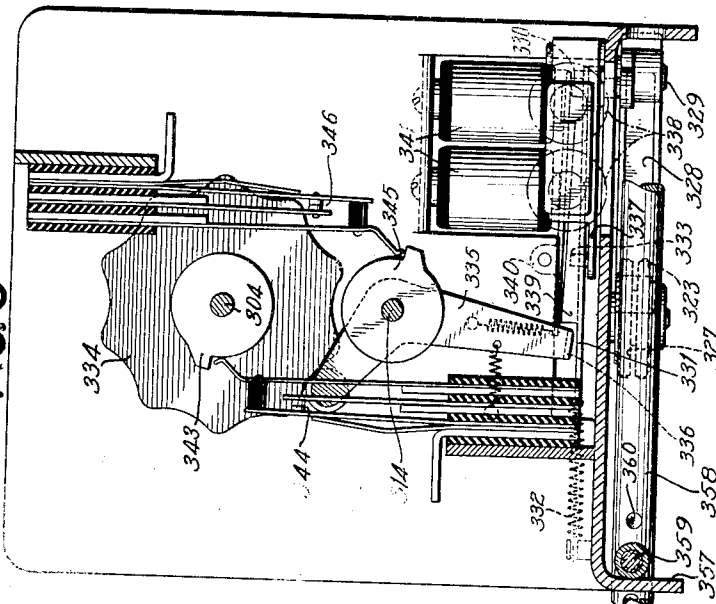


FIG. 8

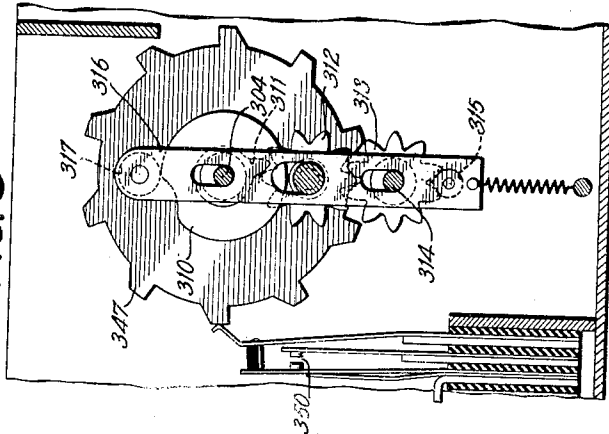


FIG. 7

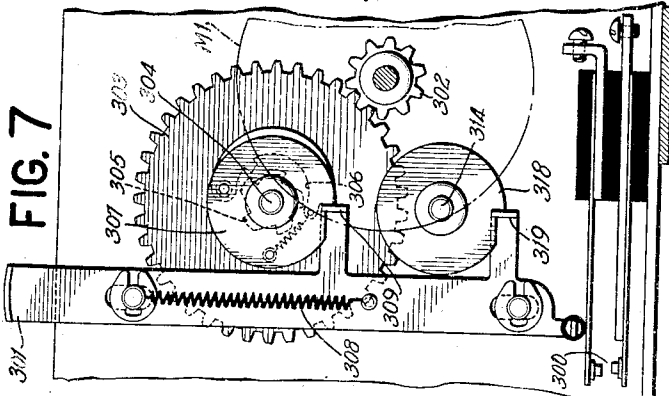
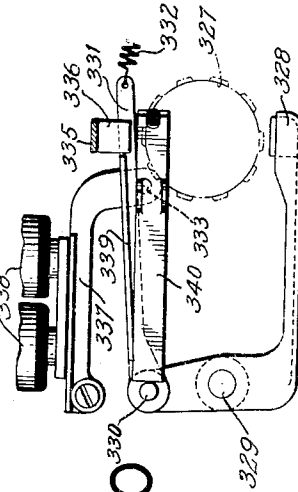


FIG. 10



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PRINTING MECHANISM

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7 Sheets-Sheet 7

FIG. 11

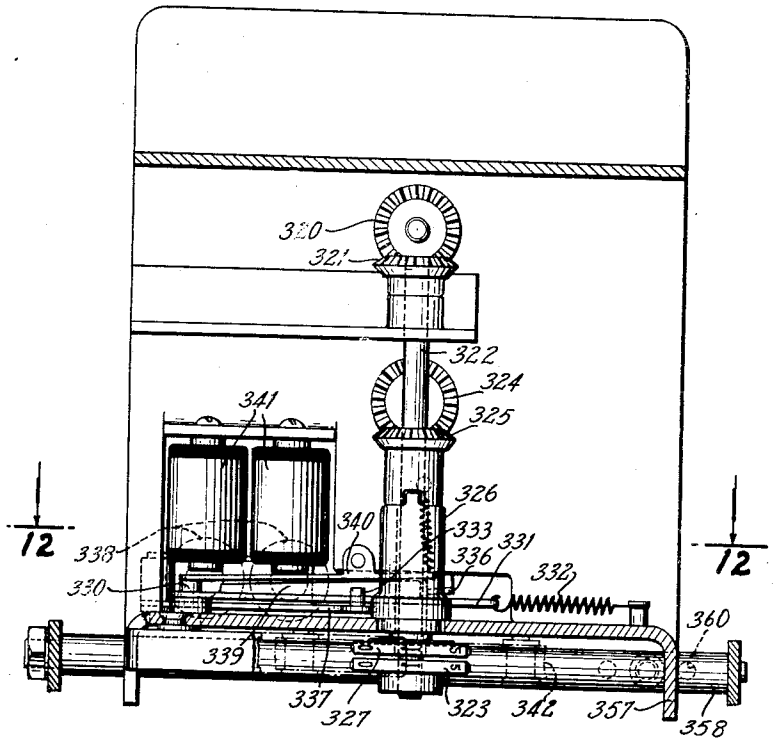
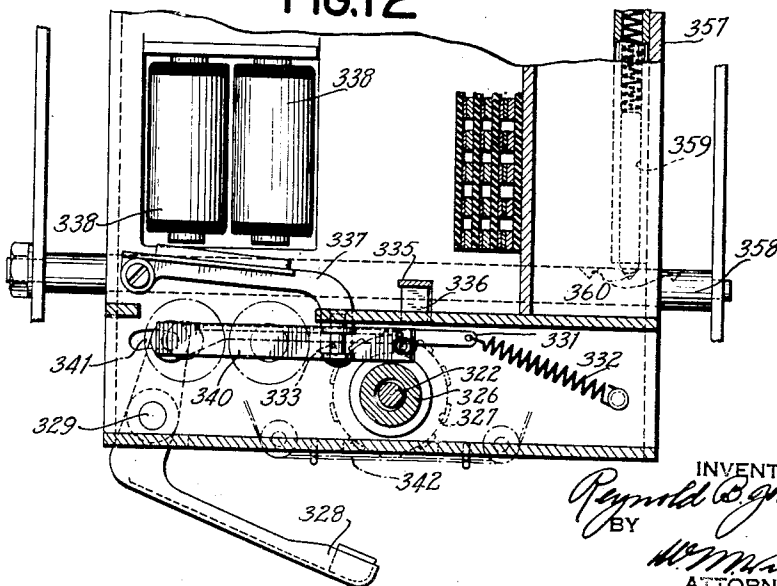


FIG. 12



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2,325,958

PRINTING MECHANISM

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Application December 27, 1940, Serial No. 371,867

8 Claims. (Cl. 235—61.3)

The present invention relates to the printing mechanism of a machine for electrically grading response sheets upon which an examinee has designated response by means of pencil marks. The machine constitutes improvements over the machine shown in my Patent No. 2,113,620, granted April 12, 1938.

The functioning of the machine depends on the fact that a soft lead pencil or special ink mark is electrically conductive and that the amount of current flowing through each pencil or ink mark may be controlled and kept to a uniform unit, whether the mark is very heavy or relatively light.

When the response sheet is inserted in the machine, it is pressed against a contact plate containing 750 sets of sensing blades corresponding to the 750 response positions on the response sheet. These sets of sensing blades consist each of five small parallel metal blades which are connected alternately to the positive and negative sides of the circuit. Whenever a pencil mark is pressed against one of the sets of sensing blades, it closes the electric gap between the positive and negative blades and a unit of current flows through the circuit.

The machine distinguishes between right and wrong answers by means of a perforated key sheet which automatically divides the sensing blade units into two groups, the "right" and the "wrong." From this division, two meter circuits result, one carrying the aggregate of the units of current from the correct responses and the other carrying the aggregate of the units of current from the incorrect responses.

In my copending application Serial No. 214,922, filed June 21, 1938, now issued as Patent No. 2,275,590, dated March 10, 1942, I provide a large milliammeter and switching devices through which the "rights" and "wrongs" circuits are variously routed. This meter is calibrated directly in terms of the unit of current flowing through the meter from each small circuit and hence the reading on the meter is equal to the number of right responses on the answer sheet being pressed against the sensing blades. The score indicated on the meter is recorded by the operator on the exposed margin of the response sheet or on a separate record sheet or the operator may call the score to a recording clerk.

If the score is in terms of the number wrong, the current from the wrongs circuit is routed through the meter which indicates to the operator the number wrong.

If the score is in terms of "rights" minus "wrongs," the "wrongs" circuit is connected to the opposite side of the meter from the "rights" circuit, so that the meter reading is the difference between the two currents, thus registering the "rights" minus the "wrongs."

According to the present invention, there is employed instead of an indicating meter a printing mechanism having a pair of printing wheels located adjacent to the examination sheet from which wheels the score is printed upon the sheet. The wheels are arranged to rotate from a zero position through all the possible scoring values up to the maximum and, when the value corresponding to the score is reached, a printing hammer is tripped to effect printing. The printing mechanism has associated with it a number of resistors which are cut into a circuit opposing the circuits through the sensed marks and, when the current resulting from the resistors introduced in the circuit by the examinee's response is balanced by the resistors introduced by the printing mechanism, this condition of balance is detected by an impulse transformer and a thyatron tube. The thyatron tube causes the print hammer to strike the rotating type wheels, recording the position of balance which is then directly proportional to the score of the examinee's answer sheet.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is a front view of the machine with the casing partially broken away to show the interior construction.

Fig. 2 is a sectional view taken transversely across the machine.

Fig. 3 is a diagrammatic showing of part of the circuit arrangement.

Fig. 4 is a view showing the control circuit for the driving motor.

Figs. 5 and 5a, placed side by side in the order named, constitute a wiring diagram of the electric circuits of the machine.

Fig. 6 is an enlarged outside view of the printing mechanism.

Fig. 7 is a section taken on lines 1—1 of Fig. 6.

Fig. 8 is a section taken on lines 2—2 of Fig. 6.

Fig. 9 is a section taken on lines 3—3 of Fig. 6.

Fig. 10 is a detail of the printing hammer and the related mechanism.

Fig. 11 is a detail of the printing mechanism looking from the left in Fig. 6.

Fig. 12 is a section taken on lines 12—12 of Fig. 11.

Reference to Patent No. 2,275,590 is made for disclosure of the detailed construction and operation of the machine to which the present invention is applied. Sufficient of such machine is shown in Figs. 1 and 2 to indicate where the printing mechanism of the invention is located, and the manner in which electrical coordination is obtained is shown in the wiring diagram (Figs. 5 and 5a). In these figures, the same reference characters are applied to parts as in the patent in order to facilitate reference thereto.

Printing unit

The location of the printing unit is shown in Fig. 1 and the details thereof are shown in Figs. 6 to 12 inclusive. The mechanism of the printing unit is driven by motor M¹ which receives current upon closure of a pair of contacts 300 (see Fig. 4). These contacts 300 are shown in Figs. 6 and 7 where they are closed by a manually operated key 301. On the shaft of motor M¹ is a pinion 302 meshing with a gear 303 which is freely mounted on the shaft 304. Integral with gear 303 is a ratchet 305 in the plane of which lies a spring-pressed clutching dog 306 which is pivoted to a disk 307 secured to the shaft 304. Normally, the parts occupy the position shown in Fig. 7.

When key 301 is depressed against the action of its restoring spring 308, disk 307 is released as is also the dog 306, which latter is then engaged by ratchet 305 for rotation. Key 301 is held in its depressed position by engagement of its extension 309 with the periphery of the disk 307. Just before the completion of the revolution of shaft 304, a disk 310 and a toothed member 311 secured thereon will be in the position shown in Fig. 8. The member 311 engages an idler pinion 312 and through it rotates a gear 313 one step or tooth, so that shaft 314 upon which pinion 313 is secured, will be advanced one tooth or a tenth of a revolution, inasmuch as pinion 313 and 312 are provided with ten teeth. The pinion 313 is normally held in position by a detent pin 315 (see also Fig. 6) which is carried by a vertically slidable bar 316 whose upper end carries a roller 317 cooperating with the disk 310. The timing is such that, as the toothed member 311 rocks pinion 312, the roller 317 is in a depression in the periphery of disk 310 so that the detent 315 is withdrawn downwardly to permit rotation of pinion 313, after which disk 310 again elevates the detent to hold shaft 314 in its advanced position.

At the extremity of shaft 314 is a disk 318 (Fig. 7) which at this time is free of the extension 319 on key 301, inasmuch as the key is held in its depressed position at this time by the disk 307. Disk 318 upon rotation will serve to maintain the key depressed even though extension 309 is freed at the completion of a revolution of shaft 304. As a result, shaft 304 continues through a second revolution, near the end of which shaft 314 is again advanced a tenth of a revolution in the same manner. This continues until shaft 304 has made ten revolutions when shaft 314 will have made one complete revolution. At such time both disks 307 and 318 will be in the relative positions shown in Fig. 7 so that spring 308 will return key 301 upwardly and

open contacts 300 to interrupt further operations.

Referring to Fig. 6, the shaft 304 has secured thereto a beveled gear 320 meshing with a similar gear 321 on vertical shaft 322 to the lower extremity of which is secured a type wheel 323 (see also Fig. 11). The shaft 314 also has a beveled gear 324 secured thereto which meshes with a beveled gear 325 freely rotatable on shaft 322 and connected to a sleeve 326 which carries a type wheel 327. It will thus be apparent that, when motor M¹ is energized, it continues running until the type wheel 323 has made ten revolutions and type wheel 327 has made one revolution to successively present the numbers 1 to 99 into printing position opposite printing hammer 328.

Hammer 328 is pivoted at 329 (Fig. 12) and has connected thereto at 330 a member 331 which is normally in the position shown in Fig. 12 where it is held by a spring 332 against a pin 333 (see also Figs. 11 and 10). Mounted on shaft 304 is a cam wheel 334 (Figs. 6 and 9) which oscillates a bell crank follower arm 335 ten times for each revolution of shaft 304. The lower end of this follower has a lateral extension 336 which rocks back and forth idly.

The pin 333 against which the member 331 is spring biased is carried by the armature lever 337 of a magnet 338 (see Fig. 10), so that when the magnet is energized the lever 337 is rocked from the position shown in Fig. 12 to that shown in Fig. 10 and an upward extension 339 of member 331 is brought into the path of the oscillating projection 336, which projection will engage the extension 339 and move member 331 rapidly toward the left as viewed in Fig. 10, whereby the hammer 328 will be rapidly rocked against the printing wheels to take an impression therefrom. The timing of the parts is such that wheel 327 is stationary at the time the hammer is tripped, whereas wheel 323 is in motion with one of the digits thereof in printing position. As will be explained later in connection with the circuit diagram, the time of energization of magnet 338 will determine the value of the amount to be printed from the printing wheels, that is, as the wheels rotate to present all of the numbers from 1 to 99, printing will be effected from one of these numbers according to the time at which magnet 338 is energized. Lying above the pivoted pin 339 is a spring pressed pivoted latch 340 (see Fig. 11) which, when the hammer is rocked from the position of Fig. 11 to that of Fig. 10, will drop down behind the pin 339 to hold the hammer against restoration and against further operation by the oscillating projection 336.

Near the end of the revolution of shaft 314, the magnet 341 is energized to rock latch 340 out of engagement with pin 339, allowing the hammer to be restored by the spring 332. In Fig. 12 there is indicated the inking ribbon 342. The detailed feeding mechanism is not shown as such devices are well known in the art.

Secured to shaft 304 is a group of nine cams generally designated 343, whose configuration is as diagrammatically represented in Fig. 5. These cams serve to close pairs of contacts 344 in succession until all are closed, and then reopen the contacts. Inasmuch as shaft 304 makes ten revolutions during a complete operation of the printing mechanism, the contacts 344 are closed in succession and concurrently open ten times.

On shaft 314 is a similar group of nine cams generally designated 345 which serve to control

contacts 346 which also serve to close the contacts 346 in succession and to open them concurrently at the end of a revolution of shaft 314. Since shaft 314 makes but a single revolution during an operation of the printing mechanism, there will be but a single closure of each of the contacts 345. The timing is such that the contacts 344 first close in succession with all the contacts 346 open, then the contacts 344 close in succession a second time with the first contact 346 closed. The next operation of the contacts 344 takes place with the first and second contacts 346 closed and so on.

On shaft 304 are three additional contact operating cams designated 347, 348 and 349 (Fig. 6). These cams control contacts designated 350, 351 and 352 respectively (see Fig. 5). There is also a cam 353 on shaft 304 which controls a pair of contacts 354 (Fig. 5). On shaft 314 is an additional cam 355 controlling a pair of contacts 356. The functions of these several cam controlled contacts will be more fully explained in connection with the circuit diagram (Fig. 5).

The mechanism of the printing unit is supported on a channel 357 (Figs. 6 and 12). This channel is mounted on a pair of cross rods 359 secured to a fixed part of the machine. Between the two cross rods is a pair of spring pressed detenting plungers 359 which cooperate with notches 360 in the rods, so that the entire printing unit may be located in one of several positions. The unit is mounted on the machine as shown in Figs. 1 and 6, so that the printing wheels lie adjacent to the examination sheet R when the latter is inserted in the guide chute 97. The latter is cut out as indicated to provide for operation of the printing hammer 328. The printing unit is made shiftable so that the numerals may be printed in any of several positions on the examination sheet.

From Figs. 6 to 12 it is seen that the printing unit in its mechanical structure comprises generally a motor M1 and a direct drive connection from the motor to a pair of printing wheels. With the motor in operation, the wheels turn so that the tens order wheel 327 makes one revolution in ten steps while the units order wheel 323 makes ten revolutions, one for each step of the tens order wheel, so that the numbers 1 to 99 are presented in succession to a printing position opposite hammer 328. Once the motor M1 is put in operation, it continues to run until all the numbers 1 to 99 have been presented and then stops. During its operation, various cams 343, 345, 347, 348, etc., function to control circuit connections as will be explained in connection with the circuit diagram to energize the printing magnet 338. The printing hammer is normally idle and lies spaced away from the printing wheels (Fig. 12). By means of cam 334 (Fig. 9) arm 335 is rapidly and repeatedly oscillated, once for each of the presented numbers 1 to 99, such oscillation being ineffective until magnet 338 is energized at the time a particular number is at the printing position. Thereupon, the hammer 328 is coupled through the intermediate lever 331 to the arm 335, so that the latter engages and forcibly rocks the hammer toward the wheels, the stroke being such that the positive action carries the hammer just up to the wheels and the inertia of the hammer completes the impression, the rebound and spring 322 thereafter bringing and holding the hammer in the position of Fig. 10 slightly away from the wheels so as not to inter-

fere with their continued rotation. Just before the motor M1 is deenergized, magnet 341 is energized to release the hammer for return to its position of Fig. 12 in readiness to be tripped during a subsequent operation of the unit.

Circuit diagram

Each of the resistors 69 shown in Fig. 5a and each of the resistors 361 in Fig. 5 has a resistance of 2 megohms. Each of the resistors 362 in Fig. 5 has a resistance of 200,000 ohms. Potentiometers designated 201 and 202 have a value of 50 ohms, and the battery designated 181 may have a value of 90 volts. In Fig. 5 the structure of the several switches in shown diagrammatically and the manner in which they are identified will be briefly set forth at this time.

Each of the knobs of formula switches 180a, 180b and 180c (Fig. 2) of Patent 2,275,590 is connected to a pair of switch blades F1 and F2 of which the former may connect a series of segments F1a designated R—W, W, R, A and B, and the latter may connect a series of similar segments F2a similarly designated. As the three switches are identical in structure, the corresponding parts are given similar reference characters and in tracing the circuits they will be distinguished as, for example "the F1 blade of formula switch A." The master control switch 189 has three blades designated C1, C2, and C3 for engagement with segments identified as C1a—C3a respectively.

The two potentiometer resistances 201 and 202 form two arms of a Wheatstone bridge, while the resistors 69 form a third arm, and the resistors 361 and 362 form the fourth arm. The bridge arrangement is diagrammatically represented in Fig. 3 in connection with which the principle of operation may be briefly set forth. When an examination sheet is sensed, a number of resistors 69 are connected in parallel into an arm of the bridge as indicated by the four resistances designated "right." When the printing mechanism is placed in operation, the resistors 361 under control of the cams 343 and related contacts 344 (see Fig. 5) are successively connected in parallel into the other arm of the bridge. As long as the bridge is unbalanced, current flows through the diagonal to energize a coil 363. As will be explained, the passage of current through this coil will normally prevent tripping of the printing hammer.

When equilibrium of the bridge is attained, current fails to pass through coil 363 and this condition will be detected and other circuits called into operation to energize the printing magnet, so that the printing hammer will print on the examination sheet a number corresponding to the value of the resistors 361 required to balance the bridge. Where the marks sensed are classified as right or wrong responses, a number of resistors 69 representing right answers is connected in the arm as explained and a number of resistors 69 corresponding to the number of wrong marks is connected into the opposite arm as represented, so that upon the sensing of the examination sheet the bridge is unbalanced in accordance with the difference between the number of right and wrong responses. Under such conditions the number of print unit resistors 361 connected into the related arm to balance the bridge will represent the difference between the two classes of marks, provided there are more right marks than wrong marks.

Referring to Fig. 5, the positive side of battery 181 is connected to the master control switch

blade C3 which may be on either the A, B, or C segment C3a. With the switches in the A position, current flows to the A potentiometer 201, through wire 210, and some of it flows back through the resistances 202, wire 203, to the A position segment C2a, switch C2 to the negative side of battery. From the connection between the two resistors 201, 202 there is a connection 211 to the A segment C1a of switch C1, thence to contact 350, a pair of contact 364 operated by a key 365, the winding 363, to a connecting point 366. Here the connection branches to a wire 191 extending to the sensing blades 58 through a wire 59 (Fig. 5a) and through a wire 367 (Fig. 5) to the resistors 361 and 362.

When a response sheet is inserted in the machine and pressed against the blades 54, 57 a circuit connection is completed for each pencil mark which is traceable from wire 191 to the wire 59, sensing blade 57, thence through the conductive mark to sensing blade 54 and to the high resistor 69 corresponding to the position in which a mark is present. According to the position of the key set pin 76, the current will follow from the resistor 69 to either the blade structure 92 or the blade structure 93, depending on whether the pin 76 is set in accordance with a wrong or right answer or, as explained hereinabove, if the pin 76 is set at an intermediate position, the circuit will go no further and the mark sensed by the blades 54, 57 will not be taken into account. All of the blade structures 93 in any horizontal row are connected by wires 192 and through a wire 193 are connected to a blade structure 96 associated with the three lower pins 82 of the field identifying pins. All of the blade structures 92 are connected together by a wire 194 and connected by a wire 195 to the blade structure 95 which cooperates with the upper three pins 82 at the end of the column, that is, the sets of pins 76 are divided into ten separate groups, each having at its outer end a set of six pins 82 (Fig. 5a). All the blade structures 92 of one set are connected to the blade structures cooperating with the upper three pins 82 and all the blade structure 93 of any group are connected to the blade structures cooperating with the three lower pins 82.

In the circuit diagram Fig. 5a only a few of the pins are shown to avoid needless repetition of like parts. The pins 82 serve to connect the circuits from the related set of pins 76 to any of the three formula switches through a selected pair of related wires 197.

For example, if the main key sheet is perforated in the position opposite the A-wrong pin 82, this pin will be shifted to make connection with the blade structure 95 so that, if mark is made in the related field in a position representing a wrong response, the circuit from line 191 will go through wire 59, the sensing blades 57, 54, resistor 69, pin 76, which will have been moved toward the left for connection with blade structure 92, thence through wires 194, 195 to blade structure 95, the A-wrong pin 82, the connecting strip 196, the A-wrong wire 197, to the blade F1 of A formula switch 181A. Similarly, if the perforation in the field selection position had been made in line with the B-wrong pin 82, the same circuit would connect the sensing blades through the B-wrong wire 197 to the blade F1 of the B formula switch 181B. In this manner the circuit through any marking position on the response sheet, if it represents a correct answer, will follow first to one of the blade structures 93

and thence according to the setting in the lower three pins 182 and the related section of the key sheet will be directed to any one of the three formula switches. If any marking represents an incorrect answer, the related sensing blade will be connected through the blade structure 92 to any of the three formula switches according to the positioning of the upper three pins 82 of the related set of pins.

When the A formula switch is in the dotted line position shown in Fig. 5 with blade F2 contacting the R segment F2a, the "A right" wire 197 is connected through wire 200 to an intermediate point on the resistance 201, thus completing one arm of the grid. Assume, for example, that four marks are sensed representing four right answers, then four of the resistors 69 are connected in the arm of the grid through the connections traced. Closure of contacts 300 (Fig. 4) will cause operation of motor M1 which will then commence to rotate, to first present the number 1 to the printing position. At this time the first of the contacts 344 closes to connect the upper-most resistor 361 in the other branch of the bridge, this branch being traceable from the connecting point 366, wire 367, upper-most resistor 361, wire 368, wire 369 to negative side of battery. At the same time, contacts 352 close under control of cam 349. This closure is ineffective, however, for the following reason.

In series with the contacts are the contacts R1a of a high speed relay magnet R1 which is in series with contacts 351 and the plate of a thyratron tube 371. The grid of this tube is wired to the secondary coil 370 of an impulse transformer whose primary coil is 363. The grid of the tube is negatively biased through connection from the negative side of battery 131, through wire 369, variable resistor 135, coil 370 to the grid. The contacts 350 open to break the circuit from the primary winding 363 to the impulse transformer. Upon such breaking a transient is transmitted from the primary of the impulse transformer to the secondary with a voltage amplification. This transient is transmitted to the grid of the tube 371 causing it to pass current through contacts 351 to the high speed relay magnet R1 which thereupon opens its contacts R1a. Immediately thereafter, contacts 352 close. Since the high speed relay has opened the circuit, no current will flow through the print magnet 338. Immediately after this, contacts 351 open the anode circuit of the thyratron tube, thus deinizing the tube preparatory to the next amount representing condition of the printing mechanism. This action takes place each time the print wheels advance one digit to introduce an additional resistor 361 in the arm of the bridge.

When four resistors have been introduced which are the equivalent of the four resistors 69 introduced in the other arm, the voltage across the primary of the impulse transformer is zero. At this point breaking of the primary impulse transformer contact 350 does not cause the transient to be impressed upon the grid of the thyratron. Hence, the thyratron does not ionize and the high speed relay magnet R1 is not energized so that its contacts remain closed when contacts 352 close, and a circuit is now completed through the print magnet 338 which is traceable from negative side of battery, wire 369, resistance 135, magnet 338, contacts 352 and R1a back to positive side of battery.

The energization of the magnet 338 at this time

will trip the print hammer and the amount printed will be that represented by the position of the printing wheels at this time. In this case the digit printed is 4 which represents the four right answer marks sensed. The operation of the printing mechanism continues from this point to successively present all the other values up to 99. Since the print hammer is latched during this subsequent operation, no further printing can take place.

While the print wheels are passing from 99 back to zero, contacts 355 close momentarily to complete a circuit from positive side of battery, through contacts 355, contacts 354, the print hammer unlatching magnet 341, back to negative side of battery and at the same time the cam shafts are uncoupled from the driving motor so the print mechanism comes to rest.

Where the number of marks sensed is greater than 9, the resistors 362 are employed. Each has a value of 200,000 ohms which is equivalent to ten 2,000,000 ohm resistors in parallel, so that when the printing wheels register 10, one resistor 362 is connected in the arm of the bridge. When the wheels register 20, two resistors 362 are connected and when, for example, the wheels register 36, three resistors 362 and six resistors 361 are connected.

Before scoring any examination sheets, an initial adjustment of the potentiometer 201 is effected which is accomplished as follows. The examination sheet containing a known number of right answers is placed in the sensing position and the print unit is manually turned to position the print wheels to represent the known number of right answers. This is done by opening switch 372 (Fig. 4), depressing the key 381 (Fig. 7) and turning knob 373 of the rotor of motor M1 until the desired number is in printing position. At this point the zero adjustment meter contacts 364 (Fig. 5) are opened by depression of key 365 to connect the zero adjustment meter 373 into the bridge diagonal and the potentiometer 201 is adjusted, so that the current flowing through the meter is zero. The contacts 364 are then allowed to close, the print wheels are advanced to home position and the machine is in readiness to score examination sheets to determine the number of right answers.

At this point the sheet with the known number of marks is in the sensing station so that key 99 is depressed to cause removal of this sheet from the machine.

An examination sheet is now placed in the sensing position and key 99 operated to cause the sheet to be pressed against the sensing blades 54, 57. A number of resistors 99 equal to the number of right answer marks is thereupon automatically connected in parallel in one arm of the bridge. Key 381 of the printing unit is now depressed and resistors 361 and 362 are cut into the other arm until equilibrium is attained, when printing will be automatically effected on the examination sheet. Key 99 is then again depressed to remove the sheet.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a printing machine, means for sensing a record sheet for marks thereon, a Wheatstone bridge having two arms of predetermined ohmic value, means controlled by said sensing means for adjusting the resistance of a third arm of the bridge in accordance with the number of marks sensed, a printing wheel, means for rotating said wheel to present a succession of type elements to a printing position, a hammer for the printing wheel, actuating means for said hammer means synchronized with said wheel for increasing the resistance of a fourth arm of the bridge as the type elements are presented, and means included in the diagonal of the bridge, operative when the bridge is in equilibrium for rendering said hammer actuating means effective to cause the hammer to print from the element that is in position when equilibrium is attained.
2. In a printing machine, means for sensing a record sheet for designations thereon, a Wheatstone bridge having two arms of predetermined ohmic value, a plurality of resistors of like ohmic value, means controlled by said sensing means for connecting a number of said resistors in parallel in a third arm of said bridge, equal in number to the number of designations sensed, a printing wheel, means for moving the same to present numbered type elements in succession and in ascending sequence to a printing position, means for effecting printing from said wheel, a second plurality of resistors of the same ohmic value as the first named resistors, means coordinated with the printing wheel for connecting said last named resistors in parallel in a fourth arm of said bridge, the number of resistors so connected corresponding to the number on the type element at the printing position, and means included in the diagonal of the bridge, operative when the bridge is in equilibrium for rendering said effecting means effective to print from the element that is in position when equilibrium is attained.
3. The invention set forth in claim 2 in which the means coordinated with the printing device is a series of cam operated contacts, there being a separate cam for each contact, the cams being configured to close the series of contacts in succession and each contact in turn connecting a resistor of said second plurality of resistors in said fourth arm of the bridge.
4. The invention set forth in claim 2 in which the effecting means comprises a printing hammer, a driving means therefor, and coupling means between the hammer and driving means, the means for rendering the effecting means effective comprising a magnet for operating said coupling means, the means included in said diagonal causing energization of said magnet to trip the hammer.
5. In a printing machine of the class described, a units digit wheel, a coaxial tens digit wheel, both wheels normally registering zero, a driving motor, means for coupling the units digit wheel to the motor for continuous rotation, means controlled by the units digit wheel for advancing the tens digit wheel one step for each revolution of the units digit wheel to cause the wheels to register the numbers 1 to 99 in succession, and then register zero again, means jointly controlled by said wheels when zero is again registered for causing the coupling means to uncouple the motor, impression taking means, a Wheatstone bridge having two arms of predetermined ohmic value and a third arm of variable ohmic value,

means coordinated with said wheels for adjusting the resistance of a fourth arm of said bridge as the successive numbers are registered to set up resistance values of all the numbers 1 to 99 in succession, and means controlled by the bridge upon reaching equilibrium for rendering the impression taking means effective to print from the wheels at the time said equilibrium is effected, said setup resistance values returning to zero at the time the wheels return to zero.

6. In a printing machine, a Wheatstone bridge having two arms of predetermined ohmic value, record controlled means for adjusting the resistance of a third arm of said bridge, printing type elements positionable to represent any amount, means coordinated therewith for adjusting the resistance of a fourth arm of the bridge in accordance with the amount represented by the type elements, an induction transformer having its primary coil conductively connected in the diagonal of the bridge, a printing control magnet, energizing means therefor, a thyatron tube having its grid connected with the secondary coil of said transformer, and means controlled by the tube for rendering said energizing means ineffective while the bridge is unbalanced and rendering the same effective when the bridge is in equilibrium.

7. In a printing machine, means for sensing a record sheet for marks thereon, a plurality of resistors of like ohmic value, means controlled by said sensing means for connecting a number of said resistors in parallel in accordance with the number of marks sensed, a printing wheel positionable to represent an amount, a second plurality of resistors connectable in parallel in accordance with the value of the amount positioned on said wheel, hammer mechanism, a magnet for causing said mechanism to print from said wheel, comparing means including a Wheatstone bridge arrangement for determining the relationship between the number of marks sensed and the amount standing on the printing wheel, and means controlled thereby for causing energization of said magnet when said compared amounts are alike.

8. The invention set forth in claim 7 in which automatically operating means is provided to advance said wheel through various amount representing positions, and means for automatically rendering said comparing means operative after each amount representing positioning of the wheel whereby the actuating magnet will be tripped upon the positioning of the wheel in correspondence with the number of marks sensed.

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