United States Patent [19]

Martin et al.

[11] **3,744,713**

[45] **July 10, 1973**

[54] VOTING MACHINE

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[73] Assignee: **AVM Corporation,** Jamestown, N.Y.

[22] Filed: **Feb. 10, 1970**

[21] Appl. No.: **10,264**

[52] **U.S. Cl.** ..... **235/54 F**

[51] **Int. Cl.** **G07c 13/00**

[58] **Field of Search** ..... 235/54 F, 50 R

[56] **References Cited**

UNITED STATES PATENTS

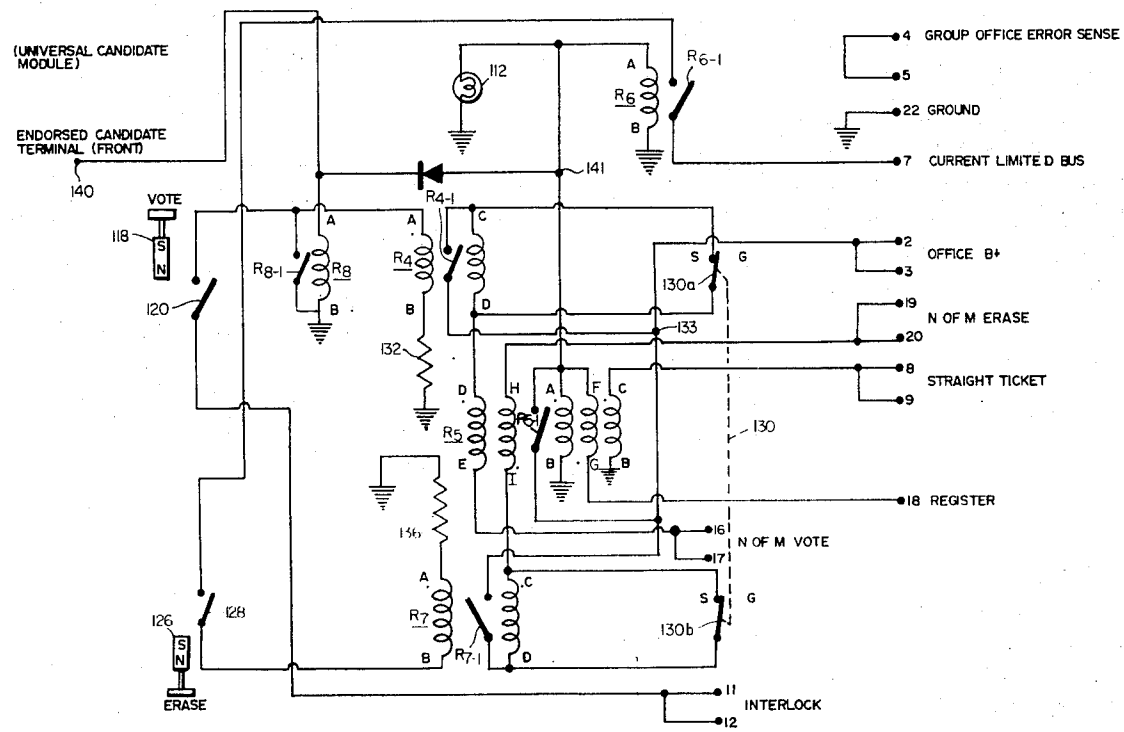
3,024,974	3/1962	Hocker	235/54 F
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3,214,091	10/1965	Clark	235/50 R

Primary Examiner—Stephen J. Tomsky
Attorney—Strauch, Nolan, Neale, Nies & Kurz

[57] **ABSTRACT**

An electrically operated voting system having a plurality of voting machine stations and a central vote accumulating register. The voting machine and register are of modular construction and may be readily programmed to satisfy the requirements of general, open and closed primary, and other type elections. Each voting machine includes a number of interlock circuits which prevent a voter from selecting a number of candidates in excess of that permitted; and also prevent a voter from casting more than one vote for a respective candidate; yet permit that a voter may reconsider and cancel a selection already made and vote for another candidate of his choice. Additionally, each machine is substantially fail-safe in that it may not normally continue to operate should a malfunction occur, and, when a malfunction occurs, the election official is immediately made aware of it and no votes already cast and sought to be registered by a voter will be lost.

11 Claims, 47 Drawing Figures



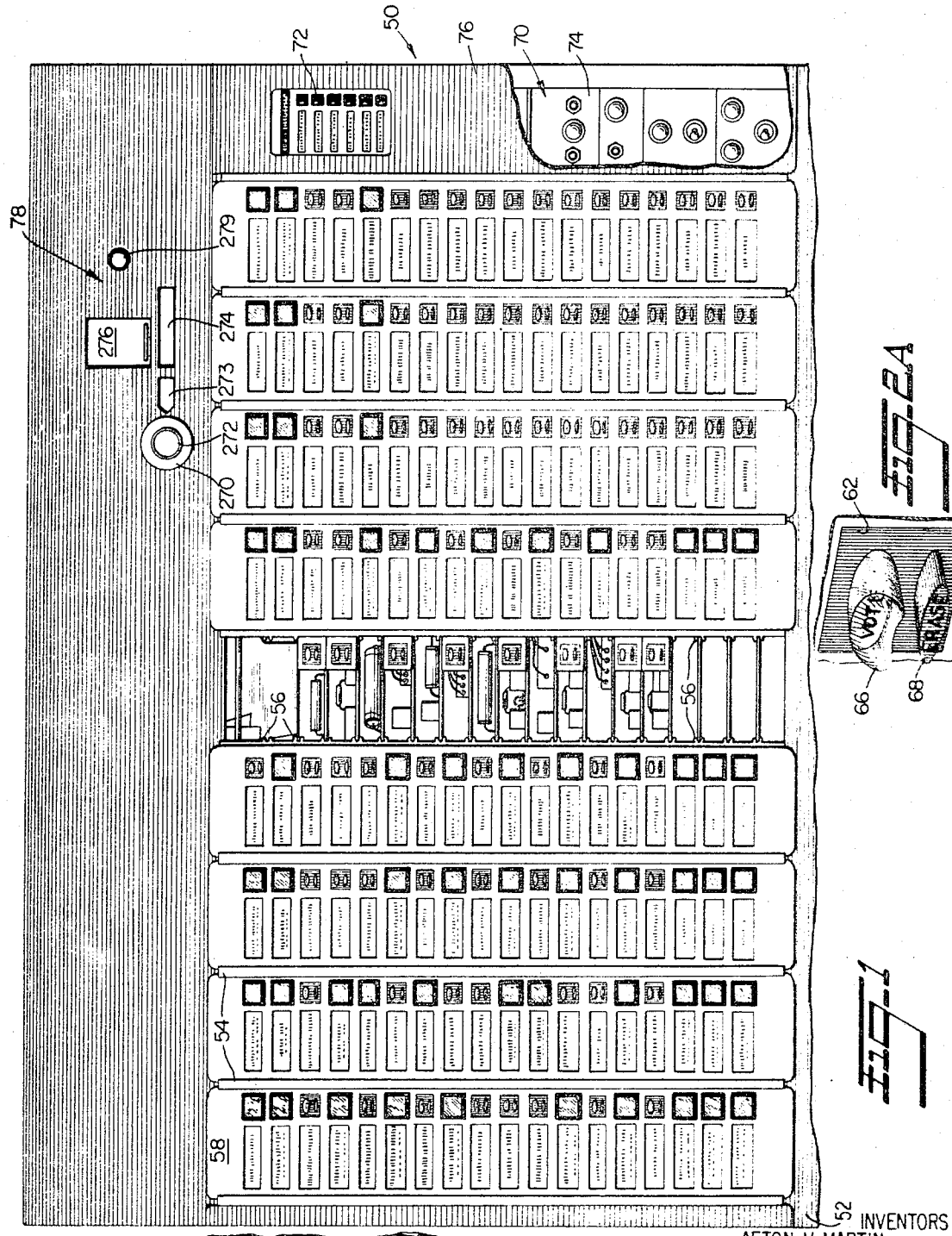


FIG. 1

FIG. 2A

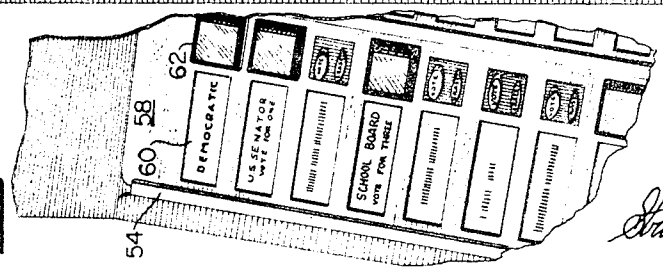


FIG. 2

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ANATOLIJUS JAZBUTIS
GUY L. FOUGERE
DONALD B. RISING
GARY C. KOGER
GENIO R. ARCIPRETE
NOEL SVENDSEN

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ATTORNEYS

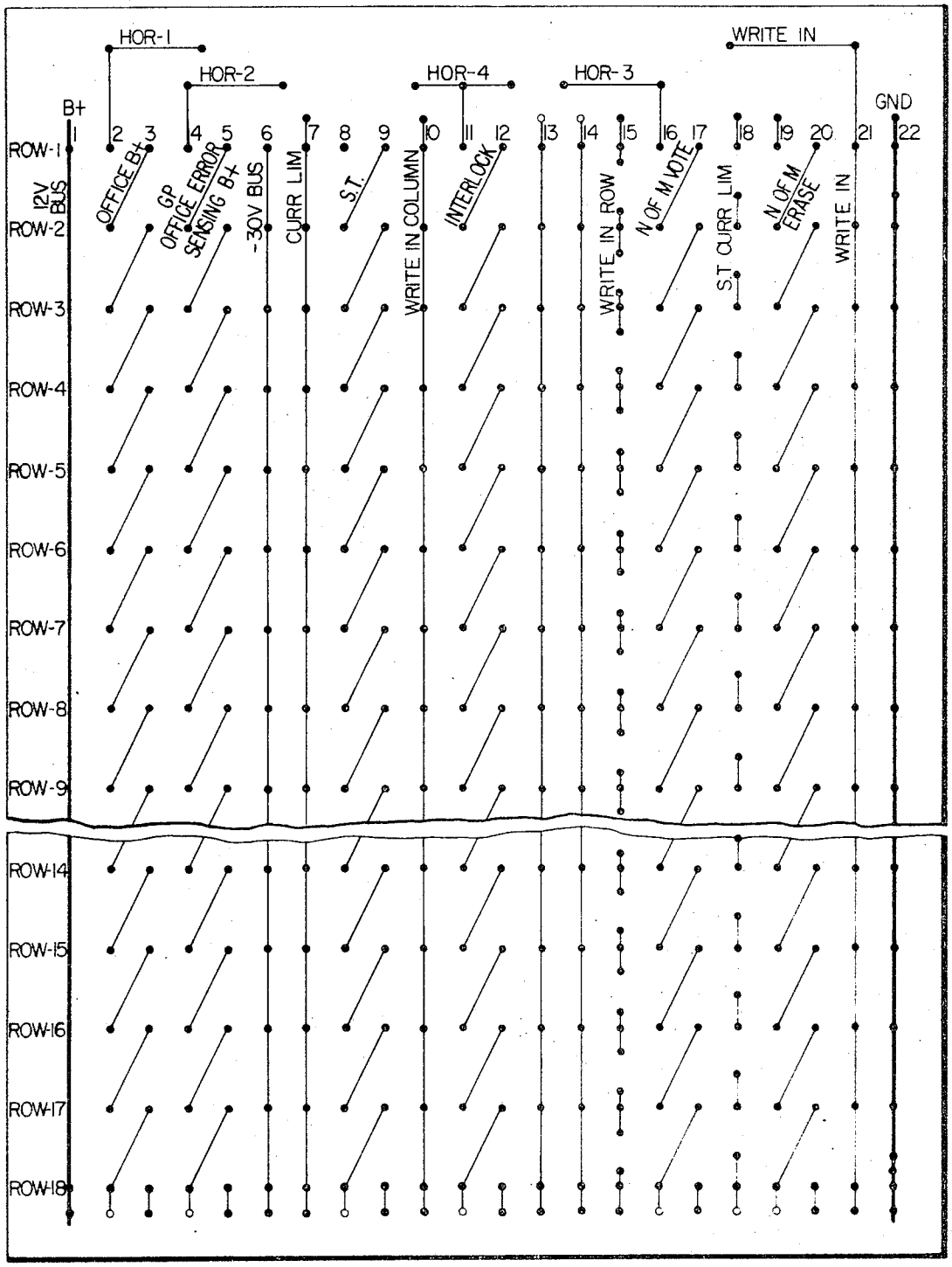
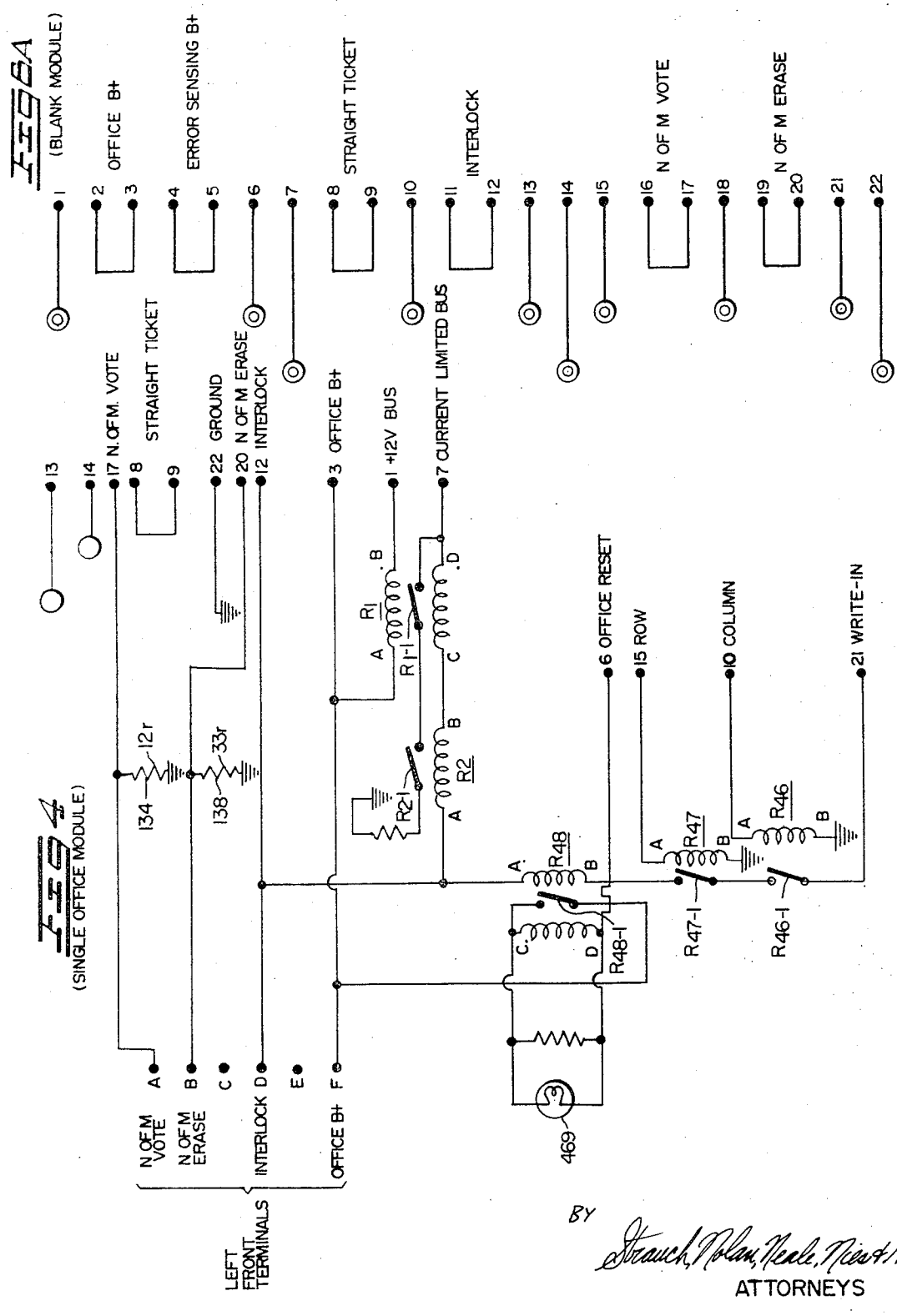


Fig. 3

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FIG 6
(SINGLE OFFICE CANDIDATE MODULE)

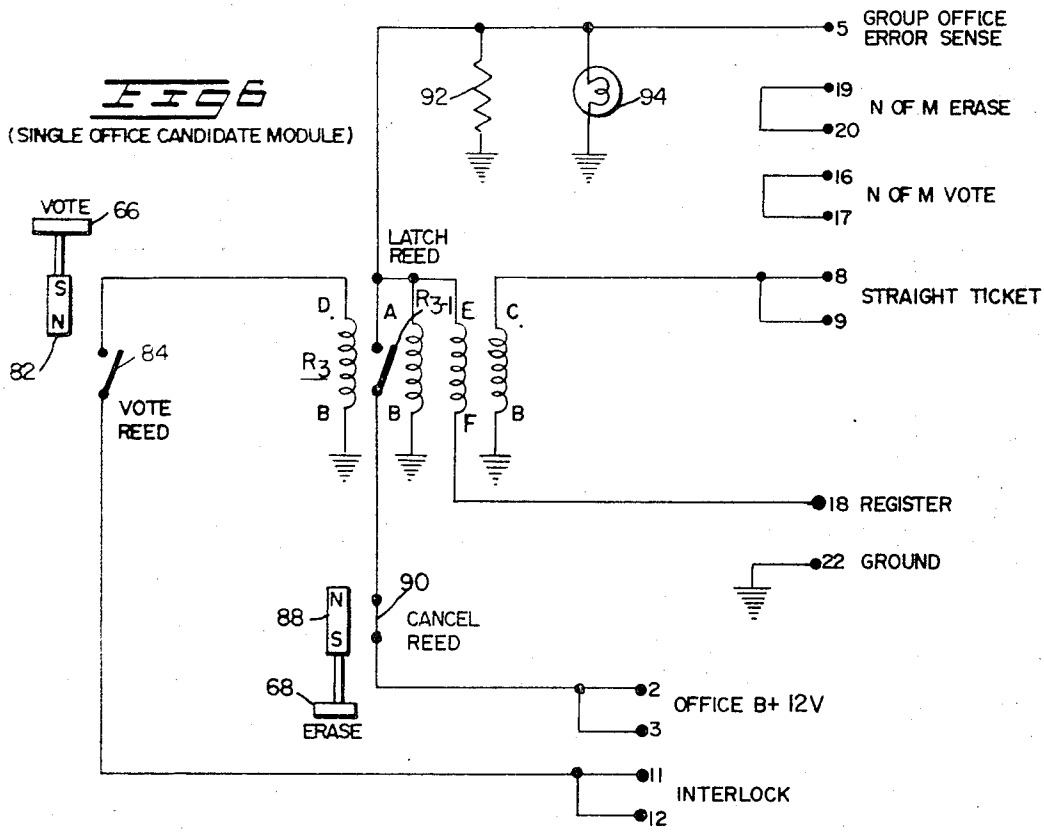
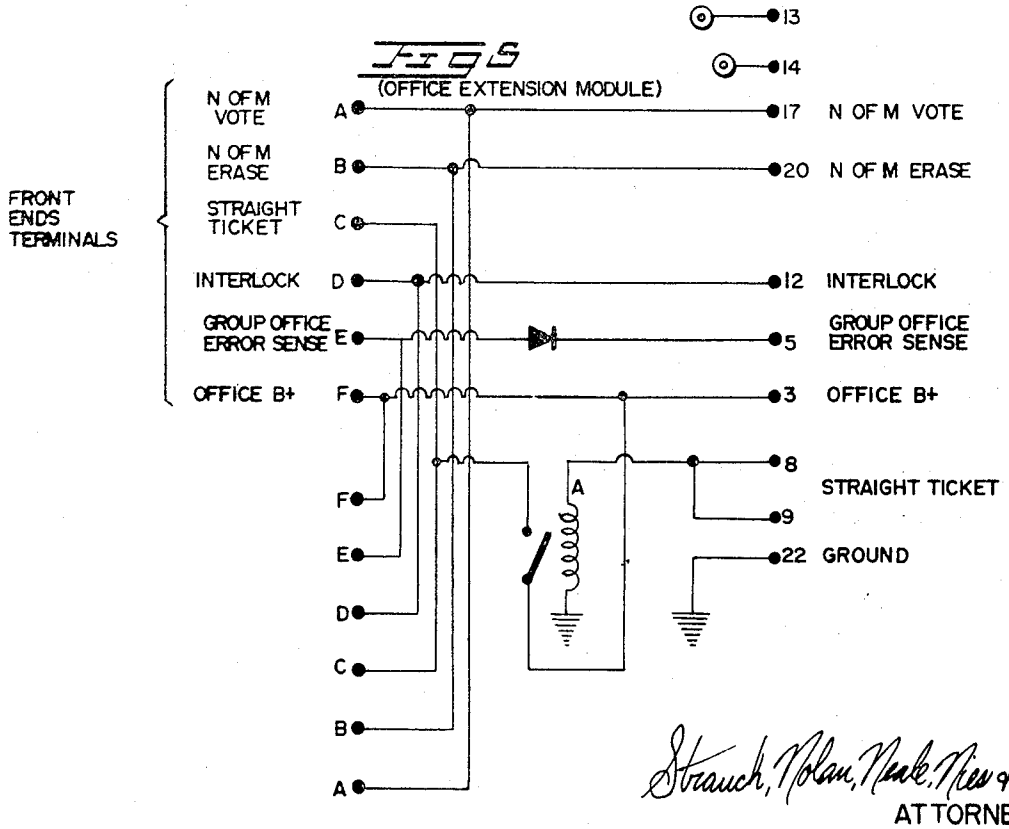


FIG 5
(OFFICE EXTENSION MODULE)



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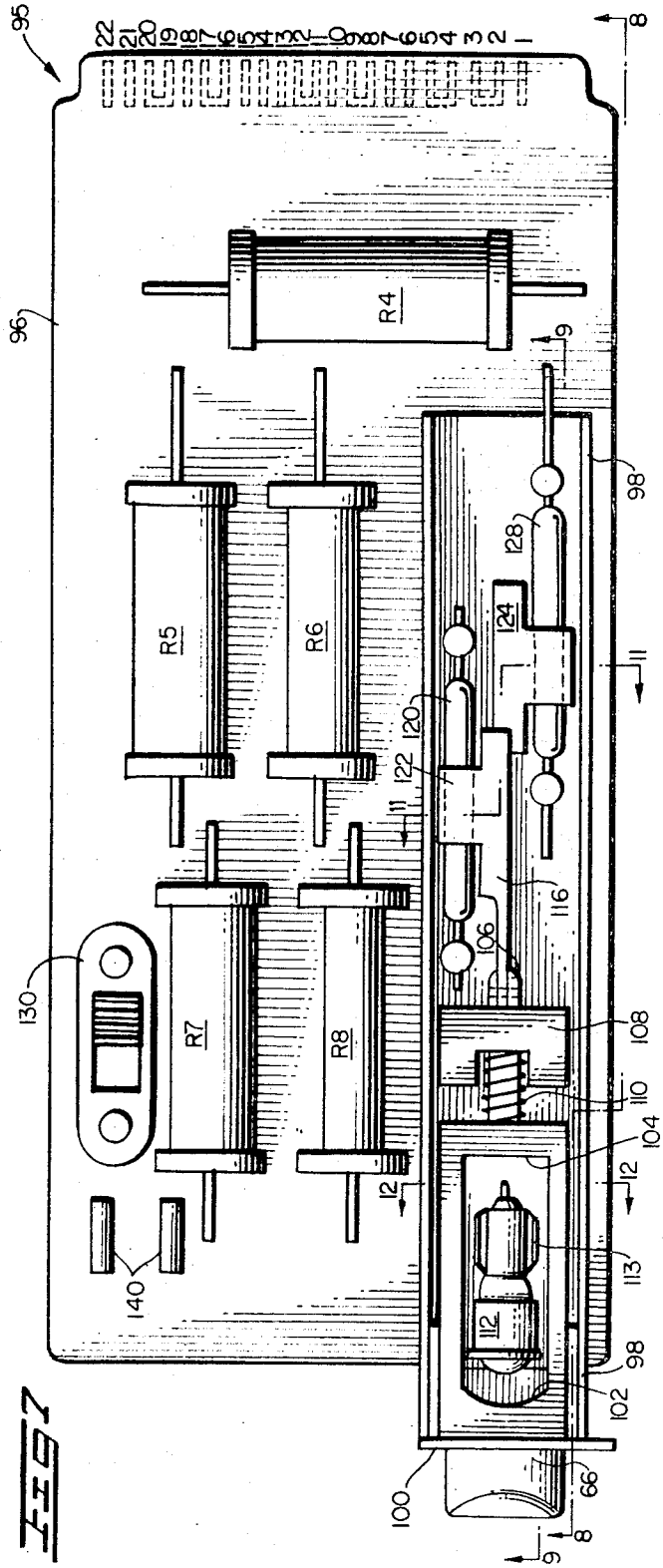

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FIG 7

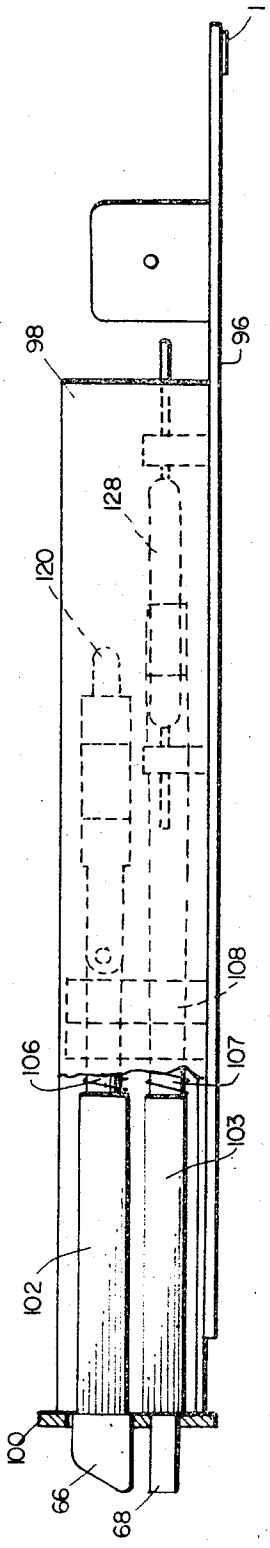

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FIG 8

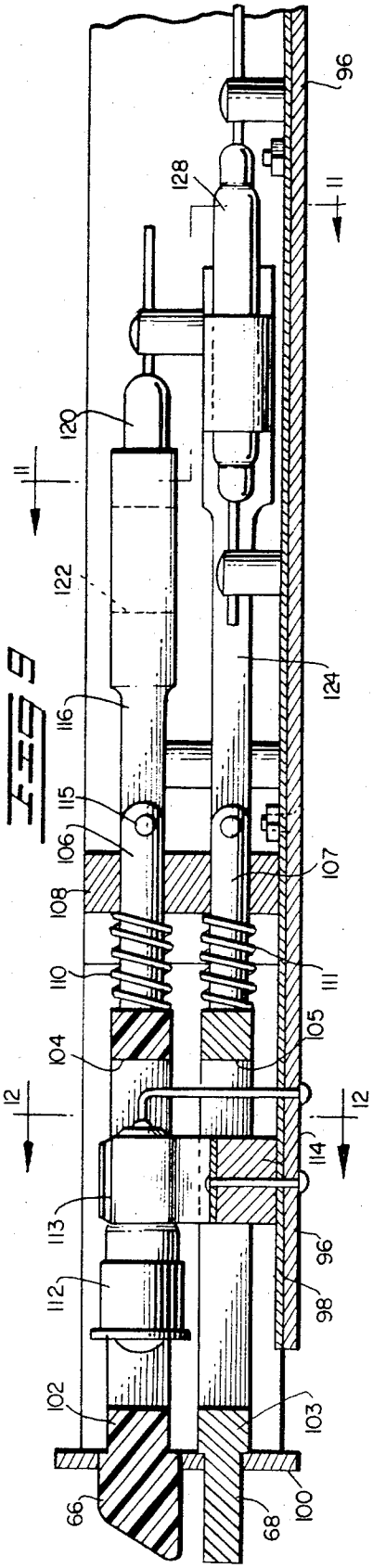


FIG 9

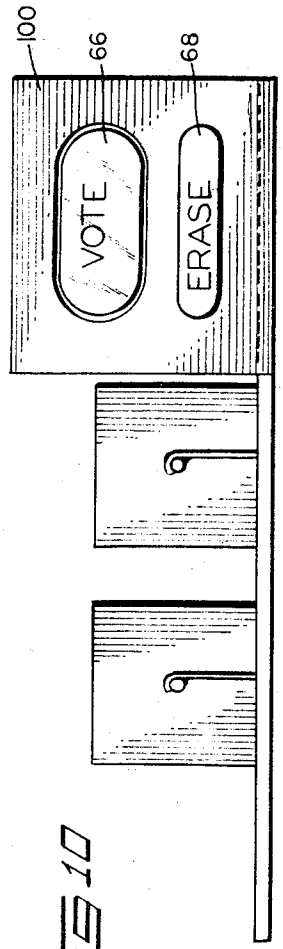


FIG 10

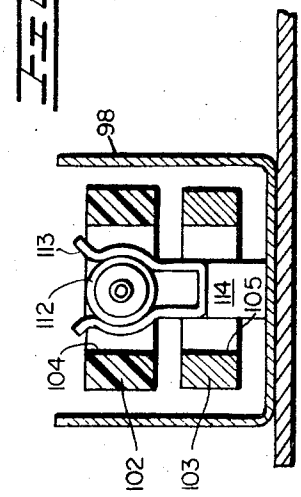


FIG 12

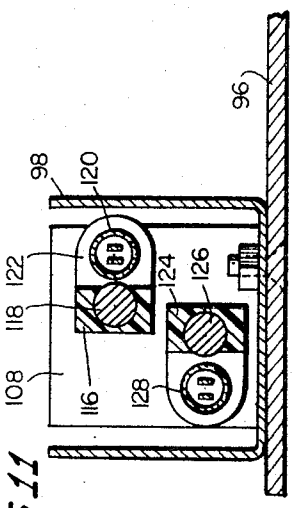


FIG 11

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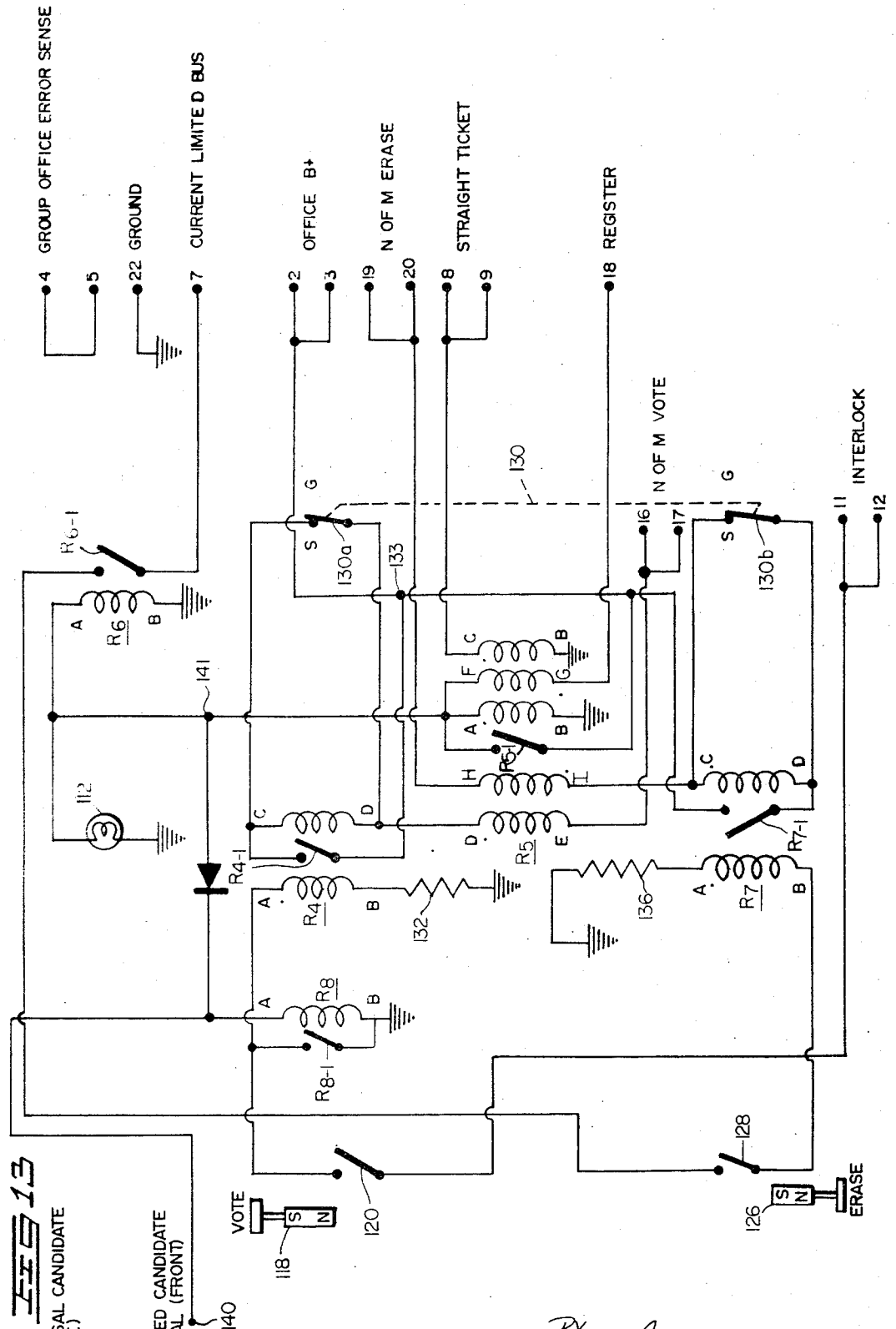


FIG 13

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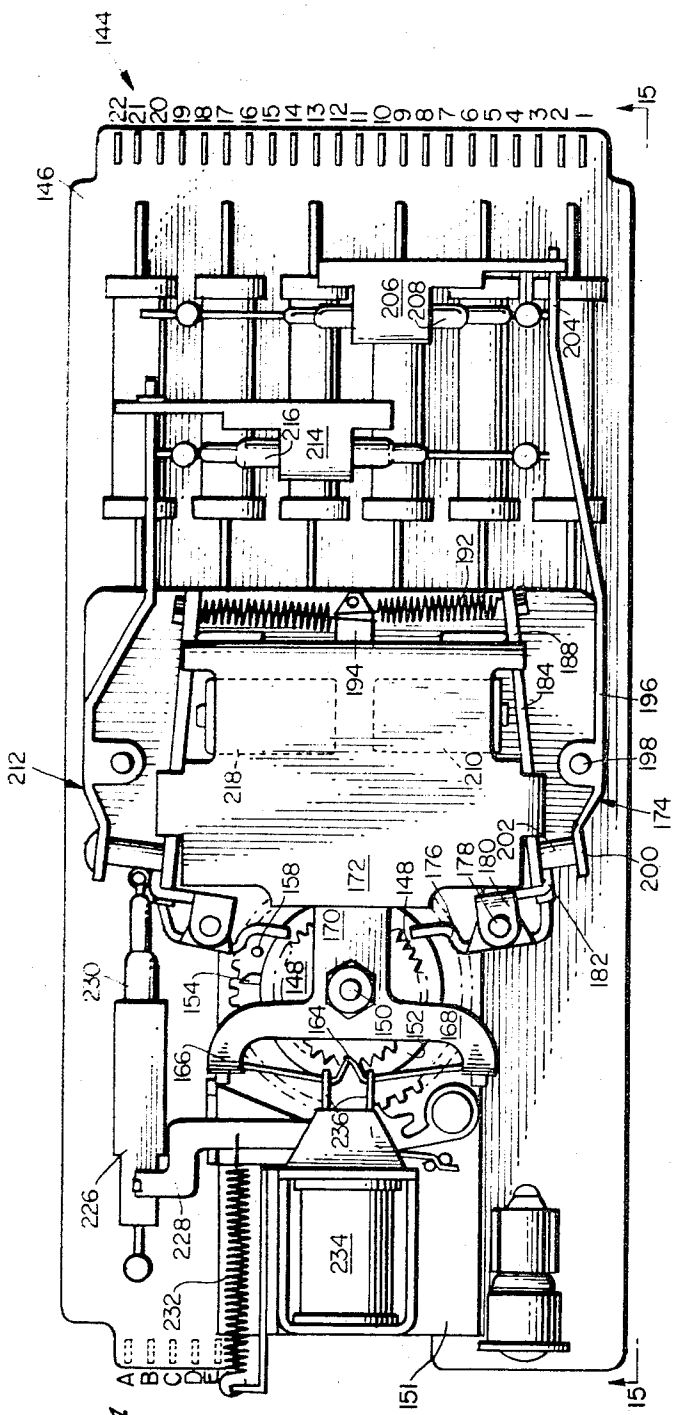


FIG 14

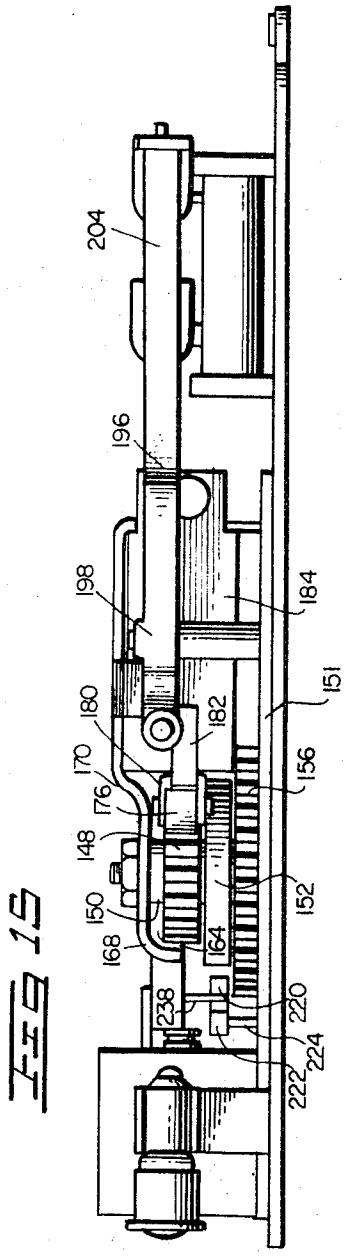


FIG 15

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Fig 16

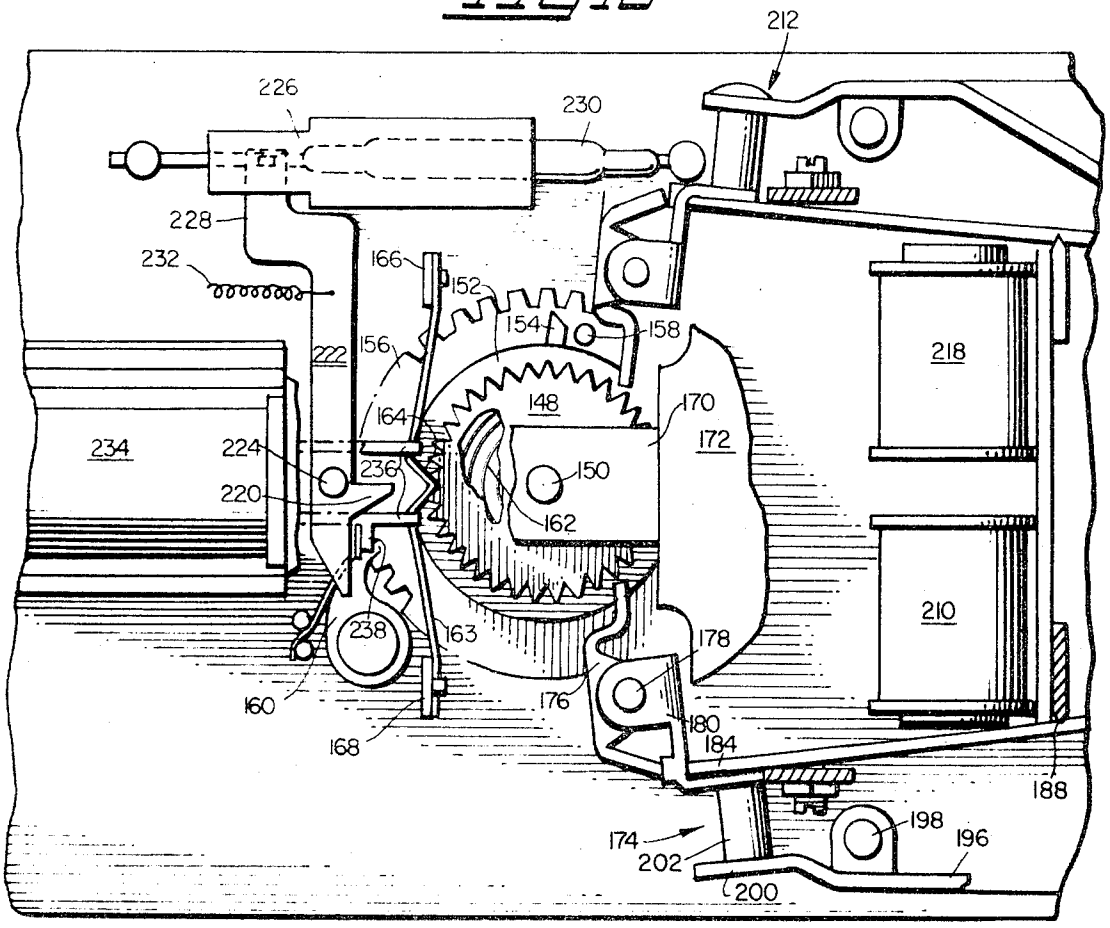
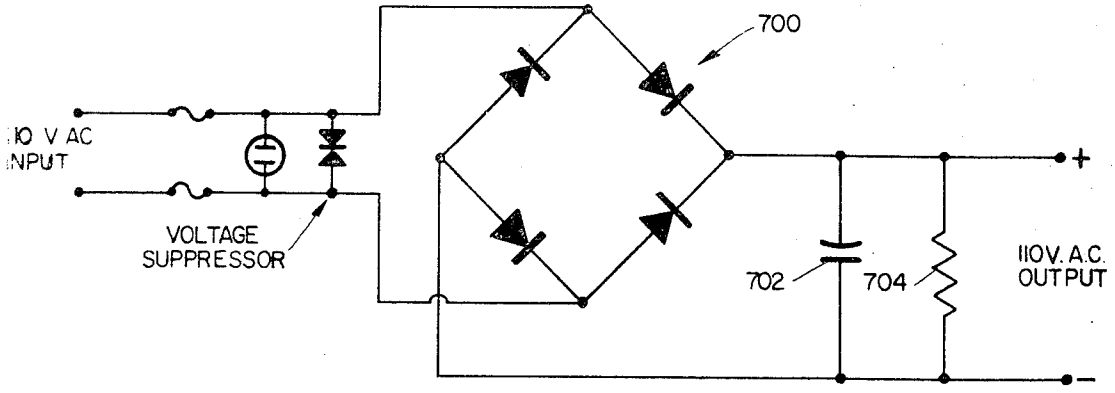


Fig 39

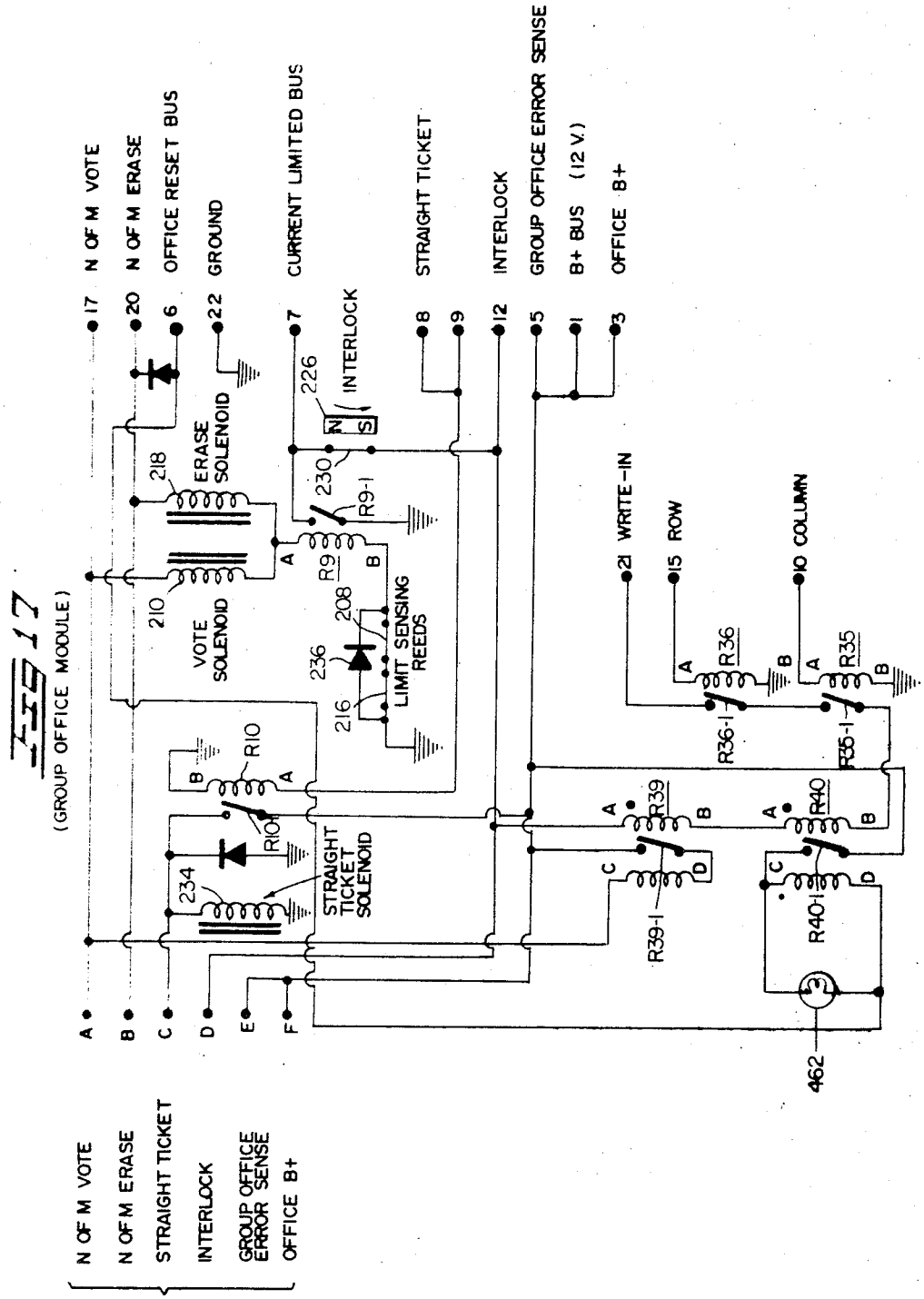
(REGISTER POWER SUPPLY)



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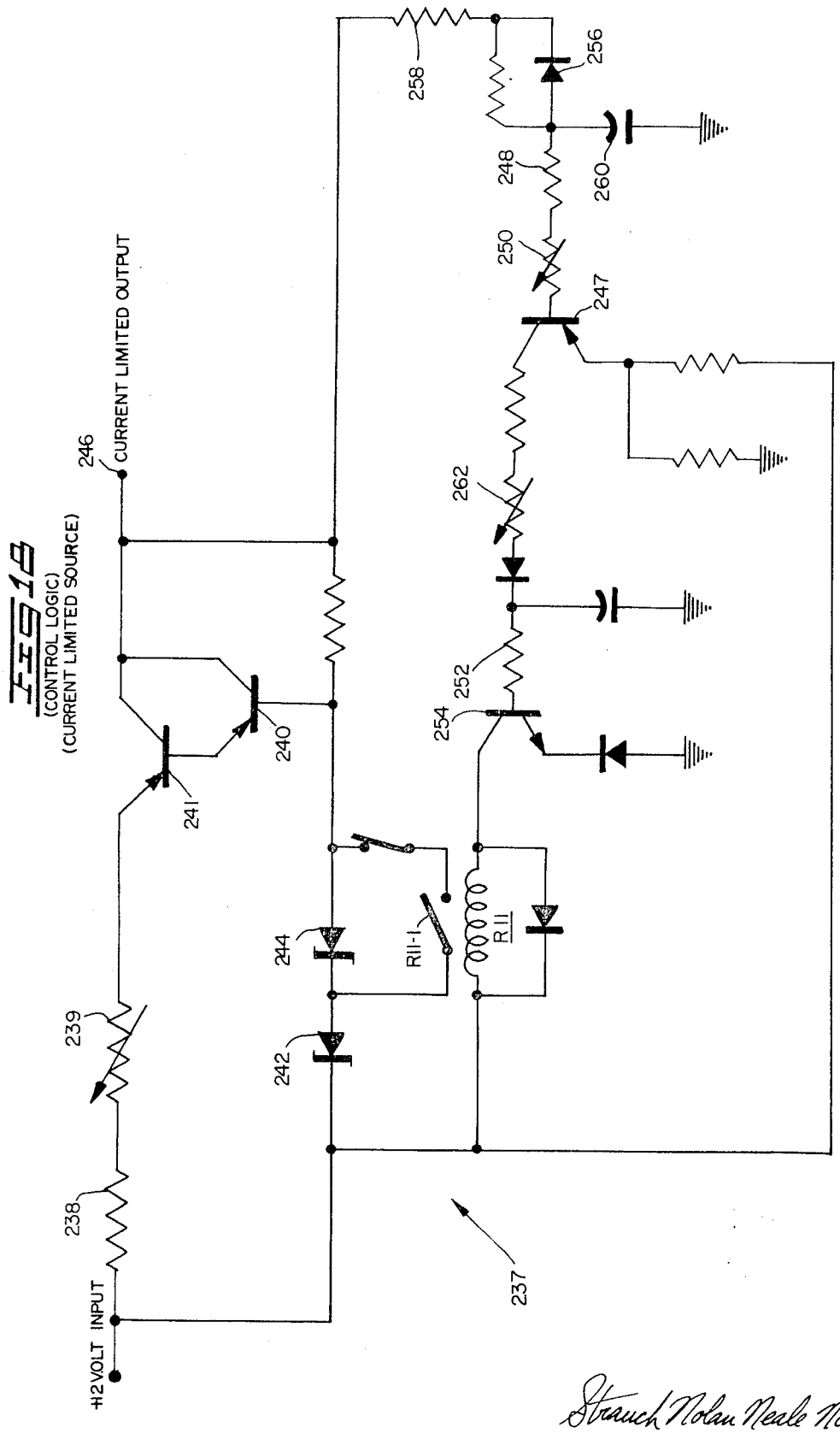


FIG 13
(CONTROL LOGIC)
(CURRENT LIMITED SOURCE)

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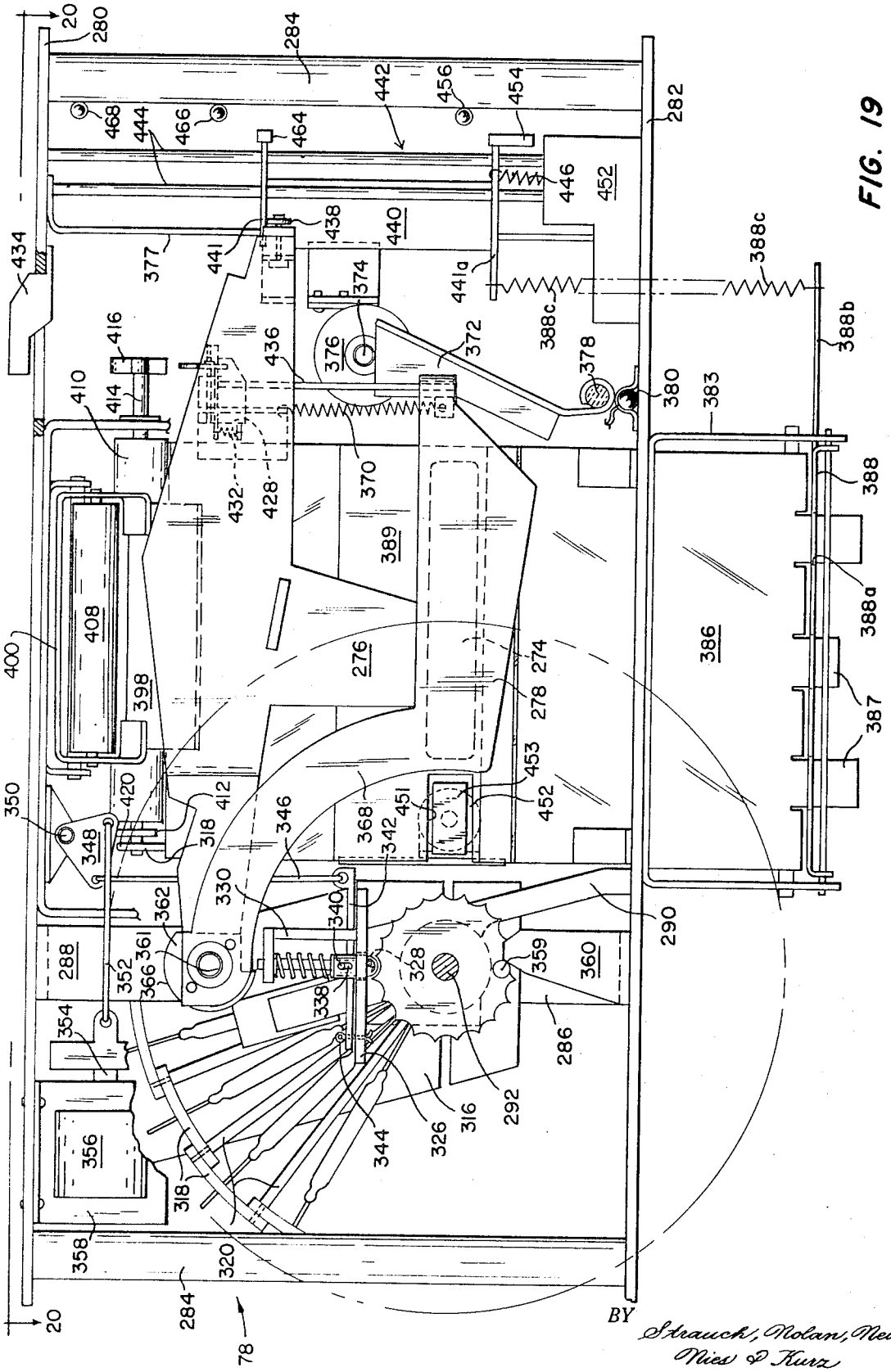

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FIG. 19

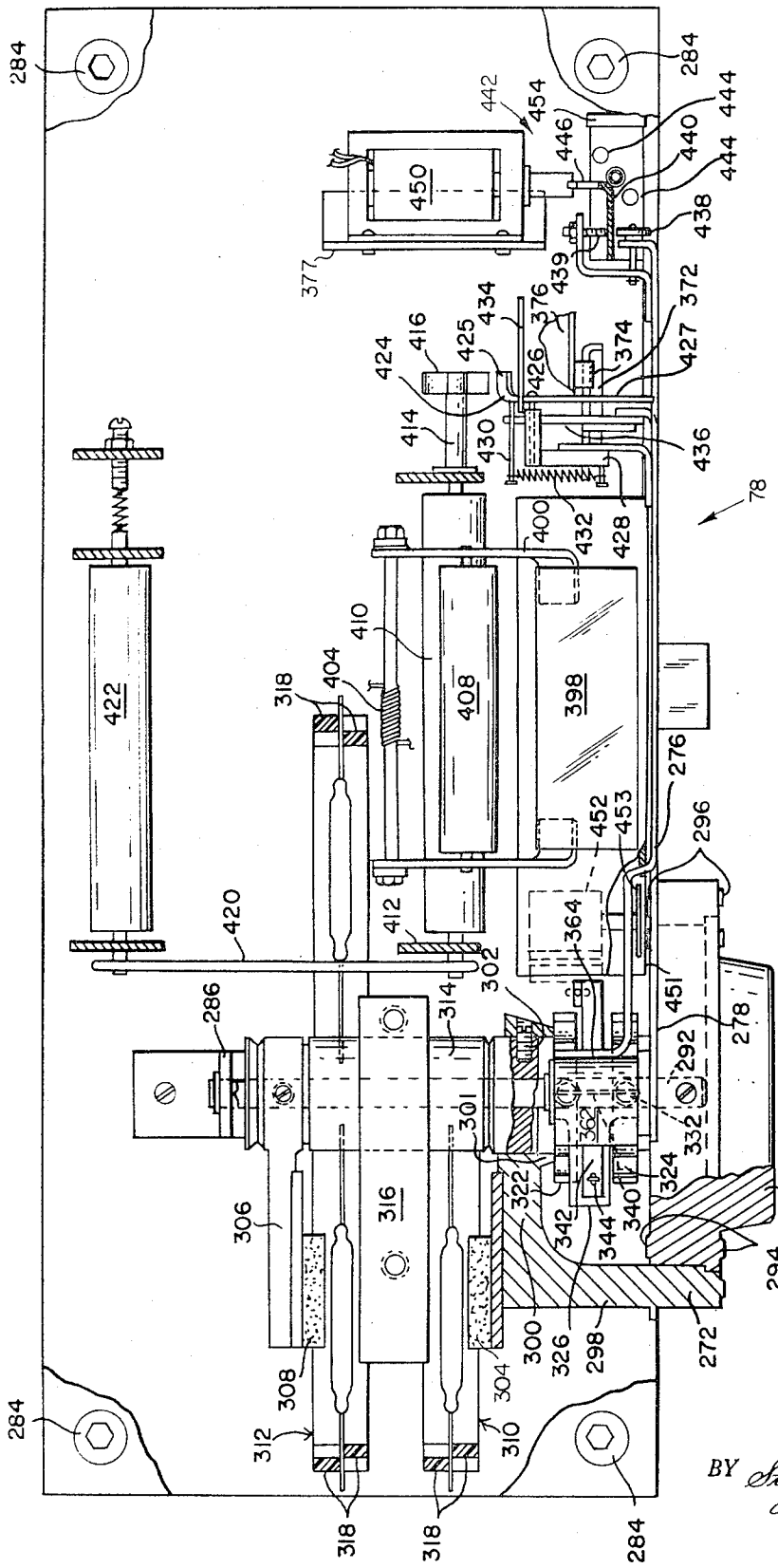


FIG. 20

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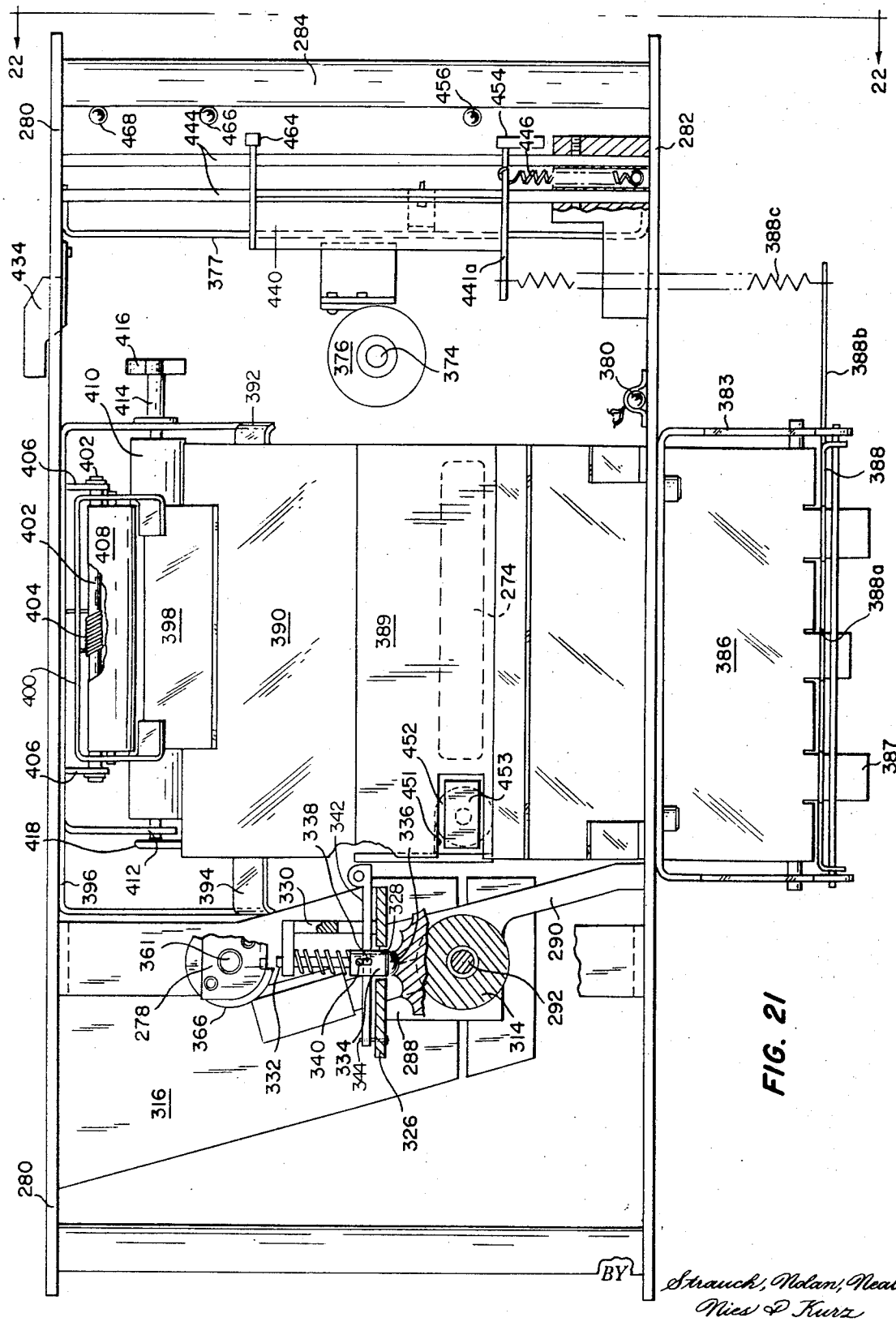
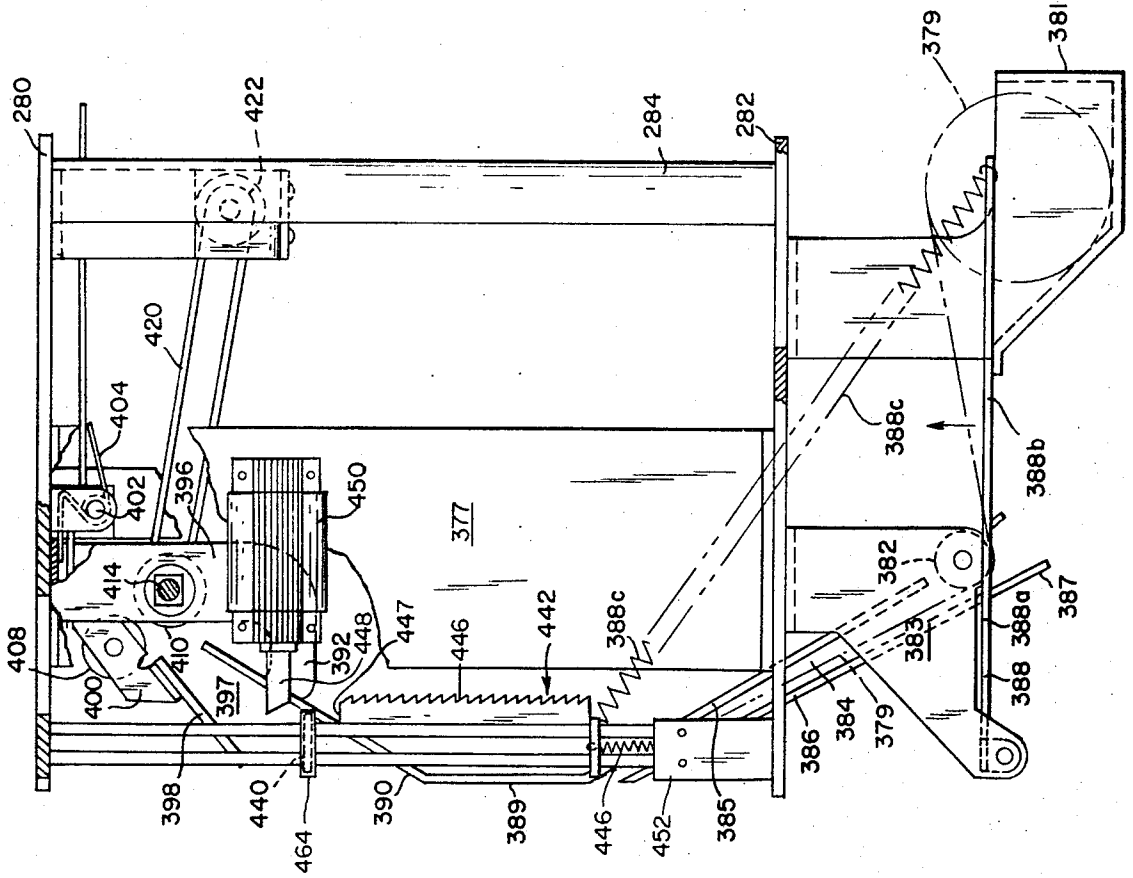


FIG. 21

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FIG. 22



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Fig 33 (REGISTER COUNTERS)

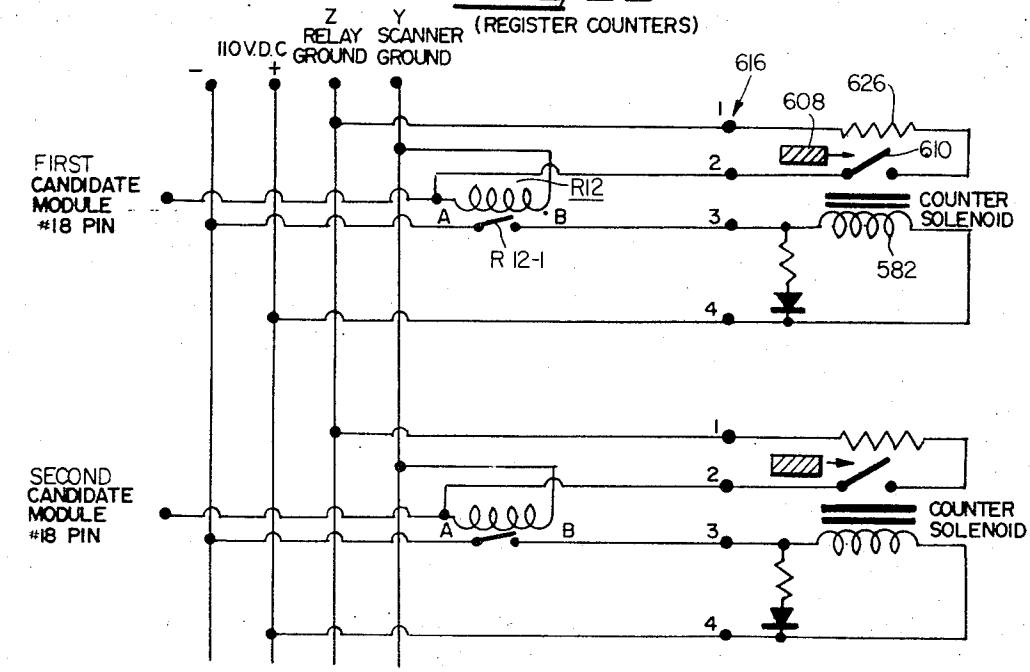
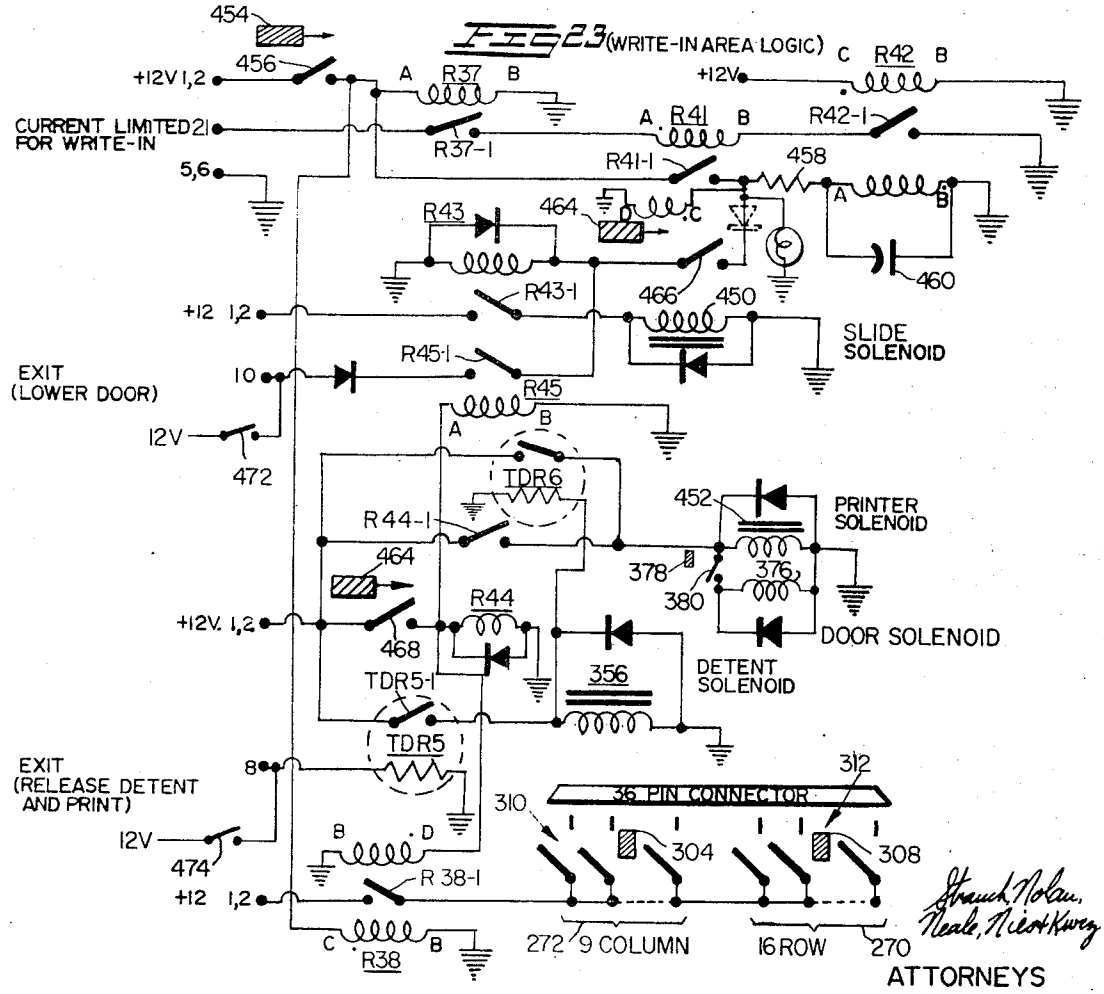


Fig 23 (WRITE-IN AREA LOGIC)



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Fig 24

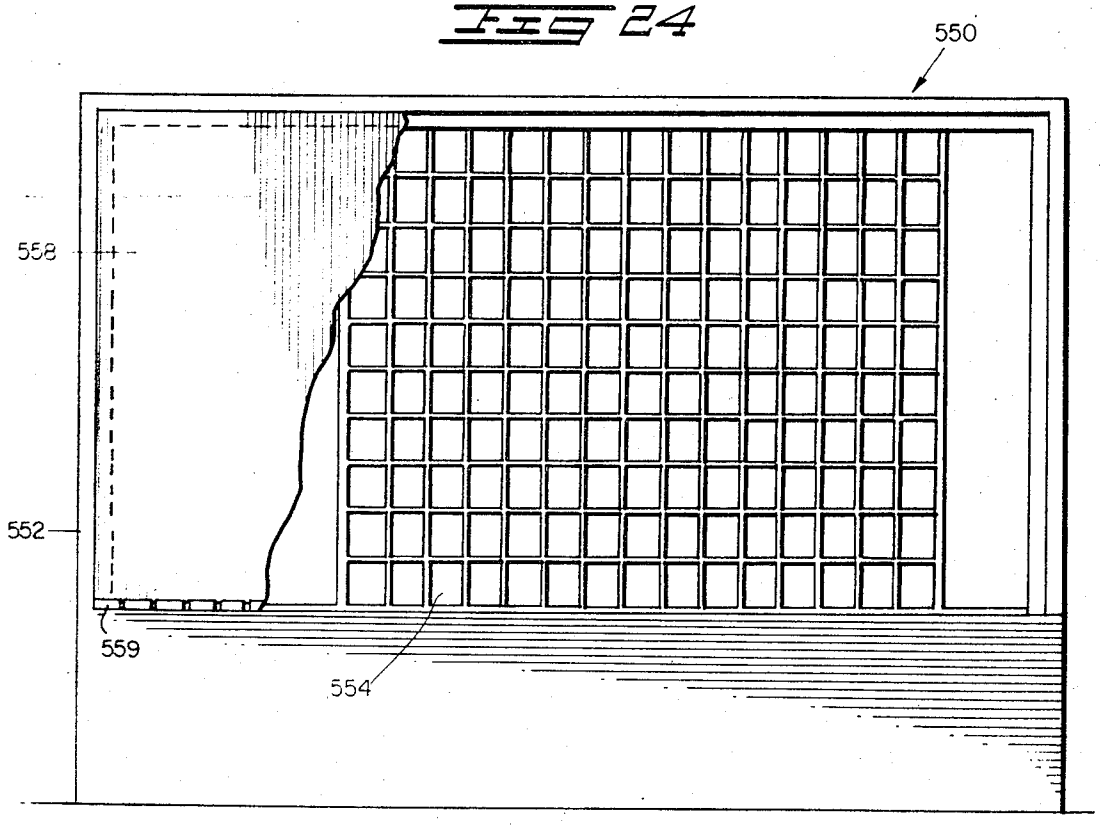
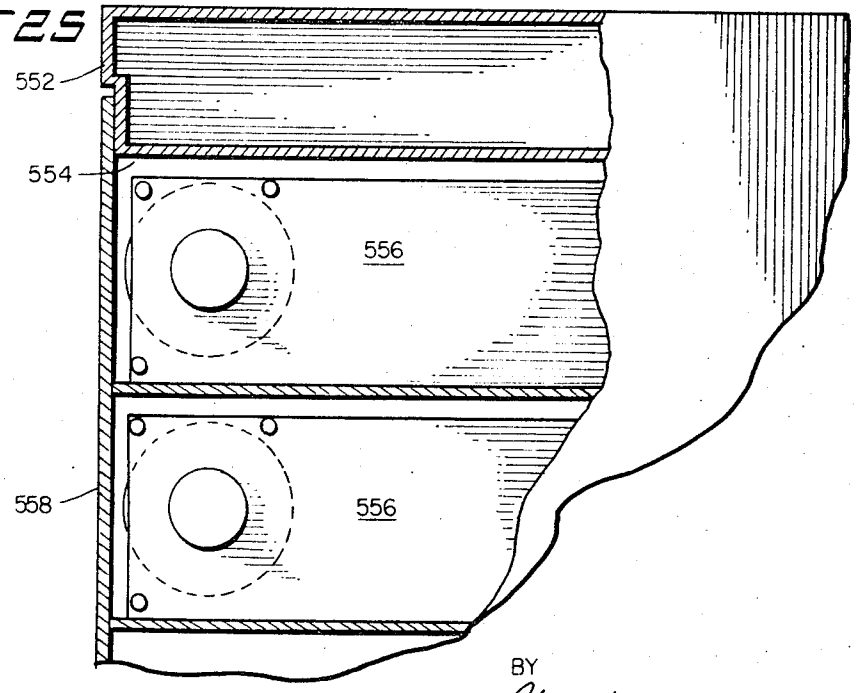


Fig 25



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Fig 28

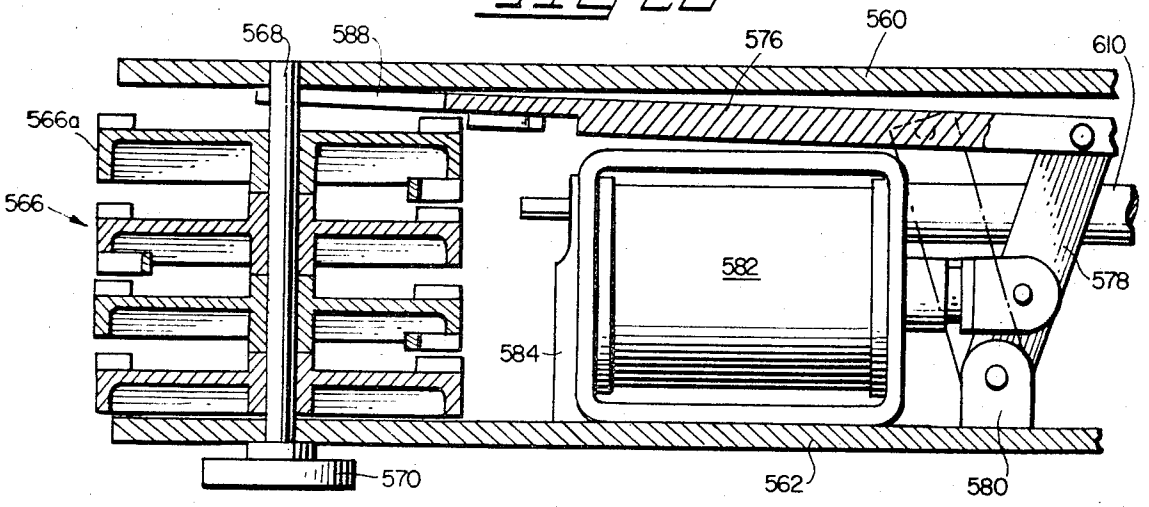


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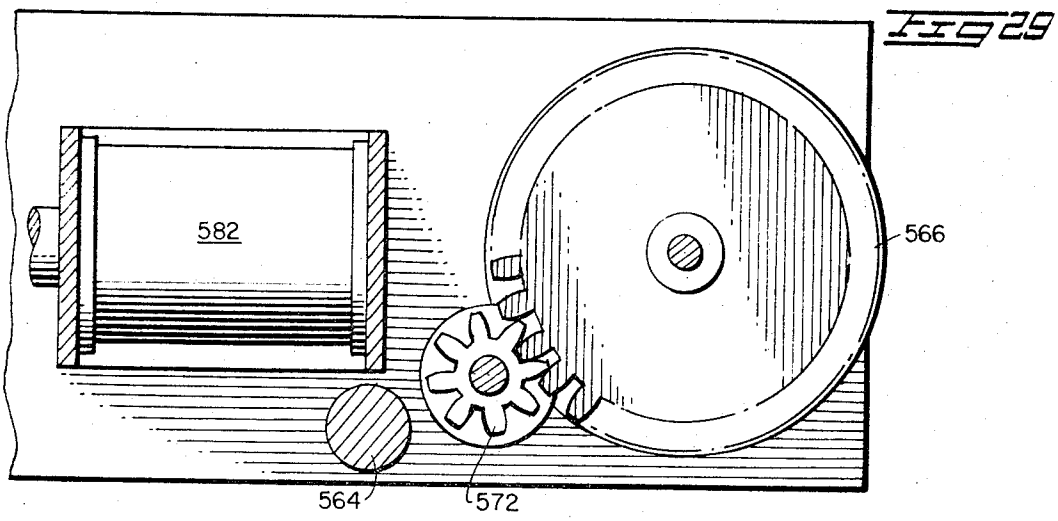
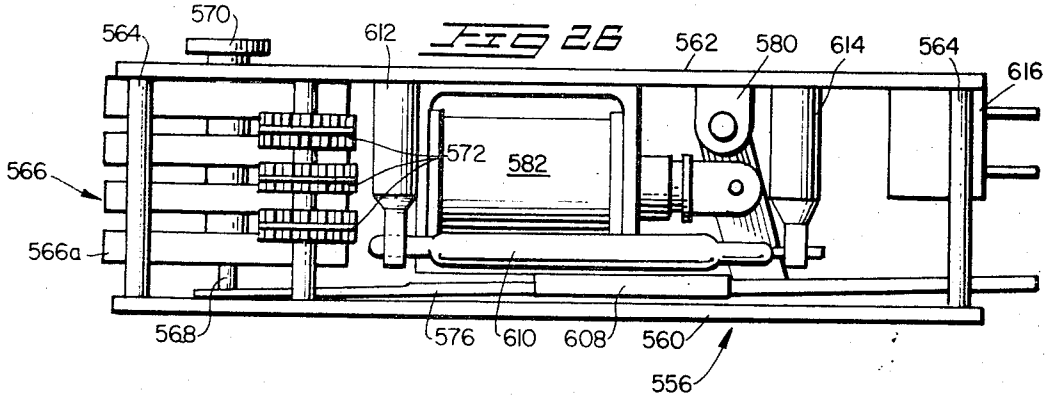


Fig 26



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Fig 27

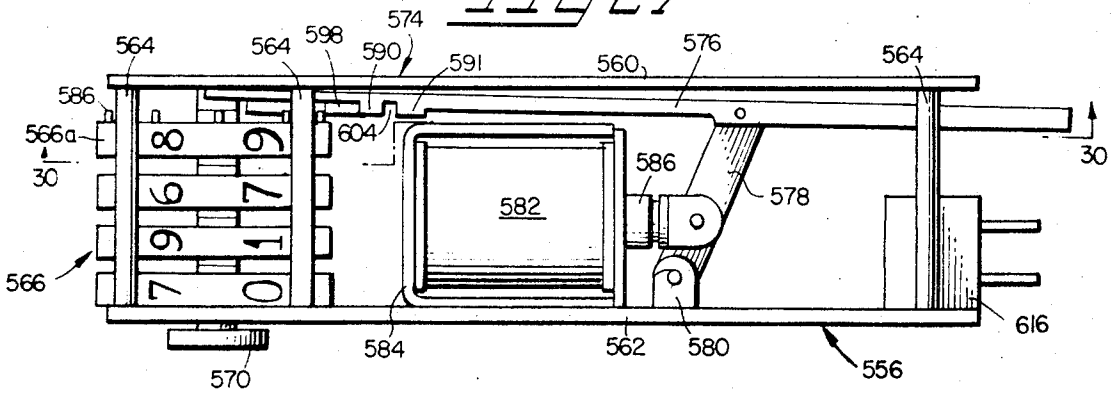
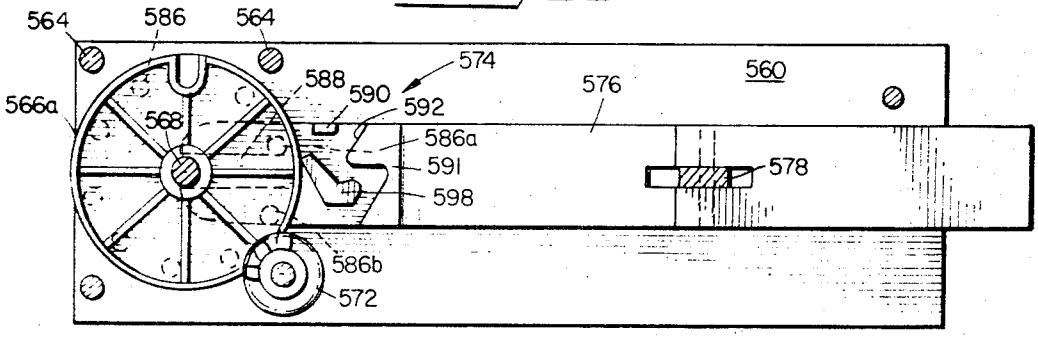


Fig 30



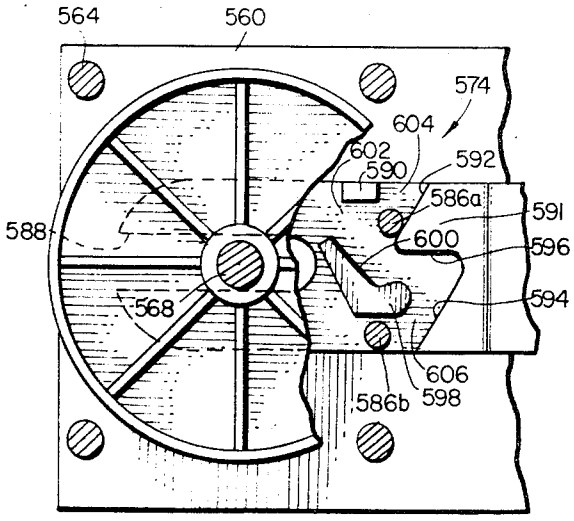


Fig 31

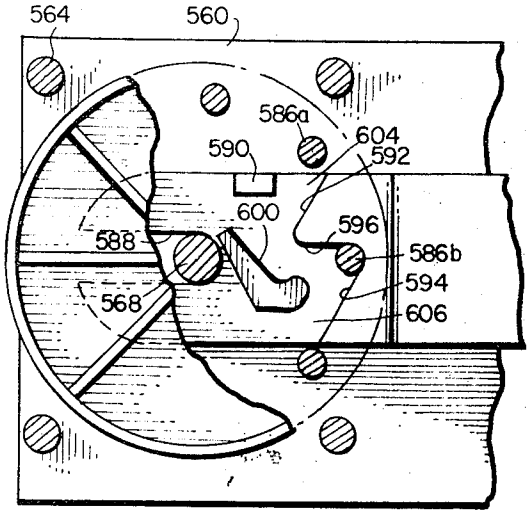


Fig 32

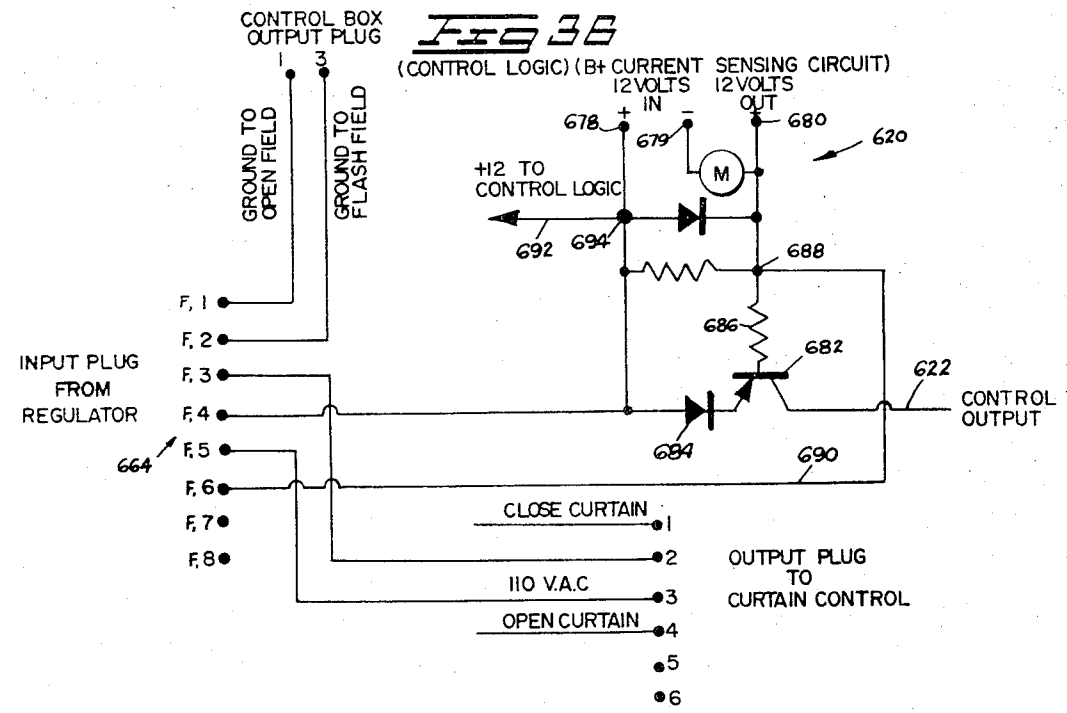


Fig 3B

(CONTROL LOGIC) (B+ CURRENT SENSING CIRCUIT)

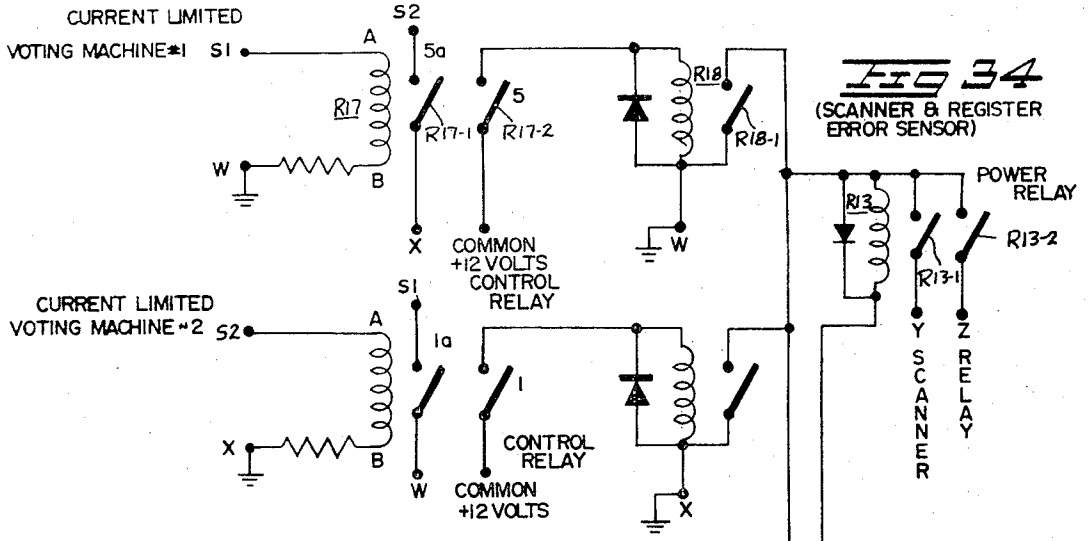


Fig 34

(SCANNER & REGISTER ERROR SENSOR)

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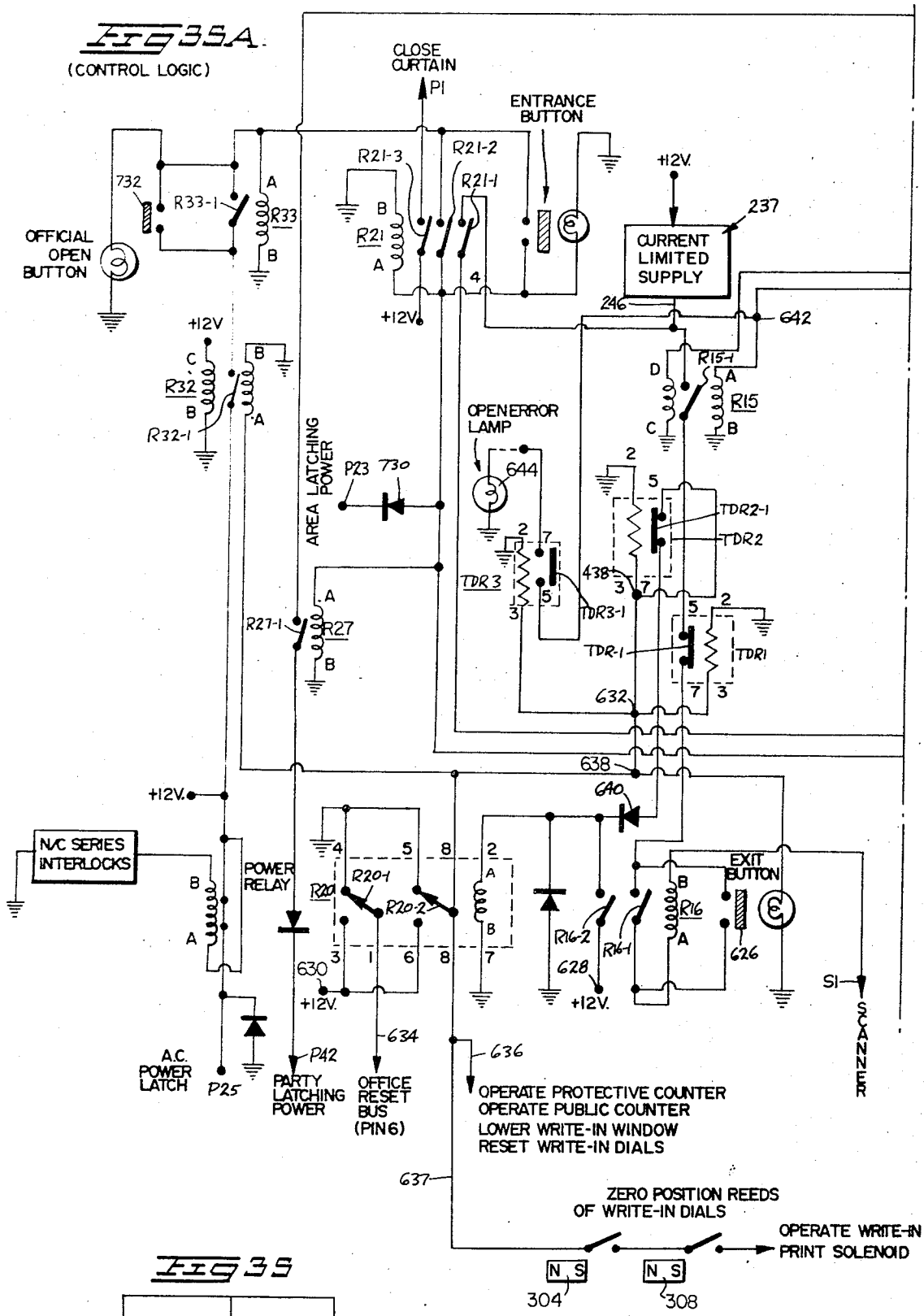
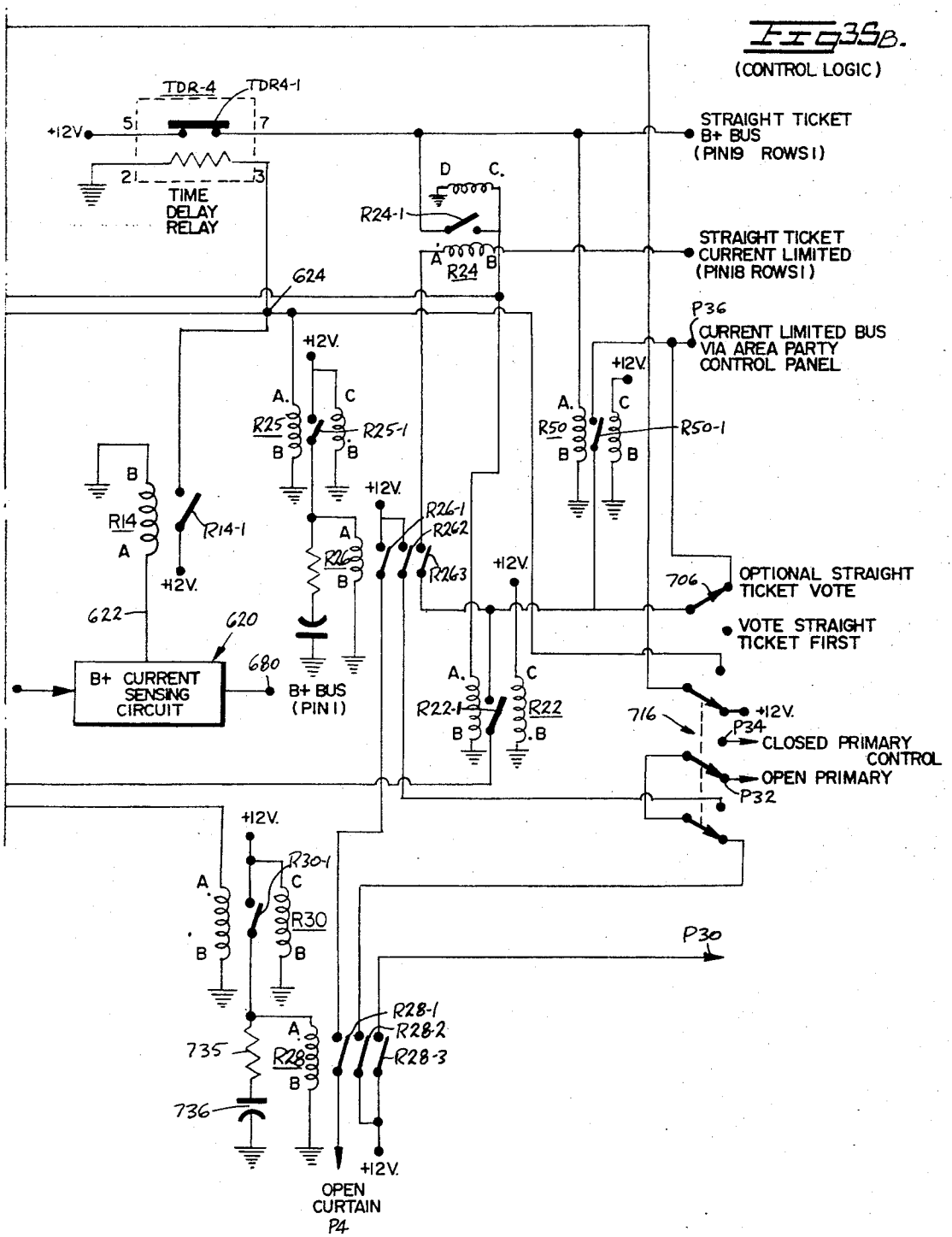


FIG 35

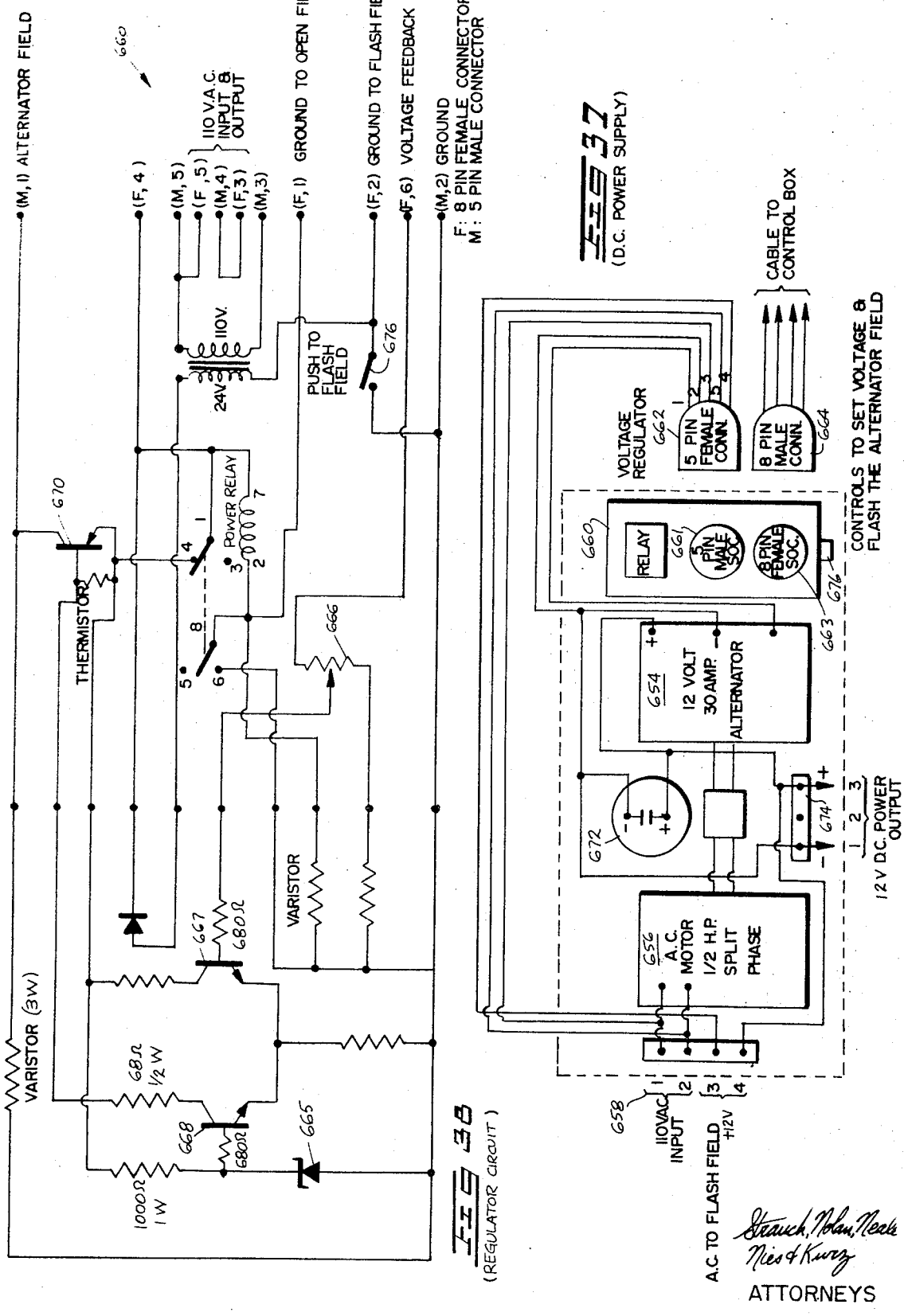
FIG 35A	FIG 35B

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FIG 35B.



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Nies & Kurz
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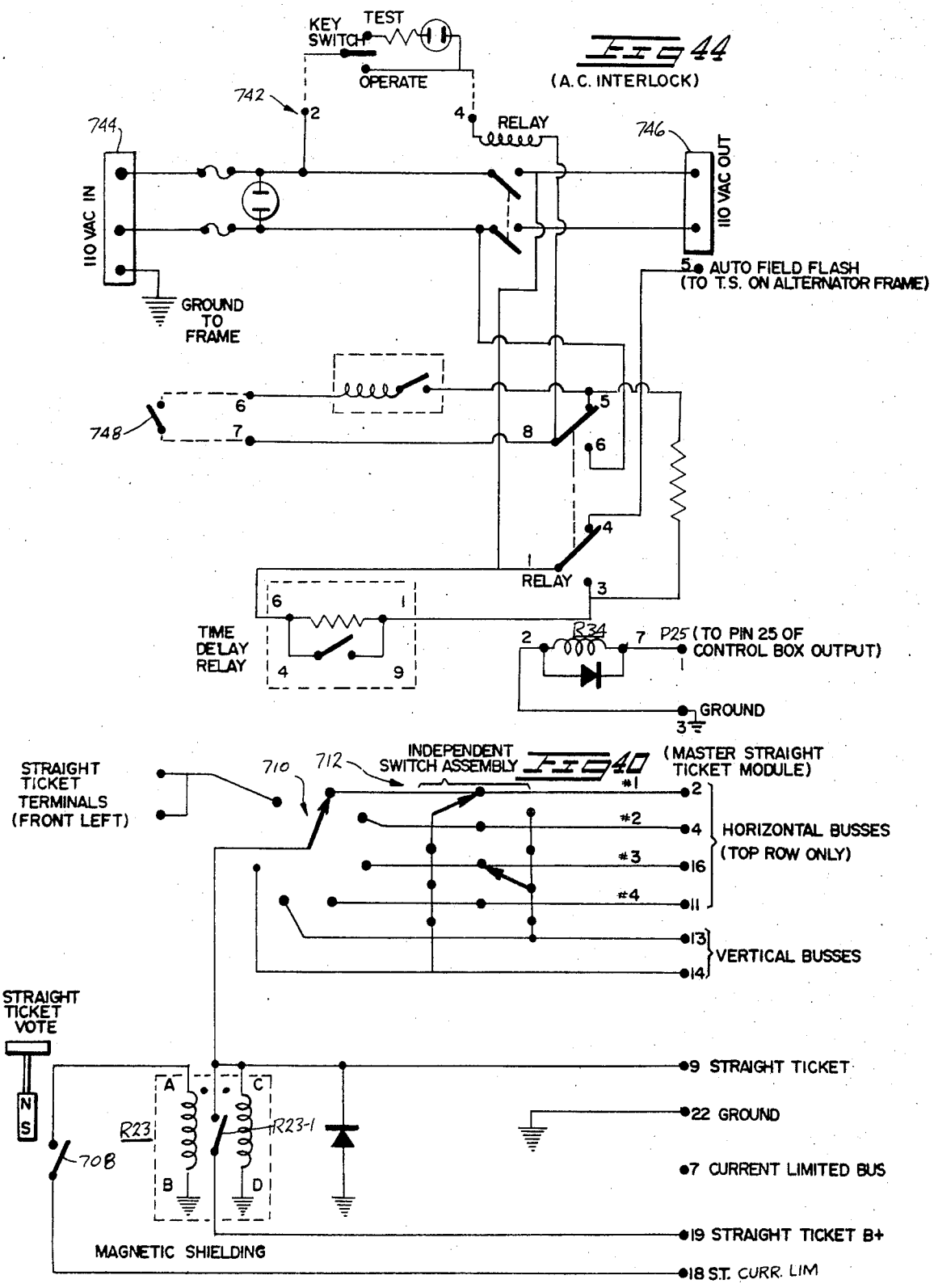


Fig 44
(A.C. INTERLOCK)

Fig 40

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FIG 41

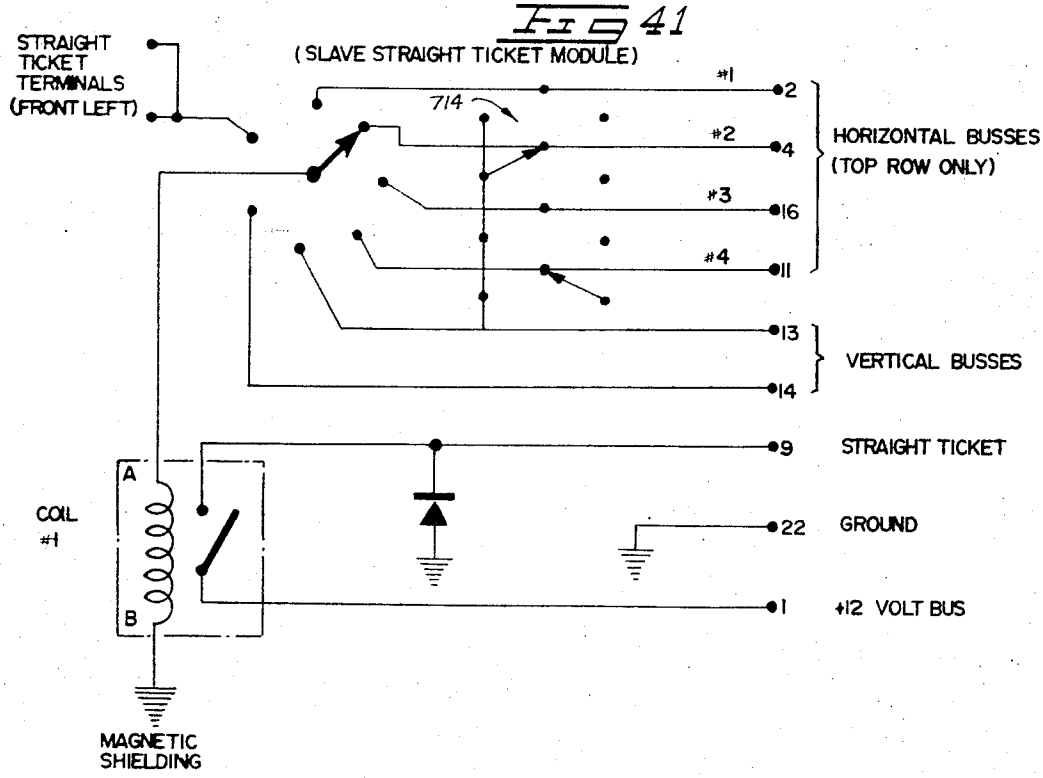
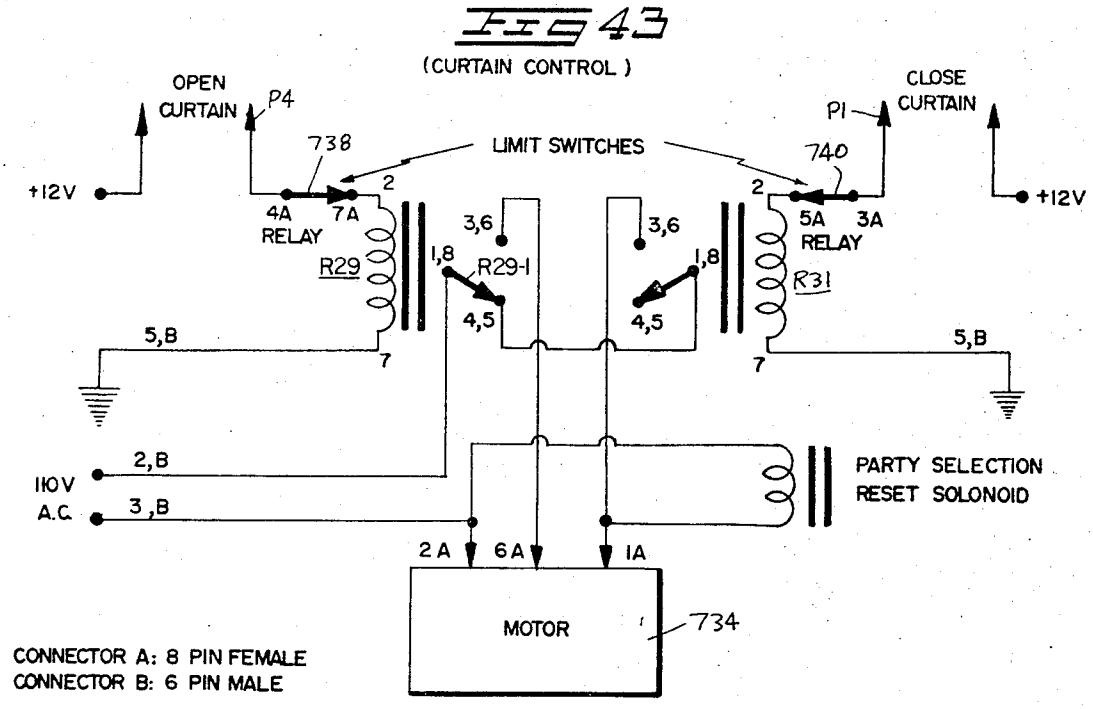


FIG 43



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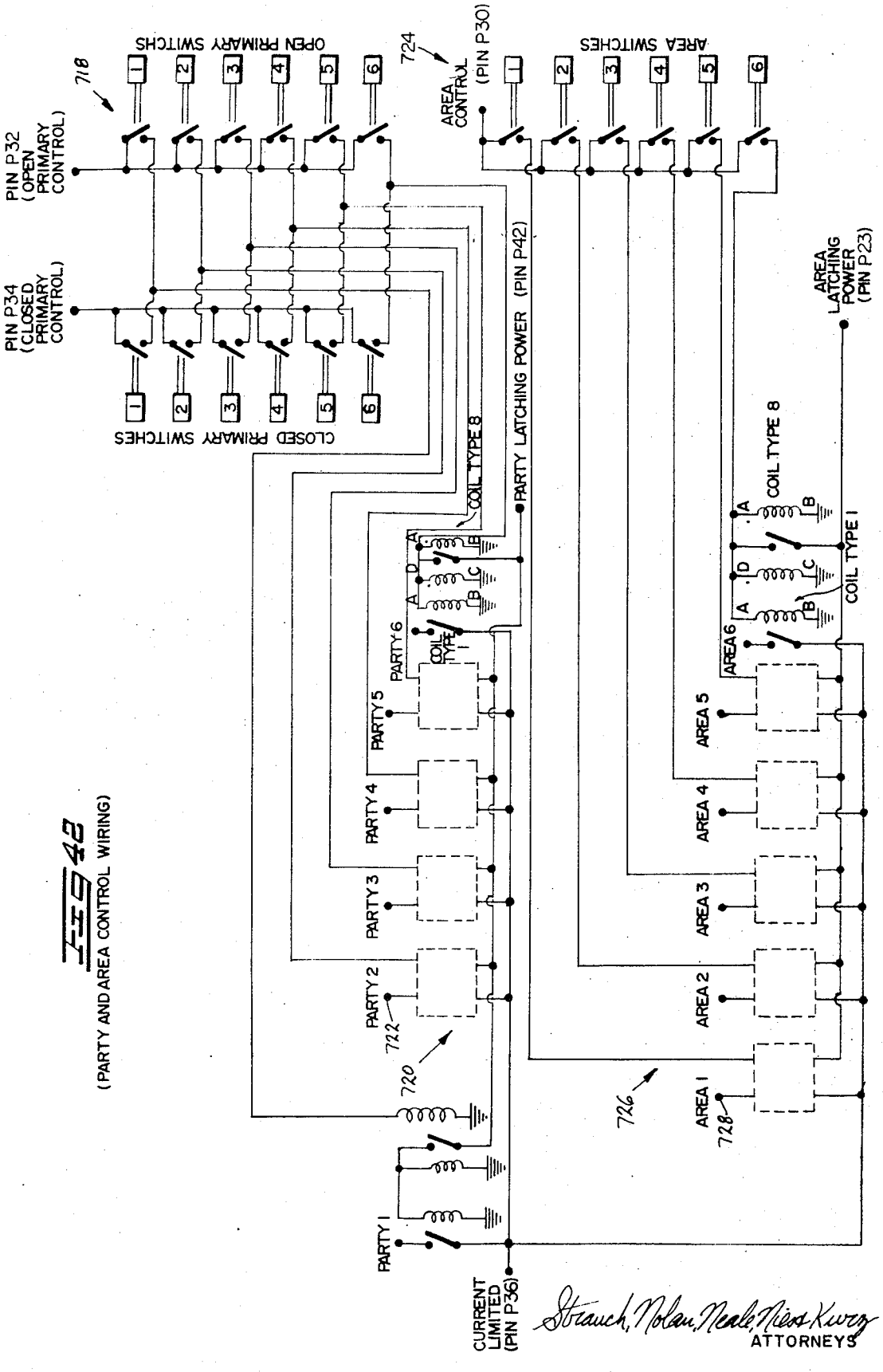


FIG 42

(PARTY AND AREA CONTROL WIRING)

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VOTING MACHINE

Each machine includes a single write-in mechanism servicing all candidates and questions on the ballot and permitting a write-in vote to be cast by a voter for any given office or question. The write-in mechanism is operatively interconnected with the interlock circuits to prevent the voter from casting an improper number of selections.

SUMMARY OF THE INVENTION

The present invention relates generally to voting machines, and, more specifically, to voting machines of an electrically operated type.

It is one important and primary object of the present invention to provide a novel, improved, electrically operated voting machine.

Other important and more specific objects of the invention reside in the provision of electrically operated voting machines:

1. which are comparable with existing mechanical voting machines in their manner of use.

2. which permit a more rapid compilation of votes than existing mechanical voting machines.

3. which have a higher group office capacity than existing mechanical voting machines.

4. in which malfunctions are quickly and unmistakably made apparent to election officials.

5. which provide a high degree of reliability.

6. which provide a secret environment for the voter and which minimize opportunities for tampering with or rigging the machine.

7. which can be easily preset to limit the number of votes which can be cast for given offices and to prevent particular voters from voting for offices and/or upon questions with respect to which they are not entitled to cast a vote.

8. which, in conjunction with the preceding object, can be preset immediately prior to use by particular voters to reflect the limitations applicable to such voters.

9. which, except for write-in votes, permit the voter to change any part or all of his selections at any time up to the point of his final exit.

10. which have a single write-in unit and provisions for identifying the office for which each write-in vote is cast as well as provisions limiting the number of write-in votes which can be cast for each office while allowing the maximum permissible number to be cast.

11. which include a plurality of voting stations and a single central location at which the votes from all of the stations are accumulated.

12. which are capable of accommodating independent candidates.

13. which are capable of preventing plural votes from being cast for endorsed candidates.

14. which can be easily and quickly programmed for general, open and selective primary and other types of elections.

15. which permit individual, straight ticket, and slate voting.

16. in which all failures are safe; i.e., in which it is normally not possible to continue uninhibited operation of the machine until malfunctions are corrected.

The novel voting system of the present invention by which the foregoing and other objects are accomplished include from one to ten voting machines and stations and a single central register having an array of counters where the votes from all of the voting stations are accumulated, a feature which significantly reduces the time spent in the compilation of election results.

Both the vote register unit and the voting machines are of modular construction with the various circuit connections in the voting machine being made at the rear of the machine automatically upon insertion of the various plug-in modules. Because the machine is of modular construction, it may be quickly and easily programmed for a particular election. The modular construction also makes the machine extremely flexible so that it may be used in both closed and open primaries and general elections and so that it can accommodate independent candidates and provide straight ticket as well as individual voting and meet special requirements imposed by statute.

A related important feature is the provision of ballot area and party controls available to the election official so that each machine and ballot may be easily preset by the official immediately before successive voters enter. This makes it possible to quickly and easily eliminate, from consideration by the voter, candidates and/or questions with respect to which he is not entitled to cast a vote.

Each voting station is typically provided with a curtain to insure the privacy of the voter while he is casting his votes. The voting machine and voting registering unit are provided with locks and seals comparable to those employed in mechanical voting machines to prevent tampering and rigging of these components.

To ensure that each voter is permitted all of the votes to which he is entitled but is prevented from overvoting or voting more than once for an endorsed candidate and to insure that his votes are properly recorded, a series of circuits enabling novel electrical and electromechanical interlocks and delays are provided. Coupled with these circuits and other devices are erase features which permit the voter to alter his selections for candidates on the ballot at any time prior to the point at which he exits from the voting location.

Another advantageous feature of the novel voting machines described herein is that, from an operational point of view (and ignoring size) there are virtually no limits on the number of candidates for a group office which can be accommodated on a ballot. By group office is meant one in which plural candidates are to be elected to the same office and each voter is permitted to vote for a number of candidates equal to the number to be elected. This is important because some states now have an many as fifty candidates for a group office on a ballot, and present mechanical voting machines have evidenced unsatisfactory operation when the number of candidates for a group office exceeds about 30.

Yet another novel and important feature of the present invention is that its components are substantially fail-safe and will not cause a vote to be lost if a malfunction occurs or, upon normal operation following a malfunction, permit any further operation of the machine as would cause the loss of a vote. At the same time provision is made for making the presence and locale of a malfunction readily apparent to the election official and in some cases also to the voter so that appropriate steps may be taken to correct the malfunction. In conjunction with the foregoing the overall construction of the machine is such that it minimizes the

incidence of malfunctions, giving the machine a high degree of reliability.

Another feature of the present invention is that only a single write-in area, i.e., a single write-in unit is required in contrast to present day voting machines in which there is a write-in unit for each office. Provision is made in this unit for addressing the office for which a write-in vote is to be cast and for printing the address on the ballot adjacent the name written in to identify the office for which the vote was cast. Provision is made, responsive to voter exit, for printing a symbol on the ballot when a voter has written in a vote. This makes it possible to easily and quickly identify the write-in votes cast by any one voter to prevent a voter from casting more than one write-in vote for the same write-in candidate.

A number of important objects, advantages, and features of the invention have been described above. Other important objects and additional novel features and advantages of the invention will be fully apparent from the appended claims and as the ensuing detailed description and discussion proceeds in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary, front elevation view of the voting panel or ballot of a voting machine of modular construction according to the invention;

FIG. 2 is an enlarged fragmentary sectional view of the end column of the voting panel of FIG. 1 and illustrating a single office area and group office area within one political party column;

FIG. 2*a* is an enlarged fragmented view of the vote and erase buttons associated with each of the candidate modules on the voting panel of FIG. 1:

FIG. 3 illustrates in fragmentation a printed circuit board and its electrical circuit diagram which closes and spans the back of each vertical column of the voting machine of FIG. 1;

FIG. 4 is an electrical circuit diagram of a printed circuit plug-in board which represents a single office module employed in an office in which only a single candidate is to be elected or in a question area requiring a yes or no answer; and

FIG. 5 is an electrical circuit diagram of a printed circuit board functioning as an office extension module used to extend a particular office area from one vertical column to an adjacent vertical column;

FIG. 6 is an electrical circuit diagram of a printed circuit board which functions as a single office candidate module which may be employed in a single office area along with the single office module of FIG. 4;

FIG. 6*a* (on the sheet with FIG. 4) is an electrical circuit diagram of a printed circuit board functioning as a blank module insertable into a particular row and serving to propagate the electrical connections between respective terminal pins of FIG. 3 and successive rows within a single column;

FIG. 7 is a top plan view of a printed circuit board functioning as a universal candidate module which may be used either in a single office or group office area;

FIG. 8 is a fragmentary side elevation of the universal candidate module taken generally along line 8—8 of FIG. 7;

FIG. 9 is a partially sectioned elevation view taken generally along line 9—9 of FIG. 7;

FIG. 10 is a front elevation view illustrating the vote and erase buttons situated at the voting end of the universal candidate module of FIG. 7;

FIG. 11 is a sectional view taken along line 11—11 of FIG. 7 and also of FIG. 9;

FIG. 12 is a sectional view taken along line 12—12 of FIG. 7 (and of FIG. 9), illustrating the location of the indicator lamp within slots in the vote and erase plunger mechanisms;

FIG. 13 is an electrical circuit diagram of the universal candidate module shown in FIG. 7;

FIG. 14 is a top plan view of the printed circuit board constituting a group office module and particularly illustrates the vote counting mechanism by which the number of permissible votes cast within the group office is limited;

FIG. 15 is a side elevation view of the group office module taken along line 15—15 of FIG. 14;

FIG. 16 is an enlarged fragmentary plan view of the counter mechanism seen in the group office module of FIG. 14;

FIG. 17 is an electrical circuit diagram of the group office module illustrated in FIG. 14;

FIG. 18 is an electrical schematic of the current limited source used to energize and initiate a vote latching procedure within the various candidate modules when a selection is made by each voter;

FIG. 19 is a fragmentary front elevational view of the write-in mechanism which is located within the upper right-hand portion of the voting machine seen in FIG. 1;

FIG. 20 is a fragmentary top plan view of the write-in mechanism taken along line 20—20 of FIG. 19;

FIG. 21 is a fragmentary partially sectioned front elevation view of the write-in mechanism, shown with the dials, handle and door removed;

FIG. 22 is a side elevational view taken along line 22—22 of FIG. 21 and particularly illustrating the ratchet slide and its associated control solenoid;

FIG. 23 is an electrical schematic of the control circuit associated with the write-in mechanism illustrated in FIGS. 19–22;

FIG. 24 is a fragmented front elevation view of a single vote counting register capable of registering the votes from as many as 10 voting machines of FIG. 1;

FIG. 25 is a fragmentary sectioned elevation view illustrating the modular construction of the voting register and the manner in which each respective counter device is positioned within a compartment of the register;

FIG. 26 is a top plan view of a counter device, one of which is associated with each respective candidate or question on the main voting ballot;

FIG. 27 is a bottom plan view of the counter illustrated in FIG. 26;

FIG. 28 (on the same sheet as FIG. 26) is an enlarged fragmentary sectioned view similar to FIG. 27 and illustrating the actuating arm and cam assembly by which a vote is registered in each counter device;

FIG. 29 is an enlarged fragmentary view particularly illustrating a counter wheel and the respective transfer wheel by which adjacent counter wheels are operatively drive connected;

FIG. 30 is a fragmented elevation view showing the details of the actuating transfer arm and cam assembly by which a vote is registered in the respective counter wheel;

FIG. 31 is a fragmentary view illustrating the position of the cam assembly as it begins to move the counter wheel;

FIG. 32 is a view similar to FIG. 31 but illustrating the forwardmost position of the arm and cam assembly in which the respective counter wheel has been rotated one-half digit;

FIG. 33 (on the same sheet as FIG. 23) is an electrical circuit diagram of the register counter device illustrated in FIGS. 26–32;

FIG. 34 is an electrical circuit diagram of the scanner and register error sensor which control the transfer of votes from latched candidate modules of FIG. 6 and FIG. 13 into their respectively associated counter devices illustrated in FIGS. 26–33 and also indicate when a malfunction occurs in the voting machine;

FIGS. 35*a* and 35*b* together comprise an electrical circuit diagram of the main control logic in each voting machine, this logic controlling the power supplies to various other electrical circuits including the office modules and the candidate modules;

FIG. 36 (on the same sheet as FIG. 34) is an electrical circuit diagram of a B+ current sensing circuit which is part of the main control logic of FIGS. 35*a* and 35*b* and which generates a signal indicative of the fact that a vote is latched in any one of the respective candidate modules;

FIG. 37 is an electrical circuit diagram of a 12 volt direct current power supply used to operate most of the functional circuits of the voting machine of FIG. 1;

FIG. 38 is an electrical circuit diagram of a solid state electronic voltage regulator employed in the power supply system of FIG. 37;

FIG. 39 (on the sheet with FIG. 16) is an electrical circuit diagram of the power supply system for supplying current necessary for operating the large number of counters present in the voting register of FIG. 24;

FIG. 40 is an electrical circuit diagram of a printed circuit board functioning as a straight ticket module and permitting a voter to select candidates according to straight ticket lines;

FIG. 41 is an electrical circuit diagram of a slave straight ticket module used in conjunction with the straight ticket module of FIG. 40 and serving to extend a party area in one vertical column to the next adjacent vertical column;

FIG. 42 is an electrical circuit diagram of party and area control systems normally accessible only to the voting official and enabling the official to limit the voting areas on a respective ballot to which a particular voter may gain access;

FIG. 43 (on the sheet with FIG. 41) is an electrical circuit diagram of the curtain control system for opening and closing the curtains normally associated with the voting cubicle; and

FIG. 44 (on the sheet with FIG. 40) is an electrical circuit diagram of an interlock system associated with the main alternating current supply for the voting machine to prevent tampering with the A.C. supply.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings, for an initial general description, the electrically operated voting machine 50 shown in FIG. 1 has a housing 52 the front portion of which is divided into a plurality of vertical columns by spaced partitions 54. Within each column, each partition carries a plurality of vertically spaced, horizontally disposed support channels 56 extending rearwardly to the back of the voting machine and, with oppositely aligned channels of adjacent partitions, effectively defining a plurality of eighteen horizontal compartments in each vertical column. In operating condition of the machine, the front of each column is covered by a flat narrow panel 58, slidably supported between partitions 54, each panel having a number of identification tag receiving sections 60 and window openings 62 corresponding in number to the number of rows in each column. The rear of each column is closed by a printed circuit board shown in FIG. 3, each of the respective terminals of which may be provided with female connectors to receive the plug-in terminals of voting modules.

Machine 50 is of modular construction and a plug-in printed circuit voting module, for example, one of those illustrated in FIGS. 4, 6, 7 or 14, is slidably supported in the manner of a drawer between selected pairs of opposed channels 56 within the respective vertical rows. Each module representing a candidate or a question for which a vote is to be cast has an upwardly inclined, inwardly dished, transparent plastic vote button 66, the face of which is slanted upward, toward the machine and is concave; and a narrow opaque erase button 68 located under the vote button. Both buttons extend forward through the associated panel window opening 62 for access by the voter. The dished and slanted face shape of the vote button minimizes the possibility of a voter's finger inadvertently slipping off the vote button downwardly into depressing engagement with the erase button. At the rear of each module are a plurality of 22 terminals which make electrical connections with respective terminal receptacles of a vertical printed circuit panel which closes the back of each column of the machine, the wiring in each column being propagated between the eighteen rows by respective connections between certain terminals in adjacent rows of the printed circuit board as shown in the wiring diagram illustrated in FIG. 3.

A normal program for machine 50 is such that each column represents a given political party. It is possible to plug in any of the various modules within any row, except that it is a requirement that one of the office modules shown in FIG. 4 and FIGS. 14 – 18 be used to head-up an area related to that office. For example, as in the ballot of the illustrated embodiment (FIGS. 1 and 2) the first column on the left may represent the Democratic party, the next column the Republican party, and so on as required by the election. As shown in FIG. 2, the first senatorial office is a single office for which only one vote is to be cast for one of the candidates for that respective office. The second office is a group office for which three dandidates are to be elected. In this manner, the machine may be programmed as desired for any number of offices, candidates within an office, questions requiring a vote within an election, etc.

The front of the voting machine includes a central control area 70 at the right of the machine having a plurality of main control buttons such as party selection buttons 72 for primary elections or straight ticket voting, main power control buttons 74, etc. During operation, panel area 70 is covered by plate 76 except possibly for the party selection buttons, and will be made accessible only to the voting official.

A write-in vote assembly **78** is positioned at the top right-hand portion of the machine to permit a voter to write-in a vote in any particular office for a candidate not represented by one of the candidate voting modules.

In an election, a plurality of voting machines **50** may be employed at a designated voting precinct, with each machine being stationed within a secret voting area or cubicle conventionally enclosed by electrically operated curtains. As a voter makes his selections, the votes will be stored temporarily within the respective machine until the machine exit button is depressed when the voter prepares to leave the vote station. At this time, the stored votes are rapidly transferred from the machine into a single vote accumulating register **550**, illustrated in FIGS. **24** and **25**, common to all machines. The final vote count from the respective precinct is thus available within a very short period of time after the polls are closed.

The manner in which the voting machines and the accumulating register operate will now be described in more detail. The various types of modules which are used in the voting machine are now described as each will function when the machine is energized for operation and when a voter has properly entered the secret voting area.

THE SINGLE OFFICE MODULE

FIG. **4** illustrates the electrical schematic for the single office module. The various components will be mounted on a printed circuit board which in the example discussed relative to FIGS. **1** and **2** will be inserted in the second row for the office of Senator in the Democratic column, its numbered terminal pins via a plug-in connection being electrically connected to the identically numbered pins in row **2** of the column wiring diagram illustrated in FIG. **3**.

When the P/C Board is plugged in, a regulated 12 volt DC supply or bus connected to all of the pins **1** of FIG. **3** is connected via pin **1** of the single office module through coil AB of relay **R1** to pin **3** which is designated "office B+ supply." At the same time, a "current limited bus," connected to circuit board pin **7** (FIG. **3**) and thus via pin **7** of the single office module, passes through coil CD of relay **R1** and coil AB of relay **R2** to a pin **12** which is designated as an "interlock" terminal.

The 12 volt DC supply generated by the power circuit shown in FIG. **37**, passes through the sensing circuit of FIG. **36** and through terminal **680** which is connected to terminal pins **1** in FIG. **3**.

Similarly, the potential on the current limited bus **237** is derived from the circuit of FIG. **18** and fed through the main machine control logic of FIGS. **35***a* and **35***b* and the party and area control circuits of FIG. **42** to pin **7** of FIG. **3**.

Each of these supply systems is described in detail below.

Returning to FIGS. **1** and **2**, the extension of the same Senate office to the second or Republican column in FIG. **1** is accomplished by use of an "office extension" module, the electrical circuit of which is illustrated in FIG. **5**. The single office module of FIG. **4** and the office extension module of FIG. **5** are electrically connected by jumper connections extending between respective terminals A, B, C, D, E, and F appearing at the front of the modules.

THE SINGLE OFFICE CANDIDATE MODULE

A single office candidate module, the electrical circuit of which is illustrated in FIG. **6**, is then plugged into row **3** in both the Democratic and Republican columns and, because pin **3** of each row, as shown in the exemplary column wiring diagram of FIG. **3**, is electrically connected to pin **2** of the next lower row, the B+ supply becomes available on pins **2** and **3** of each single office candidate module. In addition, the aforedescribed interlock supply is then available at pins **11** and **12** and makes possible the selection of one of the candidates for the Senate office while at the same time preventing a voter from improperly casting a vote for more than one candidate, as will be described.

Each of the single office candidate modules includes one of the transparent vote buttons **66**. Each button **66** has a permanent magnet **82** fixed thereto which closes a normally open vote reed switch **84** upon depression of the vote button. Each erase button **68** also has a permanent magnet **88** fixed thereto which when depressed opens a normally closed cancel reed switch **90**.

When a voter depresses a vote button **66** in a respective module of FIG. **6** representing one of the candidates, current from the the current limited bus flows in the office module of FIG. **4** from pin **7** through coil CD of relay **R1**, which closes reed **R1-1** in a period of time greater than **3** milliseconds, and coil AB of relay **R2**, which closes reed **R2-1** in less than 3 milliseconds to interlock pin **12**, thence into the candidate module of FIG. **6** through closed switch **84** and latch coil DB of relay **R3** which closes reed **R3-1** in 3 milliseconds time. Closure of reed **R3-1** connects the 12 volt B+, (FIG. **4**) from pin **1** through coil AB of relay **R1** holding reed **R1-1** closed to pin **3** into the module of FIG. **6** through closed reeds **90** and **R3-1** and holding coil AB to ground, thereby holding the reed **R3-1** closed and maintaining a circuit for the office B+ supply after release of the vote button **66**, which opens the circuit from the current limited bus and the interlock supply. B+ current will also flow through a resistor **92** having a value of approximately 330 ohms and an indicator lamp **94** to ground. The lighted condition of the lamp is visible through the transparent vote button **66** and indicates that a vote has been cast for the candidate represented by the associated candidate module. In addition, B+ current will be available to pin **18** through a coil EF, the magnetic field of which opposes that of coil AB, with pin **18** being connected to the central vote register **550** for registration of all votes cast by the voter upon his exit from the voting machine. The manner in which the votes are registered, and the respective modules are reset for the next voter, will be described hereinafter.

When a vote has been cast for a candidate in a single vote office, it is necessary that the same voter be prevented from improperly voting again for any other candidates for that same office. The modules of FIGS. **4** and **6** cooperate to provide a circuit interlock which accomplishes this result. As described above, when a voter casts a vote for a candidate, the 12 volt B+ continues to flow from pin **1** in FIG. **4** through coil AB of relay **R1** to hold reed **R1-1** closed. If the same voter should attempt to vote for a second candidate within the same office by depression of the vote button of another candidate module, current from the current limited bus will pass through coil CD of relay **R1** and coil

AB of relay R2 to pin 12 and latch coil DB of relay R3 in FIG. 6 in the same manner described above. However, the current limited bus will also be connected through the already closed reed R1-1 in FIG. 4 to reed R2-1, and because reed R2-1 closes before reed R3-1, will be short circuited through reed R2-1 to ground before reed R3-1 in the other candidate module can be closed and the second improper vote latched in the other candidate module.

It is, however, possible for a voter to change his vote choice by erasing a vote which has already been cast in one module for a particular candidate and then enter his vote on a different module for another candidate of his choice. This is accomplished by depressing the erase button 68 on the latched candidate module of FIG. 6 representing the particular candidate for which the vote was originally cast. This will discontinue flow of the office B+ supply to holding coil AB of relay R3, thereby causing reed R3-1 to become unlatched. As a result the 12 volt B+ in the office module of FIG. 4 will no longer be present through winding AB of relay R1, and therefore reed R1-1 will be open to remove the interlock and permit the voter to again enter a vote, either for the same candidate or for another candidate in the usual manner.

To satisfy the need for permitting a voter to vote a straight party ticket, if desired, terminal pins 8 and 9 of the single office candidate module of FIG. 6 may be connected to the straight ticket supply of FIG. 40 through pins 8 and 9 of the column wiring diagram of FIG. 3. When current is supplied to pins 8 and 9 it will pass through auxiliary winding CB of relay R3 to ground, closing reed R3-1 and cause the office B+ supply to flow to the indicator light 94 and pin 18 to effect the interlock circuit described above. No other vote within the single office may be cast unless the erase button for the latched office candidate module is depressed as described above.

The only other pin which is used in the single office candidate module is pin 5 designated as a "group office error sense." This circuit ensures that this particular kind of module is used only in a single office voting area and not in a group office voting area. During the initial programming of the machine, if the module of FIG. 6 is inadvertently placed in a group office area, the 12 volt supply will pass from pin 5 through lamp 94 to ground, lighting lamp 94 to indicate that the module is not to be used.

THE BLANK MODULE

In some ballot arrangements it may be desirable to leave a specific row or rows, in a column, blank, in other words to provide blank spaces separating adjacent office areas in the visible front faces of columns. In such a case, it is necessary to place in that location, a "blank" module, having the connections shown in FIG. 6A, to ensure that the required electrical connections are propagated vertically via the rear circuit board (FIG. 3). Examples of the means for vertical propagation available via the rear circuit board are those from one row to the next between pins 2 and 3, pins 4 and 5, pins 11 and 12, etc.

THE UNIVERSAL CANDIDATE MODULE

In an election, it is frequently necessary to accommodate both single and group offices on the same ballot. Because a group office candidate module becomes more complicated due to the additional functions which must be performed, it is highly desirable that a candidate module which is capable of being employed for candidates in both a single office area or a group office area be provided to reduce inventory requirements for candidate modules. Such a module will be referred to as a universal office module.

Referring to FIGS. 7 to 13, a universal candidate module comprises a plug-in, printed circuit board 96 on which the various electrical components are mounted and connected together as shown in FIG. 13. The printed circuit terminal pins 1–22 are located on the underside of the rear end of board 96 for engagement with a specific row of receptacle pins on the printed circuit supply panel at the rear of each column (FIG. 3).

A U-shaped channel housing 98 is mounted along one side of the universal candidate module board 96 and has a front apertured cover plate 100 through which the transparent plastic vote button 66 and the associated opaque erase button 68 project. Rigidly connected to the rear of buttons 66 and 68 are respective rectangular plastic blocks 102 and 103 having respective elongated openings 104 and 105 and respective rearwardly projecting plungers 106 and 107 each of which is independently slidably mounted through a vertical guide post 108 extending upwardly from the base of housing 98. The buttons and plungers coact to slidably mount the buttons and blocks and the blocks cooperate with the rear side of aperture plate 100 and support post 108 to provide limits of movement for the buttons. Coil compression springs 110 and 111 surround plungers 106 and 107 and act respectively between blocks 104 and 105 and the guide post 108 to resiliently bias buttons 66 and 68 to their forward, outwardly extending position. An indicator lamp 112 is mounted in a spring clip 113 raised by a clip support 114 from board 96 to dispose the indicator lamp within the vote button block opening 104. When the module is latched, the lighted condition of the lamp is visible through vote button 66. The inner end of "vote" plunger 106 is connected by a fork and blade fitting at 115 to a plastic carriage or holder 116 which carries a permanent bar magnet 118 for actuating the normally open vote reed switch 120 when the vote button is depressed. The holder 116 is guided for longitudinal movement along the associated reed switch 120 by an integral guide boss 122 which slidably surrounds the glass encapsulated reed switch.

A similar plastic magnet holder 124 is connected to the inner end of the erase button plunger 107 and carries a permanent magnet 126 for actuating a normally open erase reed switch 128.

Referring to FIG. 13, operation of the universal candidate module will first be described as it is employed in a single office area, e.g., the Senate office of FIGS. 1 and 2, in cooperation with the single office module of FIG. 4, which has been described hereinbefore. A switch 130, located on the universal module, will be positioned in the S (single office) position in which its contacts 130*a* and 130*b* are closed.

When the vote button 66 is depressed, closing the vote reed 120, current from the current limited bus in FIG. 4 will flow from pin 7 to pin 12 to provide an interlock supply at pins 11 and 12 of FIG. 13, the circuit of which is completed through closed reed 120, latch winding AB of relay R4 and resistor 132 to ground. The

R4 relay reed switch R4-1 will be closed, causing 12 volt B+ to flow from pin 1 of FIG. 4 into pin 3 of FIG. 13 from which the B+ supply will flow via junction 133 to and through closed reed R4-1, closed contact 130*a* (which bypasses holding winding CD of relay R4), latch winding DE of relay R5 (which closes reed R5-1), to pins 16 and 17 and through single office module (FIG. 4) pin 17 via resistor 134 to ground.

B+ current will also flow from the junction 133 through closed reed R5-1 and holding winding AB of relay R5 to ground, through indicator lamp 112 to ground, and through winding AB of relay R6 (top of FIG. 13) to ground to close reed switch R6-1. The B+ supply will also be available at the universal module's "register" pin 18 through winding FG of relay R5, for use when a voter exits from the machine and the latched votes are to be counted. As was true in the single office candidate module of FIG. 6, the magnetic field created by winding FG is opposite to that of the relay holding winding AB and causes the module to be reset after the vote is registered.

When the voter releases the vote button, reed switch 120 will open to interrupt the interlock supply to winding AB of relay R4 thus permitting reed switch R4-1 to open.

In a manner similar to that described above with regard to the single office module and single office candidate module, when a vote has been latched into one of the universal candidate modules, an electrical interlock is established to prevent a voter from improperly voting for a second candidate within the same single office. If a voter attempts to vote for a second candidate, in a single office area controlled by the single office module of FIG. 4, the current from the current limited bus on pin 7 will flow through closed reed switch R1-1 to reed switch R2-1, which closes before reed switch R4-1 in the second universal candidate module of FIG. 13 in which a second vote is being attempted, thereby short circuiting the current limiting bus to ground before the vote indicative reed switch R4-1 in the second universal candidate module can be latched.

Again, however, if a voter desires to change his vote choice, he need only depress the erase button of the latched universal candidate module to close reed 128 which results in passage of current limited bus from pin 7 through closed reed switch R6-1, closed reed switch 128, latching winding AB of relay R7 and resistor 136 to ground. Reed switch R7-1 will thus be latched to pass the B+ supply through closed contact 130*b*, winding HI of relay R5 to pins 19 and 20 which are connected to pin 20 in FIG. 4 and ground through resistor 138. The magnetic field created by winding HI of relay R5 is opposite to that of holding winding AB and cancels the holding effect of winding AB to cause reed R5-1 to open, thereby returning the module to its unlatched condition and cancelling the vote initially cast. The voter may then vote again in the normal manner for the same or another candidate of his choice within the single office.

THE GROUP OFFICE MODULE

Before discussing operation of the universal candidate module in a group office area, the group office module 144 illustrated in FIGS. 14–17 will be described.

The group office module, also designated as the "*n* of *m*" counter, is designed to permit selection of a specific maximum number of candidates in a group office area out of a limit of 50 possible candidates and, upon selection of the maximum number, to interpose an interlock which prevents improper further selection of any other candidate within the group office.

Group office module 144 is basically an electromechanically operated counter comprising a printed circuit board 146 on which the various components shown in FIG. 17 are mounted. Terminal pins 1–22 are located at the rear plug-in end of board 146 and pins A–F are positioned at the front end for making the various connections between the group office module, the universal candidate modules employed within the group office area, and the column rear circuit diagram as shown in FIG. 3.

A step-by-step counting gear wheel 148 is rotatively mounted on stationary shaft 150, projecting up from a flat plate 151 on board 146. Rotational movement can be in either a vote counting, counterclockwise direction or vote erasing, clockwise direction. Below and integral with wheel 148 is a hollow disc portion 152 which carries a radially protruding side lug 154. A bottom gear 156 having an upright stop lug 158 in the path of lug 154 is rotatably adjustable relative to gear wheel 148, but is operationally fixed, following adjustment, by a spring biased detent 160 engaged between adjacent gear teeth. Lug 158 limits the amount of clockwise rotation of wheel 148 and defines the initial maximum set position of the counter wheel as the voting procedure for the group office begins. A spiral spring 162 positioned with the hollow disc 152 biases the disc and wheel 148 in a counterclockwise direction toward a zero vote position (a 9 o'clock position in FIG. 16) in which an interlock is established to prevent any further voting within the associated group office.

A spring strip 163 having a detent 164 is end connected to the downwardly etxtending ends of side arms 166, 168 of a fixed support plate 170 which secures the upper end of shaft 150. Support plate 170 extends rearwardly and is rigidly fastened to a housing bracket 172. Detent 164 normally restrains wheel 148 against rotation under the bias of spiral spring 162.

Stepped movement of wheel 148 in a counterclockwise vote counting direction from the initial set position, determined by the location of lug 158, occurs each time a vote is cast for a candidate within the group office. This is accomplished by movement of a vote actuating pawl assembly 174 which includes an actuating pawl 176 pivotally mounted at 178 to a bifurcated pivot support 180 having an end piece 182 fixed to the forward end of an electro-magnet armature plate 184. The armature 184 extends rearwardly past the pole of a vote solenoid 210 and along the side of the housing bracket 172, being pivoted adjacent its rear end of a knife edge 188. Its rear end 190 is pulled inwardly by spring 192 between the plate and a center connecting flange 194 of housing bracket 172, to bias the armature away from the electro-magnet pole face.

A lever 196, pivoted at 198, has its forward end 200 connected to the forward end of armature plate 184 by a rod 202 for movement therewith, and has its rearward end 204 connected to a permanent magnet holder 206, movement of which opens a normally closed limit sensing reed switch 208 when the armature 184 moves at the time a vote is cast.

Pawl assembly 174 is actuated by a "vote" electromagnet 210 secured within the housing bracket 172.

The magnetic field created by energization of the electro-magnet attracts and pulls the armature plate **184** inwardly whereupon pawl **176** engages a tooth of wheel **148** and advances the wheel one step to count that vote as one of the maximum number permitted for the associated group office. As armature plate **184** moves inwardly, it causes lever **196** to pivot so that its rear end **204** moves outwardly, shifting the magnet in holder **206** to permit limit reed switch **208** to open.

Even though a vote has been preliminarily counted by wheel **148**, it still may be cancelled from that precount by indexing the wheel one step in a clockwise direction back toward its initial set position determined by lug **158**. This is accomplished by an erase actuating pawl assembly **212** which is identical to the structure of the vote pawl assembly **174** except that is on the opposite side of housing bracket **172** from pawl assembly **174**, it functions to index the wheel **148** clockwise and it actuates a permanent magnet assembly **214** which, upon movement, opens a normally closed erase limit sensing reed **216**. Movement of pawl assembly **212** is accomplished by energization of an erase electromagnet **218** secured within housing bracket **172**.

As indicated above, the counting wheel **148** is stepped a number of times between its initial maximum set position established by the selecting lug **158** and a zero vote position at which an interlock is established to prevent any further voting within the group office, the number of steps of the wheel necessary to move it from "maximum" to the zero position, corresponding to the maximum number of candidates to be selected within the office.

Referring to FIG. **16**, the zero vote condition is transmitted by a lever **222** pivoted at **224**. A projection **220** on lever **222** extends into the path of movement of and is engaged by lug **154** when wheel **148** has been advanced the maximum number of times permitted. When lug **154** engages lever projection **220**, lever **222** will be rotated clockwise about its pivot **224**, causing a permanent magnet holder carriage **226**, connected to an arm **228** of lever **222**, to shift longitudinally relative to a normally closed reed switch **230** which opens the reed switch.

A return spring **232** biases lever **222** and magnet assembly **226** back to their normal positions, shown in FIG. **16**, as the count wheel and lug **154** are returned to an initial set position, or if, after a group has been voted, a vote for one candidate is erased, indexing the wheel **148** clockwise one step which, as described, will then permit a vote for another candidate.

To permit a voter to vote a straight ticket, a solenoid **234** having a forked plunger **236** with the ends of the fork arms slotted and fitted over the spring strip **163** adjacent both sides of the count wheel detent **164**. Secured to one of the fork arms **236** is a downwardly extending spring leaf projection **238** adapted to engage an arm of lever **222**. When solenoid **234** is energized, its plunger pulls detent **164** out of restraining engagement with wheel **148** which is then rotated to its zero vote position under the influence of the internal coil spring **162**. An interlock is simultaneously established by engagement of the spring leaf projection **238** with lever **222** to rotate the lever clockwise and move magnet assembly **226**, thereby opening reed switch **230**.

When programming a group office area, such as the school board office of FIGS. **1** and **2** in which three candidates are to be selected, the group office module of FIGS. **14–17** would be placed in row four of the first column and an office extension module of FIG. **5** is placed in row four of the next column, with the front terminals A–F of each module being connected by short jumper connections. A universal candidate module of FIGS. **7–13** would then be placed into the next three lower rows of each of the first and second columns, with the several modules in each column being interconnected by the associated rear circuit boards, such as seen in FIG. **3**.

Gear **156** in the group office module is pre-set so that lug **158** is angularly spaced from the count wheel lever projection **220** an amount permitting wheel **148** to be indexed through only three steps from its initial maximum set position to its zero vote position. In this manner, only the maximum of three votes may be cast within the group office, after which the count wheel lug **154** engages lever projection **220** to establish the interlock which prevents any further voting for that office.

Assume now that the group office module is in its votable maximum set position and the switch **130** in each of the associated universal candidate modules in both of columns one and two is in its open or G (group office) position. With particular reference to FIGS. **13** and **17**, upon depression of a vote button to close an associated reed **120** in a selected one of the universal candidate modules, current from the current limited bus will flow from pin **7** (FIG. **17**) through reed **230** to pin **12** to provide an interlock supply on pins **11** and **12** of the universal candidate module (FIG. **13**) which will pass through closed vote reed **120** to energize latching winding AB of relay **R4** which closes reed **R4-1**. The office B+ supply then flows from pins **2** and **3** to junction **133** (FIG. **13**), through closed reed **R4-1**, holding coil CD of relay **R4** and latch coil DE of relay **R5** (which closes reed **R5-1**) to pins **16** and **17** which are connected to group office module pin **17** (FIG. **17**). This current continues to flow through vote solenoid **210**, coil AB of relay **R9** which closes reed **R9-1**, and normally closed limit sensing reeds **208** and **216** to ground. Energization of vote solenoid **210** actuates the vote pawl assembly **174** and pawl member **176** engages with a tooth of wheel **48** and indexes the wheel counterclockwise one step from lug **158** toward projection **220**. The actuating force of the pawl assembly is sufficient to overcome the restraining force of the spring detent **164**. At the same time lever **196** is operated to move magnet assembly **206** and cause limit reed switch **208** to open. The use of limit reed **208** ensures that the pawl assembly has moved a sufficient distance to impart adequate rotation to wheel **148** through a full step so that detent **164** will again be fully engaged between adjacent teeth of the wheel.

Opening of limit reed switch **208** results in deenergization of vote solenoid **210** and relay **R9** (FIG. **17**) and of coil DE of relay **R5** and coil CD of relay **R4** (FIG. **13**), the latter causing reed **R4-1** to open, assuming the vote button has been released. Deenergization of vote solenoid **210** causes pawl assembly **174** to return to its set position, seen in FIG. **14**, and the limit reed switch **208** to again be closed. Wheel **148**, of course, will remain in its indexed position having counted one vote and will permit two more votes to be registered in the school board group office.

Deenergization of latch coil DE of relay **R5**, however, will not affect reed switch **R5-1** since, when the reed switch was initially closed, the B+ supply will have

flowed from junction 133 through the reed switch R5-1, energizing the holding coil AB of relay R5 to latch the module. Current will also flow through lamp 112 and coil AB or relay R6 to close reed switch R6-1 and will be available at pin 18 to register the vote when the voter exists from the voting cubicle.

The voter may then continue to vote for the remaining candidates of his choice, with the group office module and each of the respective universal candidate modules functioning as described above. When two selections have been made within the exemplary group area and only one additional vote is permitted, selection of the third candidate will cause wheel 148 to index to its zero position where lug 154 will engage the arm 220 of lever 222 which shifts the permanent magnet assembly 226 relative to reed switch 230 and opens the reed swtch. This provides an interlock for the exemplary group office, preventing further votes in excess of the permitted maximum of three from being cast, because opening of reed switch 230 disrupts the circuit from the current limited bus to any of the universal candidate modules.

Provision is made to enable a voter to cancel his vote for an original candidate (or more than one) of his choice and to revote if he desires for another candidate (or the number he cancelled). This function can be accomplished by depressing the erase button in a universal candidate module representing an originally chosen candidate to cause current from the current limited bus to flow from pin 7 through closed reed switch R6-1, closed erase reed switch 128, latch coil AB of relay R7 and resistor 136 to ground. Energization of latch coil AB of relay R7 will close reed switch R7-1 enabling B+ current to flow therethrough to the relay R7 holding coil CD and thence through coil HI of relay R5 to pins 19 and 20. The magnetic field of coil HI cancels that of holding coil AB, and enables reed switch R5-1 to open whereupon the module is unlatched canelling the vote registered therein. The B+ supply on pin 20 will enter the group office module of FIG. 17 and pass through erase solenoid 218, relay R9, and normally closed limit reed switches 208 and 216 to ground. Energization of the erase solenoid 218 will actuate erase pawl assembly 212 to index the count wheel 148 one step in a backward (clockwise) direction removing one of the vote counts.

At the same time, the erase magnet assembly is moved relative to limit reed switch 216, causing the reed switch to open, discontinuing flow of the B+ current through the erase solenoid circuit. The pawl assembly 212 will then return to its normal set position of FIG. 14, but the new position of wheel 148 will permit selection of another vote choice to replace the one which was cancelled.

If all three permitted selections have been made and the erase button in one of the selected candidate modules is depressed, clockwise rotation of wheel 148 will cause disengagement of lug 154 from projection 220 and movement of magnet assembly 226 under the influence of spring 232 back to its original position adjacent reed switch 230 to again close the reed switch and permit selection of another candidate, after which reed 230 will again be opened and the interlock established.

It should be noted that holding coil CD of relay R4 and holding coil CD of relay R7, which are in circuit when switch 130 is in the G position, provide sufficient time for the vote and erase solenoids 210 and 218 to be energized and place the stepped operation of counter wheel 148 of the group office module under control of the limit sensing reed switches 208 and 216.

It should also be noted that relay R9 in FIG. 17 is energized to close reed switch R9-1 whenever either of the vote or erase solenoids is energized and ensures that while either of pawl assemblies 174 and 212 and counter wheel 148 is in a dynamic state, it is not possible to select any other candidate, since current supplied by the current limited bus at pin 7 of FIG. 17 will be grounded through closed reed switch R9-1.

Because both the vote and erase solenoids 210 and 218 require substantial current for their operation, a surge limiting diode 236 is provided across limit reed switches 208 and 216 to minimize contact damage due to the substantial currents and voltages which exist during the turn off transients.

A CANDIDATE MAY BE ENDORSED in general elections by two or more parties for a given office. When this occurs in a group office the candidate's name will appear a number of times on the ballot, that is to say, once for each party endorsing. Since no candidate is permitted to receive two or more votes from the same voter, a selection of the endorsed candidate within one party must interlock out the same candidate in all other parties even though that office may not be fully voted.

To accomplish this a parallel jumper connection would be made between all of the endorsed candidate modules via terminals 140 located at the front of each of the universal candidate module candidate printed circuit boards on all of the party tickets. A vote cast on any one of the endorsed candidate modules will close the latch relay reed switch R5-1 of that module, which thereby connects 12 Volts B+ to the endorsed candidate terminal 140 via junction 141 (FIG. 13). This closed circuit in any one of the group of endorsed candidate modules applies B+ to terminals 140 on all of the group of endorsed candidate modules. Current would thus flow through windings AB of relays R8 to latch reed switches R8-1 in all of the endorsed candidate modules. Because of such actuations a vote may be cast for the candidate on only one of the endorsed candidate modules. Thereafter, on the others, it would be impossible to cast another vote for the endorsed candidate already voted for because depression of the vote button in the other endorsed candidate modules would merely short circuit interlock supply current applied via pins 11 and 12 (FIG. 13) through closed reed switches 120 and R8-1 to ground. In this way, the endorsed candidate function of the machine is satisfied.

THE "CURRENT LIMITED" SUPPLY

At this point, the nature of the current limited bus applied to pin 7 of the column circuit diagram of FIG. 3 will be discussed. The current limited supply is specially designed to avoid the possibility of a voter simultaneously voting a number of selections in order to gain more votes than are legally pemitted within the framework of a ballot. The current limited bus is characterized by having a large enough internal resistance such that a fixed maximum current will flow for a prescribed period of 3–10 milliseconds under conditions of an applied short circuit, and thereafter a lesser maximum current will flow as long as a demand is made upon the supply.

Two levels of current supply are chosen to provide maximum protection against the possibility of overvoting by simultaneous depression of vote buttons. The problem which gives rise to this requirement derives from operating characteristics of reed relays and the manner in which these characteristics vary from reed to reed within a batch. To make reed switches economically, they are mass produced and with low cost mass production one must accept a substantial difference in the switches in the ampere turns required to close the contacts and those required to maintain the contacts closed in steady state operation. Typically, there will be about a three-to-one ratio in the ampere turns quoted. For example, about 100 ampere turns will be necessary to make the initial contact closure, and once the reed is closed the ampere turns can be reduced to between 30 and 40 before the reed once more becomes open. Within a batch of switches, the 100 ampere-turn value may vary by ± 25 percent, while ± 20 percent may obtain at the level of 30–40 ampere turns. To accommodate the least sensitive reed, which requires a large number of ampere turns, and still provide a safety margin, about 135 ampere turns should be provided as a low limit operating signal. If such a signal is applied to a situation wherein someone attempts to operate two of the most sensitive reeds in parallel (to cheat the system), then for conditions of perfect symmetry each circuit would receive 67 ½ ampere turns under steady state conditions. In practice, however, there will be differences in circuit resistance due to differences in path length and there will be minor variations in the circuit time constant determined by the ratio of inductance to resistance, which would permit an unequal division of ampere turns to be applied. Assuming the worst case, one circuit may well receive as many as 75 ampere turns for a brief period, which is enough to energize the most sensitive reed, while the other circuit would receive only 60 ampere turns at the same instant. Once the first reed is closed, however, the circuit inductance increases marginally, thereby causing a small decrease in the current applied. This additional current can flow into the second reed coil, causing the reed to close its contacts. Once this has happened the ampere turns may fall by a factor of almost 3 without the reed reopening. A similar situation applies to the first reed and hence we have both reeds permanently closed and being sustained with ampere turns applied to each at a level well in excess of the minimum required to initiate closure.

It thus becomes necessary to provide a defined current-time relationship in the current limited bus to avoid the possibility just described. This is achieved by arranging that the high-current level is applied for a period of about 3 to 10 milliseconds and followed by a much lower sustaining level of current for as long as required by the closure of any vote button or the needs of a write-in area to be described. The sustained current level is adequate to maintain reeds closed but is not adequate to provide any surplus for the operation of any secondary circuits that may be called for in an attempt to cheat the system. The magnitude of the larger current is enough to energize the least sensitive reed relay, and the smaller current is adequate only for maintaining closure of one reed. Without such a protective feature it would be possible in a group office to vote simultaneously for more than one candidate.

The counting mechanism, including wheel **148** and pawl assemblies **174** and **212** in the group office module, has a finite limitation in speed at which voted candidates within a group can be counted through the controlled stepping sequence described above, and it would therefore be possible in principle to latch several reed relays in candidate modules without a corresponding number being recorded in the group office module. Thus, theoretically, in a situation where a voter was allowed, for example, to make 15 selections out of 30 candidates in a group office, he could vote for 15 candidates simultaneously and the associated group office counter would register only one vote. The voter could then individually select as many extra candidates as he wished up to the limit of the 30 set within the group office counter. However, in the invention if two candidate modules are voted simultaneously, neither would record a vote because the available current from the current-limited bus would divide in somewhat equal proportions between the two modules, and neither current would be large enough to ensure actuation of the latching reed. The current-limited supply is a pulsed supply with a carefully prescribed current-time relationship made necessary by the operational requirements of the voting system as a whole.

The purpose of the current-limited supply can also be understood in terms of what would happen if a voltage supply had been used instead. In a group office, for example, the counting mechanism has a finite rate of response to selections made within that office. As indicated above, the "*n*" of "*m*" counter illustrated in FIGS. **14–17** is an electromechanical device and requires considerable time, even though measured in milliseconds, to log one additional vote selection. If three or four vote buttons are pushed within the office simultaneously and held down for a period slightly longer than the response time of the "*n*" of "*m*" counter, then only one count would have been added and four selections would have been latched at the candiate modules. This would be possible because a voltage supply would have delivered whatever current was demanded by the four candidate modules.

However, according to the invention, the magnitude of current that can flow is limited by using a current limited supply, and it is possible to ensure that if two or more candidate modules are selected at the same time, only one will become latched because there will not be sufficient current available to latch a second or more modules at the same time.

There is an additional requirement due to the finite response of the "*n*" of "*m*" counter in a group office which applies both to candidate selections within the office and to write-in votes within that office and this is to prevent cheating of the system by rapid fire selection of candidate modules in sequence. If a voter recognizes that the current limited supply prevents his being able to vote for more than one candidate at the same instant, he might attempt to cheat the system by making his selections in very rapid sequence, such that each selection has an adequate amount of current and time available to latch the candidate module but that the rate of selection is so high that the "*n*" of "*m*" counter in the group office module is not able to respond.

Referring to the current limited supply **237** illustrated in FIG. **18**, a 12-volt D.C. supply is made available through resistors **238** and **239** to a pair of 2N555 transistors **240** and **241** which are used for the purpose

of creating a high dynamic resistance as well as a current limited output. Provided that transistors **240** and **241** are not bottomed, they will present a high dynamic resistance when measured at the collector terminal. Typically, there will be an impedance of about 10,000 ohms. The 12-volt supply is also fed in series through two Zener diodes **242** and **244** to the base of transistor **240.** Diode **242** may be of the 1N748 type, whose Zener voltage is 3.9, and diode **244** may be of a 1N750 type, whose Zener voltage is 4.7.

Without a load connected to the current limited output terminal **246** which is connected to pin 7 of FIG. **3,** the potential of the base of transistor **240** will be approximately 8 volts. Under these conditions a 2N404 transistor **247** is caused to conduct by reason of base current flowing through a 3.9K resistor **248** and **100K** variable resistor **250,** and the resulting collector current flows through the **12K** base resistor **252** of a 2N1304 transistor **254** causing this transistor to be cut off. With no collector current flowing through transistor **254,** reed relay **R11** is deenergized and reed **R11-1** is in the open position and the circuit as a whole is ready for use.

When a load is applied at current limited terminal **246** potential at this point falls rapidly due to the high dynamic resistance of transistors **239** and **240.** This drop in potential causes transistor **247** to become nonconducting since its base is connected through variable resistor **250,** resistor **248,** a 1N1692 diode **256** and a 1,000 ohms resistor **258** to terminal **246.** Current necessary to charge a **1UF** capacitor **260** which is connected between resistor **248** and diode **256** is available through the low impedance path of the diode and resistor **258.** The base potential of transistor **247** therefore drops rapidly, cutting off the transistor and allowing transistor **254** to conduct. Collector current then flowing through the coil of relay **R11** causes the associated reed **R11-1** to close after a period of about 3 to 10 milliseconds, depending on the particular value of a variable **10K** resistor **262.** As soon as reed **R11-1** closes, ode **244** is shortcircuited causing the base potential of transistor **240** to rise by 4.7 volts. This reduces significantly the magnitude of the current limited output to a level less than one-half of what prevailed initially.

The aforedescribed reduced sustaining level will continue to flow as long as a demand is made upon the supply. As soon as the demand is removed, the potential at the base of transistor **240** will rise abruptly, but a much smaller rate of change will occur at the base of transistor **247.** This latter rate of change is determined by the relatively long time constant of resistor **250** and capacitor **260** to ground at the junction of resistor **248** and diode **256** in the base circuit. The recovery period can in fact be set between 50 and 300 milliseconds by a suitable selection of the value of resistor **250.** A delay therefore ensues before transistor **247** can conduct and thereby cause transistor **254** to become nonconducting. Soon after this occurs the collector current through transistor **247** ceases to flow, transistor **254** becomes non-conducting and the relay **R11** is deenergized to open reed **R11-1** which again places diode **244** in circuit. At this time the current limited supply is ready once more to be used in the normal candidate selection process. In this way there is restricted access to the supply for a period long enough to establish equilibrium in all related circuits, thereby preventing a voter from cheating the system either by simultaneously voting for a number of candidates or by voting in a rapid sequence.

THE WRITE-IN MECHANISM

The write-in mechanism **78** illustrated in FIGS. **1** and **19–23** enables a voter to cast a write-in vote as often as legally permitted within any office on the ballot. This is accomplished by addressing any office on the ballot through clockwise rotation of a pair of dials **270** and **272** to a three o'clock indicator position **273,** the dials representing, respectively, the columns and rows within a column as they appear on the voting panel or ballot. The dials are normally biased to a zero set position and must be positively restrained from zeroing when they are in an address position. They control circuitry that provides B+ supply to pins **10** and **15** of the column wiring panel of FIG. **3.**

The structure of mechanism **78** will first be described and then its function as related to the control circuitry of FIG. **23** will be discussed. As shown in FIG. **1,** the only elements of the mechanism which are exposed at the front of the machine are dials **270, 272,** dial indicator **273,** a write-in window opening **274** in housing **52,** and a handle **276** for raising a pivotable door **278** which normally closes window **274** and covers the paper on which the write-in candidate's name is to be written. A reset pushbutton **279** enables a voter to reset the mechanism and cast a number of write-in votes if desired.

As illustrated in FIGS. **19–22,** mechanism **78** comprises a frame having upper and lower mounting plates **280, 282** connected together by four corner-located vertical posts **284.** Shown in FIG. **19,** a straight vertical rear bracket **286** and a front vertical bracket **288** extends between the plates **280** and **282** rotatably support the dial shaft **292.** Bracket **288** has its lowermost portion **290,** offset underneath dial shaft **292.** Inner dial **270** is fixed by a pin to the forward end of shaft **292** and has a plurality of embossed successive letters **294** (see FIG. **20**) on the inner and outer faces thereof corresponding in number to the number of rows within each vertical column. Outer dial **272** (see FIG. **20**) is rotatably mounted on the periphery of inner dial **270** and has a plurality of embossed numerals **296** extending only partially around its inner and outer faces and corresponding in number to the number of vertical columns on the voting panel. For example, in the panel of FIG. **1** there are nine vertical columns and 18 rows in each column. Hence, there will be nine numerals **296** on dial **272** and 18 letters **294** on dial **270** enabling a voter to select and address any office located in a specific column and row on the ballot. The dials also have on their rear face embossed zero indicators which align with indicator **273** when the dials are zeroed.

Shown in FIG. **20** dial **272** includes an integral rearwardly extending arm **298** having a right angle flange portion **300** with a hub **301** connected to a sleeve **302** which is rotatable on shaft **292.** A permanent magnet **304** is fixed on arm portion **300.**

Fixed by a set screw to the back end of shaft **292** is a support arm **306** which mounts a second permenent magnet **308** so that upon rotation of dial **270,** both the arm **306** and the magnet **308** rotate therewith.

A pair of multiple reed switch assemlies **310** and **312** are mounted respectively adjacent the rotational paths of magnets **304** and **308** to be closed thereby, each of the two assemblies including a plurality of radially disposed reed switches corresponding in number to the

number of letters or numbers on its associated dial. The inner terminal wires of the reed switches are fixedly supported in an electrically conductive sleeve **314** freely mounted on shaft **292**, but maintained against rotation with the shaft by a plastic bracket **316** fixed to upper support plate **280**. The outer ends of the reed switches extend through dielectric support strips **318** which are themselves supported in annular arrangement by tie rods **320** extending radially from sleeve **314**.

Clockwise rotation of the row selector dial **270** to align a particular letter with pointer **273** (see FIG. 1) will position magnet **308** adjacent a specific reed switch in assembly **312** representing that row. Similarly, clockwise rotating of column selector dial **272** locates magnet **304** adjacent a particular reed switch in assembly **310**. In this manner, any office, regardless of its column and row location on the front panel of the machine, may be addressed.

Referring to FIGS. **19** and **20**, a detent wheel **322** is fixed on hub section **301** of dial **272** and a similar forwardly axially spaced detent wheel **324** is fixed to shaft **292**. A small horizontal shelf plate **326** between and above the detent wheels, formed as an integral section of forward bracket **288**, has a pair of apertures **328** and also carries a rigidly secured L-shaped upstanding bracket **330** with a pair of apertures aligned with apertures **328**. The upper ends of a pair of vertically slidable shafts **332** extend through the L-shaped bracket apertures and the lower ends of each shaft are fixed to small bearing blocks **334** which extend through openings **328** in the shelf plate and carry rollers **336** which engage within the detent grooves of wheels **324** and **322** serving to retain the dials in selected positions. Each small bearing block **334** is slotted at **338** (FIGS. **19** and **21**) and a cross pin **340** extends within the slots between the two blocks. A lever **342** pivoted at the left hand end **344** to the shelf plate **326** extends horizontally to the right between blocks **334** and underneath the cross pin **340**.

Shown in FIG. **19** the right hand end of lever **342** is pivotally connected to the lower end of a vertical rod **346** which at its upper end is pivotally connected to one arm of a bell crank **348** pivoted at **350** on support plate **280**. Another lever arm of the bell crank is pivotally connected to one end of a wire connecting rod **352**, the other end of which is pivotally connected to the plunger **354** of detent solenoid **356** mounted on a support bracket **358** secured to plate **280**. When solenoid **356** is energized, its plunger **354** and rod **352** are pulled to the left, pivoting bell crank **348** clockwise to raise connecting rod **346** and lever **342**. The lever **342** engages cross pin **340** thereby raising rollers **336** out of engagement with wheels **322** and **324**. Dials **270** and **272** which are normally spring loaded to a zero set position are now free to return to their zero position which is defined by engagement of detent wheel lugs **359** with a stop bracket **360** (FIG. **19**).

Above the dial shaft **292**, a second stationary shaft **361** extends between vertical brackets **286** and **288**. Rotatably mounted on the forward end of shaft **361** is an axially elongated cam **362** to which the aforedescribed handel **276** is connected by a weld at **364** (see FIG. **20**). Cam **362** overlies the upper ends of the vertical detent guide shafts **332**, and when the handle is raised, a high rise cam surface **366** is rotated into contact with the ends of shafts **332** to mechanically hold both rollers **336** in engagement with their respective detent wheels **322** and **324**. Thus the selected write-in address can not be changed while the write-in window handle lever is raised.

Also rotatably mounted on shaft **361** is the upper end of the arcuate arm portion **368** of door **278**. A spring **370** extends between handle **276** and door **278**, the spring being tensioned as the handle is raised to its upper position. Door **278** has an elongated bar **372** rigidly secured to its right hand end, the top edge of the bar normally engaging the lower surface of a forwardly extending plunger **374** of a door solenoid **376**. The solenoid **376** is rigidly secured on a bracket **377** mounted between plates **280** and **282** and prevents door **278** from being raised with the handle lever **276** until the door solenoid is energized to pull the plunger **374** in, out of its latching position.

A permanent magnet **378** is carried at the lower end of door latch bar **372** and normally is positioned to hold closed a reed switch **380**, mounted on lower plate support **282**, when door **278** is in its lower closed position.

A roll of write-in paper **379** (FIG. **22**) is carried in a tray-like compartment **381** depending from the rear part of support plate **282**. The paper strip **379** passes from the roll under an idler locking roll **382**, FIG. **22**, journalled in ears of a depending U-bracket **383** connected to the bottom of a plate **382** in front of the roll tray **381**. The paper will pass upwardly from lock roll **382**, through a guide passage **384** defined by the lower inclined portions of panel **385** and a fixed guide plate **386**. Plate **386**, at its lower end, has a plurality of fingers **387**. A paper lock plate **388** is pivoted at the front end of bracket **383** and has a plurality of slots **388*a*** through which pass the fingers **387** of guide plate **386** for clearance. The lock plate has an offset, rearwardly extended, spring anchor arm **388*b*** connected by a coil spring unit **388*c*** to a vertical slide **440** to be described. The paper then passes over the front vertical writing support face **389** of panel **385** which is suspended from depending side arms **392**, **394** of a U-shaped bracket **396** fixed to top plate **280**.

The paper next passes through passage **397** defined by the upper end **390** of panel **385** and a top guide plate **398** connected to bracket **400** which is resiliently supported at its rear end from pin **402** and coil spring **404**, the pin **402** being mounted in end braces **406** connected to top plate **280**. An idler roller **408** is rotatably mounted between the arms of bracket **400**.

An advance drive roller **410** is rotatably supported between arm **392** of bracket **396** and an end bracket **412** fixed to the top plate **280**. A shaft **414** connected to roller **410** extends through arm **392** and has at its outermost end a star wheel **416** (FIGS. **20** and **21**) which is incrementally turned in 90° steps to advance the paper upwardly between drive roller **410** and spring biased idler **408**. A pulley **418**, fixed on the other end of shaft **414**, through a belt connection **420** drives a spring loaded paper take-up roller **422** mounted at the rear of upper plate **280**.

Star wheel **416** is rotated in 90° steps by the base **425** of a generally L-shaped advance lever **424** (FIG. **20**) which is pivoted at **426** along its long leg **427** to a stationary rearwardly extending L-bracket **428** mounted on handle **276**. An elongated pin **430** extends from lever **424** parallel to the axis of pivot **426** and an overcenter spring **432** connects the end of pin **430** to bracket **428**, the spring normally biasing the end of leg

427 into engagement with the upper edge of handle 276.

As the handle 276 is raised, the advance lever base 425 will engage star wheel 416 to turn it 90°, thereby advancing the paper a pre-determined distance so that a clean section of paper is present in front of support face 389 and in alignment with window 274.

When the handle is raised to its uppermost position a tip-over bar 434 cams advance lever base 425 downwardly to snap the spring 370 over center so that the voter may not repeatedly advance star wheel 416. The advance lever will be reset to an operative position by a rearwardly angled vertical rod 436 fixed to door 278 and engaging lever pin 430 and this function occurs only as the handle is fully lowered after a write-in vote has been cast to pivot the advance lever back to its set position.

Seen in FIGS. 19 and 20 the right hand end of handle 276 carries a roller 438 and adjustable set screw 439, the roller and set screw frictionally engaging therebetween a slide plate 440 of a ratchet assembly 442 (FIGS. 19 and 22) which is vertically slidably mounted on guide posts 444. Slide 440 has a rearwardly facing ratchet rack 446 extending along part of its length. a ratchet solenoid 450 mounted on bracket 377 is spaced above the upper edge 447 of the ratchet. Its spring biased plunger 448 latches and limits upward movement of the slide until solenoid 450 is initially momentarily energized. When the plunger 448 whose end serves as a ratchet engaging pawl, now engages the slide ratchet teeth,the slide may still be moved in an upward direction but is latched against downward movement until the ratchet solenoid 450 is again energized whereupon the entire slide assembly as well as the handle are lowered by the force stored in ratchet tension spring 446 connected between assembly 442 and a support block 452 mounted on lower support plate 282.

Shown best in FIGS. 20 and 21, a small left-hand portion of panel face 389 is cut out at 451 adjacent the rear faces of the two address dials 270 and 272 at their three o'clock indicating positions. A print solenoid 452, mounted behind panel face 388, has a print head or plate 453 adapted to enter cut out 451 and press the paper against the respective embossed letter 294 and numeral 296 indicating the respective row and column at which the dials are set. This readily identifies on the paper the office for which the write-in vote is being cast. Any conventional marking or inking device such as ribbons or rollers or pressure sensitive paper can be used to transfer the symbols to visual records on the paper.

OPERATION OF THE WRITE-IN MECHANISM, will be better understood with further reference to the control circuit of FIG. 23 and the single office and group office module circuits of FIGS. 4 and 17. Write-in with the group office module will be discussed first.

A voter must first turn dials 270 and 272 from their zero set positions to their respectively indicated row and column positions adjacent pointer 273 corresponding to the row and column location of the office in which a vote is to be cast. Turning of the dials positions magnets 304 and 308 adjacent the appropriate reeds of switch assemblies 310 and 312, closing the reeds and thereby enabling 12 volts to be later supplied to pins 10 and 15 of the appropriate group office module of FIG. 17 to energize relays R35 and R36 and close contacts R35-1 and R36-1. Detents 336, biased into engagement with wheels 332 and 324, will retain the dials in their desired set position.

As the voter begins raising handle 276, cam 366 engages the top of shafts 332 and 334 to maintain the detents in mechanically locked contact with wheels 322 and 324. Simultaneously therewith, slide 440 is raised because roller 438 engages over-hanging slide flange 441. Door 278 at this point is prohibited from following the handle because the latch plunger 374 of the deenergized door solenoid 376 extends in latched position over the top edge of bar 372.

A first elongated permanent magnet 454, vertically mounted on the outer edge of the lower slide flange 441*a*, will close reed switch 456 mounted on post 284 as slide 440 is raised a short distance. As shown in FIG. 23, closure of reed switch 456 enables the 12 volt supply to energize relay R37 and close reed switch R37-1 and also energizes coil BC of relay R38, thereby closing reed switch R38-1 and causing the 12 volt supply through the closed reeds of switch assemblies 310 and 312 to energize relays R35 and R36 in FIG. 17.

Assuming the voter has dialed a votable office, when reed switch R37-1 closes, the current limited supply from pin 7 of the group office module, FIG. 17, will flow through coils AB of relays R39 and R40, closing reed switches R39-1 and R40-1, thence through closed reed switches R35-1 and R36-1 to write-in pin 21 of the group office module controlling the vote. That pin 21 is connected to terminal 21 of the write-in circuit, FIG. 23, through closed reed switch R37-1, relay R41 to close reed switch R41-1, and through reed switch R42-1 which will have been closed by energization of coil BC of relay R42 when the machine was turned on for operation. When reed switch R41-1 closes, the 12 volt supply energizes holding soil CD for relay R41 and also connects through a time delay network, including resistor 458 and capacitor 460, to coil AB of relay R42, with coil AB being oppositely wound from coil CB.

After a period of time determined by the time constant resistor 458 and capacitor 460, coil AB will be energized to cancel the effect of coil CB and will cause reed switch R42-1 to open. The time delay is sufficiently long to insure that a vote has been counted in the group office counter through energization of vote solenoid 210 from the B+ pin 1 through closed reed switch R39-1 and coil CD of relay R39. The delay, however, is not long enough to permit the counter to runaway and count more than one. In addition, the counter circuit itself prevents such a runaway, since the vote limit sensing reed 208 will be opened as one vote is fully counted, thereby deenergizing coil CD of relay R39 and causing reed switch R39-1 to open, since the lower level of the current limited supply passing through coil AB is not sufficient to hold reed switch R39-1 closed without the aid of coil CD.

When relay R40 is energized and reed switch R40-1 closed, the B+ current flows through latch coil CD of relay R40 and also through indicator lamp 462 which indicates that the vote registered in the group office counter has been cast in the write-in area.

As handle 276 and slide 440 continue to be raised, with reed switch 456 still closed by magnet 454, a second permanent magnet 464 mounted on upper flange 441 will close a reed switch 466 mounted on post 284, which, because reed switch R41-1 is already closed, will cause rlay R43 to be energized to close reed switch R43-1. This in turn connects the 12 volt B+ supply

through the coil of slide solenoid **450**, energizing the same which withdraws plunger **448** from its outermost extended position in which it prevents complete upward movement of slide **440** by engagement with the upper edge **447** of ratchet **446**. The handle and slide may then be freely raised even though reed switch **466** will again open and deenergize solenoid **450**, after magnet **464** has moved past, since the bevelled end of the spring loaded plunger **448** acting as a pawl will merely ratchet over the teeth of moving ratchet rack **446**. Continued upward movement of the handle causes the base **425** of advance lever **424** to engage star-wheel **416**, causing it to rotate 90° and advance the paper so that a fresh paper area is present in front of write-in face **389** and also to insure that the voter may not learn the name of the person for whom the previous voter has cast a write-in vote. Simultaneously with advancement of the paper the tension in spring **388***c* will be sufficient to urge the pivoted paper lock **388** into locking enegagement against the paper passing over idler **382**. The take-up spool **422** is also driven to maintain the effective length of paper between idler **382** and spool **422** in a taut condition and prevent any arbitrary, uncontrolled advancement of the paper.

When handle **276** and slide **440** reach their uppermost raised position, lever **424** strikes the underside of bar **434** to pivot the lever downwardly to an inoperative position, it then being necessary to reset the lever before star wheel **416** can again be advanced.

When the slide reaches the uppermost position in which it is retained by the pawl end of slide solenoid plunger **448** and it in turn holds handle **276** in the up position because of its friction engagement with screw **439** and roller **438**, magnet **464** will close reed switch **468** mounted on post **284** to enable the 12 volt B+ supply to energize relay R44 which closes reed switch R44-1, thereby energizing printer solenoid **452** and door solenoid **376**, the latter being energized only if reed switch **380** was closed by magnet **378** indicating the door had been fully closed. Closure of reed switch **468** also causes relay R45 to be energized to close reed switch R45-1.

Actuation of printer solenoid **452** causes the print hammer plate **453** to press the paper against the appropriately aligned letters and numerals in the rear face of dials **270** and **272**, thereby marking the paper with an identifying code of the office in which the write-in vote is being cast.

Energization of door solnoid **376** withdraws plunger **374** from restraining engagement with member **372** and permits door **278** to be swung upwardly by the tensioned spring **370**, uncovering a clean section of paper which is accessible for the write-in vote through window **274** on the voting panel.

When a voter completes the write-in process and is about to exit the machine, depression of exit button **626** (FIG. 35A), as described later, will supply 12 volts through line **637** to terminals **8** and **10** in FIG. **23**. From terminal **10**, current flows through closed reed switch R45-1 to relay R43 to close reed switdh R43-1, again energizes slide solenoid **450**. This releases the pawl plunger **448** from ratchet rack **446** and permits the slide **440**, handle **276**, and door **278** to lower to their normal set position of FIG. **19**. As handle **276** lowers, the upper m innermost edge of door rod **436** engages pin **430** to pivot the advance lever base **425** upwardly reset the lever **424** to its operative position in which it may again rotate star wheel **416** and thereby advance the paper.

When the handle is lowered, the mechanical address wheel detent lock is removed. The current from terminal **8** supplies 12 volts to the coil of time delay relay TDR5 which, after 2 seconds, closes contact TDR5-1 to supply 12 volts to energize detent solenoid **356**. The energized solenoid pivots detent support lever **342** upwardly, removing the two detents and thereby releasing wheels **322** and **324** to permit dials **270** and **272** to return under spring bias to their zero set position. 12 volts is also supplied to the coil of time delay relay TDR6, which after 2 seconds, closes its contacts and energizes print solenoid **452** which marks the ballot paper with zero markings to indicate the end of the write-in selections of a particular voter. Hence, after an election it is possible not only to count individual write-in votes, but also the number of voters who cast write-in votes.

When dials **270** and **272** have returned to their zero positions, magnets **304** and **208** will open the zero position reed switches, and discontinue flow of current from line **637** in FIG. 35A.

The write-in function has been described relative to the group office module circuit of FIG. **17**. However, it operates identically for the single office module shown in FIG. **4**.

When the particular single office module has been addressed on the write-in dials, relays R46 and R47 are energized to close contacts R46-1 and R47-1 and supply limited current to pin **21** and into the write-in circuit of FIG. **23**. This limited current energizes coil AB of relay R48 (FIG. **4**) to close contact R48-1, energize holding coil CD, and light a write-in indicator lamp **469**. The flow of the current limited supply also establishes the office interlock, as hereinbefore described, to prevent any further voting within the particular single candidate office.

If a particular voter desires to cast several write-in votes, instead of depressing the exit button to reset the write-in mechanism, he need only depress a manual reset pushbutton **279** (on the front panel, FIG. **1**, of the machine), closing contacts **472** and **474** (see FIG. **23**) to supply 12 volts to terminals **8** and **10** of FIG. **23** resetting the mechanism and zeroing the dials as described above. The voter then repeats the write-in procedure.

As indicated initially, the write-in mechanism will operate through a complete cycle and permit a write-in vote to be cast only if the voter has addressed a votable office through the two dials **270** and **272**, i.e., an office in which the permitted number of votes has not already been cast. If a non-votable office has been dialed, there will not be any current limited supply available on terminal **21** of the write-in circuit of FIG. **23** because of the established interlocks in the office modules of FIG. **17** and FIG. **4**. Hence, the write-in circuit will not be functional.

THE ACCUMULATING COUNTER, SCANNER AND REGISTER ERROR SENSOR

As was hereinbefore generally described, a register assembly **550** illustrated in FIGS. **24** and **25** is provided to enable registration of the votes from as many as 10 voting machines. The register has a housing **552** enclosing a plurality of compartments **554**, each adapted to receive a counter device **556**. The front end of the compartment section is normally closed and locked

during an election by a closure panel **558** hinged along its bottom edge at **559.**

An indicating counter device **556** is provided for each of the candidates included on the ballot. Hence, it is necessary to accumulate votes on the one counter from as many as 10 candidate modules, each of which represents the same candidate on the ten different voting machines.

As illustrated in FIGS. **26 – 32,** each counter unit **556** has a pair of side walls **560, 562** cross connected by a plurality of rods **564** forming the module support structure. A plurality of counter wheels **566** are mounted on a shaft **568** rotatably supported in side walls **560** and **562** and an adjusting knob **570** is fixed on one end of the shaft. The least significant decimal wheel **566***a* is keyed to the shaft **568** while the other wheels are freely rotatable thereon. Each of wheels **566** has embossed digits 0–9 around the periphery thereof, the digits functioning not only to visually display the vote count but also as type faces to imprint ballot return sheets by means of pressure applied by an externally driven roller (not shown). A plurality of counter wheel transfer gears 572 operatively connect adjacent wheels **566** in conventional manner.

Wheel **566***a* is rotated by a unique camming arrangement **574** at the forward end of a reciprocating bar **576** which is pivotally connected to one end of an operating lever **578,** the other end of which is pivotally connected to a bracket **580** fixed to a side wall **562.**

A solenoid unit **582,** supported from wall **562** by a bracket **584,** has the end of its reciprocable spring loaded plunger **586** pivotally connected to lever **578** between the ends of the lever. Upon energization of solenoid **582,** its plunger **586** is pulled in and via lever **578** moves bar **576** in a forward direction, i.e., toward the counter wheels.

Linear reciprocation of bar **576** is converted into rotary motion of the unit wheel **566***a* through the cooperation between its cam section **574** and a plurality of side pins **586** equidistantly spaced around wheel **566***a* near its periphery, the number of pins being equal in number to the number of digits on the wheel. As illustrated in FIGS. **30 – 32,** a slot **588** in the forward end of bar **576** guides the bar in a slidable manner over shaft **568.** The cam section **574** has three cam pieces on the face of bar **576** consisting of a small upper horizontal block **590,** a cam profile **591** having upper and lower inclined faces **592** and **594** with an intermediate horizontal face **596,** and a cam profile **598** having a cam face **600** oppositely inclined to that of face **592.**

In operation, as bar **576** is moved forward, it passes one of the side pins **586***a* (FIG. **31**) as permitted by the space **602** between upper cam block **590** and the top of cam profile **598.** As the bar continues to shift to the left in FIG. **31,** cam face **592** will engage and force the pin **586***a* upward causing wheel **566***a* to start a counterclockwise rotation as seen in FIG. **31.** When bar **576** reaches its forward limit position shown in FIG. **32,** pin **586***a* will have been rotated up and away from the cam area, through passage **604.** However, the next pin **586***b* will have been rotated up into engagement with cam face **594** and thereby forced through passage **606** into contact with the intermediate horizontal cam face **596.** Thereafter when bar **576** is retracted to its initial rest position, upon deenergization of solenoid **582,** pin **586***b* is engaged and will be moved by cam face **600** to the position of pin **586***a* in FIG. **30,** thereby completing one indexing step of the unit counter wheel **566***a*.

The several cam faces are designed so that bar **576** must be moved forward and then returned to its rest position befor wheel **566***a* is indexed one full digit to register a vote. Movement of the bar in only one direction only rotates the wheel a half step or digit.

Bar **576** carries a permanent magnet **608** (FIG. **26**) which, when the bar is moved to is forward position, closes a normally open reed switch **610** supported from wall **562** by posts **612** and **614.** A four pronged terminal assembly **616** provides the electrical connections for the solenoid **578** and reed switch **610.**

Normal operation of the register system and counter will now be described with particular reference to FIGS. **33, 34, 35***a*, and **35***b*. To simplify the description, it will be assumed that only one voting machine **50** is connected to register **550,** although it is understood that in an actual election there may be as many as ten machines feeding into the same register.

In the FIG. **33** circuit (same sheet with FIG. **23**), pin **18** of a specific candidate counter circuit will be connected through a main network to the register pin **18** of either a single office candidate module of FIG. **6** or a universal candidate module of FIG. **13** representing that specific candidate. The counter solenoid **582** is operated from a 110 volt AC supply through an associated reed switch **R12-1** of relay **R12** in circuit with counter module pin **18.** The counter circuit includes two ground terminals Y and Z which are connected to contacts of respective switches **R13-1** and **R13-2** of the power relay **R13** in FIG. **34.**

As described hereinbefore, during a voting process, the respective votes cast are temporarily stored within the latched candidate module. The final act of voting is depression of the exit button as the voter prepares to leave the voting cubicle, and at this time, the module stored votes are transferred from the latched candidate modules to the respective counters.

Referring to FIGS. **35***a* and **35***b*, a B+ current sensing circuit **620,** shown in detail in FIG. **36,** senses whether any candidate modules are drawing B+ current, which denotes that they are latched. When B+ current is being drawn by a latched module, current will flow from the sensing circuit **620** through line **622** and relay **R14** to ground. Reed **R14-1** will be closed, thus passing current from the 12 volt supply to junction **624** and through coil AB of relay **R15** to ground, thereby closing reed **R15-1.**

Upon depression of exit button **626,** the current limited supply **237** is connected through closed reed **R15-1,** normally closed reed switch **TDR1-1** of a time delay relay **TDR1,** closed exit button **626,** coil AB of relay **R16,** which closes reed switches **R16-1** and **R16-2,** to scanner terminal **S1.** This terminal is connected to the **S1** terminal for voting machine **1** in FIG. **34** which passes current through coil AB of control relay **R17** to ground connection W. Energization of relay **R17** closes reed switches **R17-1** and **R17-2,** which energizes relay **R18** to close reed switch **R18-1.** This results in the flow of current from a 12 volt supply through coil AB of relay **R19,** closed reed switch **R18-1,** to ground connection W. Reed switch **R19-1** will be closed and the 12 volt supply will flow therethrough to energize relay **R13** closing reed switches **R13-1** and **R13-2,** thereby connecting terminals Y and Z to ground W.

Office B+ current will then be supplied from pin **18** of the latched module of FIG. **6** or FIG. **13** into the counter circuit of FIG. **33** to energize relay **R12** which is connected to the grounded terminal Y. Due to the high resistance of relay **R12**, the magnitude of current flow, however, is insufficient to unlatch the candidate module. Reed switch **R12-1** will close and the 110 volt supply is fed to counter solenoid **582** energizing the same and causing bar **576** and its magnet **608** to move forward, as described above. The magnet closes reed switch **610** causing current from pin **18** to be supplied therethrough to a resistor **626** of about 56 ohms and grounded terminal Z. Resistor **626** is lower in value than the resistance of relay **R12** and its introduction into the circuit causes an increased current to flow from terminal pin **18** of the candidate module, this increased current in the module of FIG. **6** creating a field of sufficient magnitude, in opposing coil EF of relay **R3**, to cancel the holding effect of coil AB and thereby permit reed switch **R3-1** to open and the candidate module to return to its normal votable condition in readiness for the next voter. Similarly, if a universal candidate module of FIG. **13** is being employed, the increased current through opposing coil FG of relay **R5** creates a field which cancels the effect of holding coil AB and opens reed switch **R5-1.**

When either of reed switches **R3-1** or **R5-1** opens, B+ current can no longer flow to pin **18** of FIG. **33** and relay **R12** will be deenergized to open reed **R12-1** which will interrupt current flow to solenoid **582**, thereby deenergizing the solenoid and causing bar **576** and its magnet **608** to retract to their normal rest position permitting reed switch **610** to again open. The forward and return movement of arm **576** will as has been described, register the vote on the counter wheel **566*a***.

When the votes have been transferred from all the latched candidate modules (which occurs essentially at the same instant) and the modules have been unlatched, in FIGS. **35*a*** and **35*b***, the B+ circuit no longer senses a latched module condition and current no longer is supplied through line **622**, thus deenergizing relay **R14** which opens reed switch **R14-1** and deenergizes coil AB of reed switch **R15-1.** This disconnects the current limited supply, thereby deenergizing coil AB of relay **R16** and causing reed switches **R16-1** and **R16-2** to open. In FIG. **34**, relay **R17** is deenergized to open reed switches **R17-1** and **R17-2**, which interrupts current flow to relay **R18** to open reed switch **R18-1.** As a result, relay **R19** is deenergized to open reed switch **R19-1** and power relay **R13** is deenergized causing opening of reed switches **R13-1** and **R13-2.**

In this manner, the various circuits are returned to a normal votable condition suitable for the next voter.

It houls be noted at this point that upon initial depression of exit button **626** and energization of relay **R16** to close reed switch **R16-1** and **R16-2**, a 12 volt supply from terminal **628** connects, through reed switch **R16-2**, to energize coil AB of a power relay **R20** which moves contacts **R20-1** and **R20-2** from the respective upper grounded terminals **4** and **5** to their lower terminals **3** and **6.** The 12 volt supply from terminal **630** is then connected through contact **R20-2** to a time delay relay **TDR2** whose reed switch **TDR2-1** opens after a 3 second time delay. The 12 volt supply also passes from junction **632** to relay **TDR1** whose reed switch **TDR1-1** opens after 10 seconds time and to time delay relay **TDR3** whose reed switch **TDR3-1** closes after a 5 second time delay.

The 12 volt supply is also applied through reed switch **R20-1** and line **634** to pin **6** of the group office module of FIG. **17** to reset the module for the next voter. Current will flow from line **634** to pin **6** of the group office module in FIG. **17** and will repeatedly energize erase solenoid **218** to rotate counter wheel **148** clockwise in a stepped fashion back to the maximum set position defined by lug **158.**

The B+ supply similarly connects, through reed switch **R20-2** and line **636**, to operate the protective counter and the public counter and through line **637** and the zero dial position reeds which are closed when the dials are not zeroed, to lower the write-in window, to reset the write-in dials and operate the write-in print solenoid if necessary.

During a normal operation in which all candidate modules become unlatched within a fraction of a second and B+ current is no longer sensed by circuit **620** to cause reed switch **R15-1** to open and interrupt flow of current from the current limited supply, relay **R16** is deenergized to open reed switches **R16-1** and **R16-2** but power relay **R20** remains energized under the control of relay **TDR2.** This is due to the flow of current from terminal **630** through reed switch **R20-2** to junction **638**, from which it passes through closed reed switch **TDR2-1**, diode **640** and energizing coil AB of relay **R20.** Hence, the power relay is maintained energized for **3** seconds until reed switch **TDR2-1** is opened to provide current through lines **634** and **636** for a sufficient period of time enabling the various functions associated therewith to be performed.

REGISTER AND COUNTER MALFUNCTION

There are several most likely forms of malfunctioning which may occur in the register and counter systems, and these systems have been designed to ensure that all failures are safe, i.e., they are indicated in a way that will allow an election official to immediately become aware of the problems and interrupt machine use until the necessary repairs have been effected.

One form of malfunction may be a discontinuity or open circuit in the wiring between a candidate module and its respective counter. In this instance, no current will flow from register pin **18** of the module into the counter circuit of FIG. **33**, hence the candidate module will remain latched and the respective counter solenoid **582** and bar **576** will not be actuated.

Similarly, an open circuit winding or a short circuited or partially short circuited winding in the counter solenoid will prevent the solenoid and its cam bar from being actuated and the candidate module will remain latched.

Also, a mechanical failure in bar **576** and/or cam assembly **574** may prevent the bar from moving forward or, after having moved forward, may prevent it from returning to its normal rest position. If, for example, cam **574** were to be jammed in the forward position, no further votes could be accumulated on the associated counter, regardless of how often the actuating solenoid **582** is powered.

Considering first the situation in which, after depression of exit button **626**, a respective cam bar **576** does not move forwardly either because the counter solenoid **582** is not actuated due to an open circuit or short circuit condition or because of a mechanical failure in

the cam assembly **574.** Assuming that pin **18** of a universal candidate module (FIG. **13**) is connected to pin **18** of the first counter circuit in FIG. **33,** when bar **576** and magnet **608** fail to move forwardly, reed **610** will not close and thus there will not be sufficient current flow through coil EF of relay R3 in FIG. **6** to unlatch the candidate module.

Referring again to FIGS. **35***a* and **35***b*, if a candidate module has failed to unlatch, the B+ sensing circuit **620** will keep relay **R14** energized, thereby maintaining reed switches **R14-1** and **R15-1** closed and relay **R16** energized.

As indicated previously, 3 seconds after power relay **R20** is initially energized it is normally deenergized by the opening of reed contact TDR**2-1.** However, because relay **R16** now remains energized and reed switches **R16-1** and **R16-2** are closed, the 12 volt supply from terminal **628** will maintain coil AB of relay **R20** energized even after 3 seconds expire and reed switch TDR**2-1** opens. Two seconds later relay TDR3 causes reed switch TDR**3-1** to close and the 12 volt supply from junction **642** will pass therethrough and light the open error indicator lamp **644** located on the front panel which informs an official that a candidate module is still latched because the associated counter bar **576** did not move forwardly to close the motion sensing reed switch **610.** After 10 seconds have passed, relay TDR1 will open reed switch TDR**1-1** to interrupt the flow of the current limited supply and deenergize relay **R16,** thereby opening reed switches **R16-1** and **R16-2** and deenergizing power relay **R20.**

Having seen the error lamp **644** light up, the official need only to then inspect the front of the voting machine and immediately observe which module has its indicator lamp **112** still lit up, and he knows which counter is malfunctioning.

Consider next the situation in which the counter solenoid **582** has been energized and bar **576** moved forward to close reed switch **610** and rotate the counter wheel **566***a* one half step by cam **574,** but the bar and cam become jammed in the forward direction. Because reed switch **610** has closed, the candidate module associated with the counter will become unlatched as in the normal operation.

The motion-sensing reed **610** which is still closed may be in any one of **200** counters that are distributed within the main register, so provision is made to detect the specific counter location wherein the fault lies. A fault detection system **646** is provided for this purpose in the scanner and register error sensor circuit of FIG. **34.** At this point in time, the voter has been able to depress the exit button, make all his selections and depart, and the fault or malfunction is that the specific counter has jammed with the cam **574** in the forward position and the motion-sensing reed **610** is short-circuited. The least significant digit counter wheel **566***a* is therefore half-way between one state of count and the next. It is not possible, inadvertently, to release the counter without the extra half count being registered because, as indicated previously, return movement of cam **574,** following the forward movement must result in fully registering a vote.

At this time (because of the malfunction) the detection circuit **646** will indicate to the official that such a malfunction exists. Since all the candidate modules become unlatched and the B+ sensing circuit in FIG. **35***b* no longer generates its control signal, the current limited supply to terminal S1 in FIG. **34** is discontinued and relays **R17, R18,** and **R13** are deenergized. However, current will flow from the common 12 volt supply through the AB winding of relay **R19,** the AB winding of relay **R21** to the Z terminal of FIG. **33,** through resistor **626** and the jammed reed switch **610** to pin **18** into the candidate module of FIG. **13** associated with the jammed counter and to the module ground through coil FG of relay R5 and lamp **112.** This current is of sufficient magnitude to energize relay **R21,** closing reed switch **R21-1,** thereby causing the common 12 volt supply to be connected to a shorted reed lamp **648** located on the official indicating panel and informing an official that a malfunction exists. Then, by closing the contacts **650** and **652** of a manual switch, the official may pass the 12 volt supply through closed contact **650,** lamp **648,** closed contact **652** and the Z terminal through the above circuit to ground in the candidate module to cause the lamp **112** in the respective candidate module to light up. Since this will be the only lamp on the voting panel which is lighted, the official may readily determine which counter is jammed.

If, for some reason, the indicated malfunction initially goes unnoticed by the official, the voting machine and register will continue to function in an apparently normal manner, provided a subsequent voter does not vote for the respective candidate associated with the jammed counter. Hence, the real problem is that subsequent selection of the respective candidate will not permit any further votes to be recorded in the register.

The next time a vote is cast for the specific candidate and the particular candidate module is latched in its normal manner, it will also behave apparently normally as the voter casts his votes. However, when the exit button **626** is depressed, the current limited supply is passed to terminal S1 of FIG. **34,** thereby energizing control relay **R17** and switch relay **R18** in conventional manner to establish a connection to ground W. When reed switch **R18-1** closes, reed switch **R19-1** and reed switch **R21-1** are closed substantially simultaneously by the common 12 volt supply. Reed switch **R19-1** closes because current flows through coil AB of relay **R19.** Reed switch **R21-1** closes because current flows through the AB coil of detection relay **R21** from the Z terminal of FIG. **33** which is at 12 volts due to the closed condition of sensing reed switch **610** in the jammed counter with the 12 volt supply from pin **18** of the candidate module passing through this closed reed to the Z terminal. However, due to the high resistance of coil AB of relay **R21,** the current flow is not sufficient to unlatch the candidate module.

Closure of reed switch **R19-1** connects the 12 volt supply to power relay **R13.** Closure of reed switch **R21-1** connects the 12 volt supply to coil CD of relay **R19,** with coil CD creating a field greater in magnitude and opposite in polarity to that of coil AB, and thus causing reed switch **R19-1** to open. Because the response times of reed switches **R19-1** and **R21-1** are quite short relative to that of power relay **R13** and its contacts **R13-1** and **R13-2,** coil CD of relay **R19** will be energized to again open reed switch **R19-1** before contacts **R13-1** and **R13-2** are closed. Since contacts **R13-1** and **R13-2** do not close, none of the votes from the other latched candidate modules are transferred into register **550.** Hence, the machine will be inhibited and cannot be used conventionally.

The shorted reed indicating lamp **648** connected across coil CD of relay **R19** will immediately indicate to the election official that an abnormality in the nature of a jammed counter exists. By closing the manual switch contacts **650** and **652** the official provides a bypass through contact **652** around coil AB of relay **R21** and directly connects the Z terminal of FIG. **33** to machine ground W through closed reed switch **R18-1.** This permits an increased flow of current from pin **18** of the candidate module through the jammed reed switch **610** to unlatch the module. The only module which will unlatch will be that one associated with the jammed counter and the official need only to observe which module unlatches, i.e., reed **R5-1** opens and lamp **112** goes off, to determine which counter is malfunctioning. In addition, after the module has been unlatched, each time switch **650** is closed, the lamp **112** in the specific candidate module will again be lighted, since the common **12** volt supply will pass through closed contact **650,** the shorted reed lamp **648,** closed contact **652,** the Z terminal into the circuit of FIG. **33** and through resistor **626** and the jammed reed **610** to pin **18** of the respective candidate module of FIG. **13** to the module ground through coil FG of relay **R5** and lamp **112.**

Hence, it is apparent that all the likely errors and malfunctions which may occur are compensated for and the voting system is fail safe in that it is not normally possible to continue complete uninhibited operation of a machine until the malfunction is corrected.

When a number of voting machines are feeding into the same register, it is possible that a situation may arise in which two or more machines may attempt to simultaneously transfer their votes into the register. This is prevented in the circuit of FIG. **34** in which, for the sake of brevity, only two machines are illustrated. The first machine to gain access to the register will block out all other machines until its transfer of votes is complete. For example, if voting machine **1** is the first to gain access, reed switch **R17-1** will be closed and will bring the input terminals of all other machines, e.g., terminals **S2** and **X** of voting machine **2,** and thereby prevent closure of the respective control relay of the other machines. In each machine, the votes are transferred very rapidly in a fraction of a second and the other machines need only wait a very short time before gaining access to the register. Furthermore, the presence of time delay relay TDR1 in the logic circuit of FIGS. **35***a* and **35***b* of each machine ensures the existence of the current limited supply for a ten second period of time which enables each machine to be placed on a waiting cycle while another machine registers.

THE 12-VOLT DC POWER SUPPLY

Many of the circuits used in the voting machine of the invention are powered from a 12 volt direct current supply illustrated in FIGS. **37** and **38.** Under conditions of maximum demand a current of approximately 30 amperes is required. In order to maintain proper circuit operation, it is desirable that the supply have good steady state regulation and a very low effective output impedance over a bandwidth of at least 100 Hf cycles. These requirements could best be met by the use of a conventional automobile alternator **654,** as fitted e.g., in a 1960 Chrysler Valiant automobile and to rotate the same with an AC half horsepower split-phase motor **656** operating directly off a 110 volt 60-cycle AC supply **658.** To meet the functional requirements just stated, a transistorized regulator **660,** whose circuit is shown on FIG. **38,** is connected to alternator **654** and the A.C. source **658,** by mating connectors **661** and **662.** Connector **661** is a five terminal male socket type whose terminals are labelled M,1 to M,5 in FIG. **38.** Another pair of mating connectors **663** and **664** connect the regulator to the circuit of FIG. **36** and a control box (not shown). The terminals of connector **663** which are in circuit are identified as pins F,1 to F,6 in FIG. **38.**

A voltage reference of 6.8 volts is provided by 1N957A Zener diode **665.** This output is compared with a voltage feedback output appearing on pin F,6 which is divided by the 250 ohm 2-watt potentiometer **666** and fed to one side of the long-tailed pair of 2N1304 transistors **667, 668.** The differential output of this pair of transistors is fed to the base of the 2N1545 transistor **670,** whose collector output controls the current fed to the field winding of the alternator by way of pin M,1. Substantial gain is provided in this amplifier and the stability of the alternator output is adequate for purposes of the voting machine. Alternator **654** is a three-phase alternator whose outputs are full wave rectified and thereby create a six-phase ripple of 4 percent rms amplitude. This ripple is substantially reduced by the action of a 25,000 uf capacitor **672** which is placed across the output terminals of the alternator's rectifier network (not shown). Provision is made by means of the 250 ohms potentiometer **666** to exactly set the magnitude of the 12-volt D.C. power supply available at output terminal assembly **674.**

In addition a pushbutton switch **676** permits flashing of the alternator field in order to ensure that there is enough residual magnetism for the system to start up and generate output voltage. In all other respects, the D.C. power supply is conventional.

THE CONTROL LOGIC B+ CURRENT SENSING CIRCUIT

Referring to FIG. **36,** the B+ sensing circuit **620** which is part of the main control logic illustrated in FIGS. **35***a* and **35***b* is illustrated as it is connected to terminals F,4 and F,6 of regulator **660** by connector **664,** the other active terminals of which are connected to a control box (not shown) and to the curtain control circuit of FIG. **43.**

Circuit **620** comprises a pair of input terminals **678** and **679** connected to terminal assembly **674** to receive the regulated 12 volt D.C. power supply (FIG. **37**). An output terminal **680** is connected to pin **1** of the circuit of FIG. **3** to supply the main B+ bus for operation of the various office and candidate modules. A 2N508 transistor **682** has its emitter circuit connected to terminal F,4 of regulator **660** and the input terminal **678** through a diode **684** and its base connected to output terminal **680** through resistor **686** and junction **688.** The collector is connected to line **622** which provides a control output signal to relay **R14** in FIG. **35***a* indicative of whether or not any of the modules are latched and drawing current from terminal **680.** When the voltage at junction **688** is high with no current being drawn from terminal **680,** transistor **682** is biased off and no collector control current flows to line **622.** However, when a candidate module is latched and drawing current from terminal **680,** the base voltage drops and the transistor conducts to energize relay **R14** to render the

current limited supply available for operation of the scanner circuit as described above.

A conductor **690** connected to junction **688** provides the voltage feedback through terminal F,6 to potentiometer **666** of regulator **660.**

A supply line **692** is connected to input terminal **678** at junction **694** and provides the +12 volt supply to the various operating circuits of FIG. **35***a*.

THE REGISTER POWER SUPPLY

The power supply for operating register **550** illustrated in FIG. **39** is conventional and merely comprises a full wave rectifier system **700** which produces a 110 volt D.C. output from a 110 volt A.C. input. The output is smoothed by a smoothing network including capacitor **702** and resistor **704.** This 110 volt D.C. output has been found adequate to provide the high instantaneous power requirements of the large number of accumulating counters in which a vote is to be registered as a voter exits from a voting machine.

STRAIGHT TICKET VOTING AND AREA CONTROL

In order to facilitate voting procedure in primary elections and also straight ticket voting in general elections as well as fulfill those requirements relating to restricted offices and questions, controls are provided to energize only certain areas of the voting machine, these controls ordinarily being available only to the election official.

Regarding straight ticket voting, in an election a voter may either be compelled to vote a straight ticket first in order to gain access to other sections of the ballot, or may have the option initially of voting a straight ticket or not. A straight ticket module, the circuit of which is illustrated in FIG. **40,** may be inserted in the top row of each column representing a particular party with its respective terminal pins contacting the same numbered pins in the circuit of FIG. **3.**

Referring to FIGS. **35***a* and **35***b*, when a straight ticket vote initially is compulsory, switch **706** is in its lower position to interrupt the normal flow of current from the current limited supply **237,** to pin **P36** which, through the main party and area switches of FIG. **42** leads to pin **7** of FIG. **3** in each vertical column.

The straight ticket B+ supply is available at pin **19** because reed switch **TDR4-1** of relay **TDR4** is normally closed and the current limited supply is available at pin **18** through closed reed switch **R21-1** of entrance relay **R21** and reed switch **R22-1** which is closed by **12** volt current flowing through coil CB when the machine is turned on.

When the vote button of FIG. **40** is depressed to close reed switch **708,** straight ticket limited current flows through coil AB of relay **R23** to close reed switch **R23-1,** thus enabling the straight ticket B+ supply to flow through holding winding CD of relay **R22.** The B+ supply also flows to pin **9** and into each candidate module within the respective party ticket, causing those candidate modules to become latched and the interlocks described earlier to be established.

The connecting of limited current supply to pin **18** in FIG. **35***b* energizes coil AB of relay **R24** to close reed switch **R24-1** and connect 12 volt B+ current through coil AB of relay **R22,** the field of which is opposite to that of coil BC, thereby cancelling the holding effect of coil BC and opening reed switch **R22-1.**

As soon as the straight ticket B+ flows from pin **9** of FIG. **40** into the candidate modules and these become latched, the B+ sensing circuit **620** generates a control signal through line **622** to energize relay **R14** and close reed switch **R14-1.** B+ current then flows to junction **624** and through relay **TDR4** which opens its reed in 2 seconds time to discontinue flow of the straight ticket B+ buss. Current also passes from junction **624** through coil AB of relay **R25** to cancel the effect of coil BC and open reed switch **R25-1,** thereby deenergizing coil AB of relay **R26** to open reed switches **R26-1, R26-2,** and **R26-3,** the latter of which prevents the voter from voting straight ticket for any other party. When reed TDR-1 opens, coil AB of relay **R22** is deenergized and reed **R22-1** again closed. Similarly, coil AB of relay **R50** is deenergized and reed switch **R50-1** is again closed to make the current limited supply available at pin **P36** for further voting in the normal manner.

In this manner, the voter is compelled to vote a straight ticket before he can gain access to any other vote function of the machine. Following this, since the current limited supply is available at pin **P36,** the voter is free to cancel any or all selections made within the selected party and distribute his votes as desired.

If however, the voter initially had the option of voting a straight ticket or not, switch **706** would have been positioned in its upper position. In this manner, the current limited supply is available at pin **P36** in the normal manner independent of the straight ticket supplies and the voter, subject to the limitations imposed by the area and party controls of FIG. **42** can vote at random in any part of the machine. The voter, however, may vote straight ticket if he desires in the same manner as that first described.

As shown in FIG. **40,** horizontal propagation of the straight ticket supply is carried out by switch **710** and pins **2, 4, 11** and **16** while pins **13** and **14** are used exclusively for vertical distribution. In this way, flexibility is obtained for every vertical column in which straight ticket control is required. When it is necessary to extend the area controlled in a horizontal direction to the next column, use must be made of the slave straight ticket module whose circuit diagram is shown in FIG. **41.** In addition, the independent switch assemblies **712** and **714** shown on FIG. **40** and FIG. **41** permit distribution of the straight ticket B+ and FIG. **41** permit distribution of the straight ticket B+ to suit individual ballot formats in a way that has considerable flexibility.

The area and party control circuits illustrated in FIG. **42** and referred to above are under the control of the election official and determine whether or not the current limited supply flows in a normal manner from pin **P36** of FIG. **35***b* to pin **7** of FIG. **3** of a vertical column representing a respective party, a respective question or a respective office. These controls are intended for usage in primary elections and in restricting voters to only certain portions of the ballot, e.g., local or area offices such as school boards, local bond issues, etc.

Assume switch assembly **716** in FIG. **35***b* is in its lower position and the election is an open primary, i.e., one in which the voter must inform the election official of which party he intends to make his selection before entering the voting area. The official then depresses the appropriate one of six party switches **718,** all of which are connected to terminal **P32** of FIG. **35***b*. Initially, closure of one switch **718** makes 12 volts available from pin **P32** to the AB winding of the respective party

relay 720, the outlet terminal 722 of each of which is connected to pin 7 in the circuit of FIG. 3 in each party vertical column. If the latching power is present on pin P42 of FIG. 35*a*, both reed switches of relay 720 will close and thereby make the main current limited bus from pin P36 available within that party. The latching power will be available provided that reed switch R27-1 of relay R27 is closed, which occurs just after the entrance button has been depressed and provided that the election is an open election with switch 716 in its lower position.

For a closed primary election, i.e., one in which the voter need not indicate to the official the party within which he will make his selections, switch 716 is in its upper position and the latching power is available only after a straight ticket has been voted and the B+ sensing circuit has connected the 12 volt supply to junction 624. This operational procedure has been described above in the section discussing straight ticket voting.

In a similar way, the area controls restricting access by the voter to only certain ballot areas are activated from the main current-limited supply. By depressing appropriate ones of switches 724, the official makes the 12 volt supply available from pin P30 in FIG. 35b to selected area relays 726 each of which has its output terminal 728 connected to pin 7 in the ballot area with which it is associated. Latching power is derived from the 12 volt supply through a 1N1692 diode 730 and pin P23 as soon as the entrance button is depressed. The diode is necessary since the area 12 volt supply, pin P30 is controlled in conjunction with the logic for curtain control, i.e., through reed relay R28.

ENTRY AND EXIT CONTROLS

These controls are partly illustrated in the Control Logic circuit of FIGS. 35*a* and 35*b*, and the Curtain Control Circuit in FIG. 43. In a normal sequence of operations the closure curtain will be open in order to permit entry of a voter as soon as the official open button 732 has been activated to turn the machine on by energizing relay R33 to latch reed switch R33-1 and make the 12 volt supply available through reed switch R32-1 which is closed by energization of winding BC of relay R32. The necessary 12 volt supply for opening the curtain is fed from control logic terminal P4. This supply line is marked "Open Curtain" and flows through reed relay R28 which is normally closed as soon as the machine is turned on and the 12 volt supply energizes coil BC of relay R30 to close reed switch R30-1 and energize relay R28 to close its three reeds. The 12 volt supply then flows into pin P4 of FIG. 43 to energize a curtain open power relay R29 and move contact R29-1 to its upper position. This drives a reversible motor 734 in one direction from the 110 volt A.C. supply of FIG. 36 to open the curtain.

Once the entrance button is depressed, 12 volts is connected to the AB winding of relay R30 and this serves to cancel the field produced by the CB winding, and in turn allows reed switch R30-1 to open. After a short delay determined by a 39 ohm resistor 735 and 5mF capacitor 736, the reed switches of relay R28 open soon after current ceases to flow in its AB winding, thereby disconnecting the 12 volt supply from pin P4. However, depression of the entrance button energizes relay R21 and closes reed switch R21-3 to connect the 12 volt supply to pin P1 which energizes closing power relay R31 in FIG. 43, to drive motor 734 in the opposite direction and close the curtain.

The limit sensing switches 738 and 740 remove power from motor 734 when the curtains have reached their limits of travel.

When the voter has made all his selections as described above and depresses the exit button 626 to leave the machine, the 12 volt supply from relay R20 passes through the AB winding of relay R32 to cancel the effect of winding BC and thereby open reed switch R32-1 to disconnect the 12 volt supply from relay R21 and open its respective reed switches. This permits reed switch R30-1 to close and energize relay R28 to again supply current to pin P4 to open the curtain and permit the voter to exit.

AC POWER INTERLOCK

A number of interlocks on the power supplies are provided to prevent tampering with the voting machine of the invention, e.g., interrupting the power supply in a way that is advantageous to one party and disadvantageous to another party.

The main AC interlock circuitry is illustrated in FIG. 44. A key operated switch assembly 742 connects the 110 volt AC source 744 with output terminals 746 which are connected to input terminals 658 of the regulator circuit of FIG. 37. Relay R34 is connected to terminal P25 in FIG. 35*a* and when the 12 volt supply is available to the control logic because of operation of alternator 654, its relay contacts will be in their lower position and no AC current flows to the field flash terminal of terminal assembly 658 in FIG. 37. However, when first starting the machine, the alternator will not be running and relay R34 will be deenergized. Hence, the AC supply will blow to the field flash terminal to provide a flash current for starting the alternator.

A manual switch 748 is provided internally of the machine to override key assembly 742 and allow servicing and maintenance of the machine during non-election times.

In summary, it is apparent that the described invention accomplishes the objects and provides the advantages initially set forth. Due to the provision of the various type plug-in modules which may represent offices and candidates for the respective offices or questions and either yes or no answers to the questions, the described voting machine may be readily programmed for various type elections and selective ballot formats. The modular construction of the single register unit which is employed to register the votes from a number of voting machines complements the modular construction of the voting machine and together therewith provides a highly versatile and adaptable voting system which is tamperproof and foolproof, and in which all malfunctions are fail-safe and readily detectable by the election official.

It is also apparent that an important feature of the vote modules and the control circuits is provision of visual information feedback while a voter is making his selections. The lamp behind the vote button on both kinds of candidates modules is a direct indication that the voter succeeded in the act of making a selection. In addition, he is visually notified when he changes his mind and presses the erase button because the light goes out. Furthermore, when he has made all the allowable selections within a given office, he is so informed

by the failure of the lamp to light when he tries to vote once too often.

Throughout the specification and the claims, the casting of a vote for a selection of a votable item has been described primarily with respect to selecting a candidate for a particular office. However, it is to be understood that the selection of a yes or no answer in a question area is accomplished in the same manner as selection of a candidate for a particular office. Thus, in the claims which follow, reference to a votable office and selection of a candidate for that office is to be interpreted to include a question area and selection of an answer to that question.

The invention may be embodied in other specific forms without departing from the spirit of essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. A voting machine of the electrically operated type comprising, voter-actuatable switch means representing a specific vote such as a candidate for an office, an electrical relay operated latch means including a relay having a coil and a contact, said coil being energizable by voter effected actuation of said switch means to close said contact and provide preliminary storage of such specific vote, means effective subsequent to the energization of said coil to transfer and register said pre-stored vote for the candidate associated with said switch means and to deenergize said coil, and voter-actuatable vote erasing means selectively operable before transfer of said vote to deenergize said coil and open said contact, thereby deleting the pre-stored vote and permitting the voter to again cast his vote.

2. A voting machine of the electrically operated type comprising a voter-actuatable switch means representing a specific vote such as a candidate for an office, an electrical relay operated latch means associated with said voter-actuated switch means and energizable by voter effected actuation of said switch means to provide preliminary storage of such specific vote, said relay operated latch means including a normally open contact and a coil capable of generating a magnetic field which will maintain said contact in a closed vote storage position when current is flowing through the coil, means effective subsequent to the energization of said coil to transfer and register said pre-stored vote for the candidate associated with said switch means and to deenergize said coil, and voter-actuatable vote erasing means selectively operable before transfer of said vote to deenergize the latch means, said vote erasing means comprising an erase coil capable when energized of producing a magnetic field opposed to that of the coil of said latch means and means for energizing said erase coil, whereby, when said erasing means is actuated, the erase coil produces a magnetic field which cancels the magnetic field of the coil in the latch means and allows the contact of said latch means to return to its normally open position, thereby deleting the pre-stored vote and permitting the voter to again cast his vote.

3. A single office candidate module used to represent a candidate for a single elective office comprising: first electrical circuit means including a normally open, voter actuatable voting switch means and a latch coil energizable upon closure of said voting switch means; second electrical circuit means including a normally open latch switch closed upon energization of said latch coil, and a holding coil energized upon closure of said latch switch to maintain said latch switch in a closed position and thereby pre-register a vote within the module for the respective candidate represented by the module; and voter actuatable vote erasing means in said second circuit means operative upon voter actuation thereof to deenergize said holding coil and thereby open said latch switch to cancel the vote within the module and permit the voter to again cast his vote.

4. A single office candidate module as defined in claim **1**, said second circuit means including indicator means operative upon closure of said latch switch to indicate that a vote is registered within said module.

5. A single office candidate module as defined in claim **1**, said second electrical circuit means including a register coil adapted to be electrically connected to a central register upon completion of the voting process of an individual voter, said register coil upon energization thereof being effective to cancel the holding power of said holding coil, thereby opening said latch switch and resetting the module for operation by the next voter.

6. A universal candidate module useful in either a single elective office or a group office comprising: first electrical circuit means including a normally open voter actuatable voting switch means and a first latch coil energized upon actuation of said voting switch means; second electrical circuit means including a first latch switch closed upon energization of said first latch coil, a second latch coil, a second latch switch, said second latch coil being energized upon closure of said first latch switch to close said second latch switch, a holding coil for said second latch switch energizable upon closure of said second latch switch to register a vote within said candidate module for the respective candidate represented by said module, voter actuatable erase means effective upon actuation thereof to open said second latch switch and cancel the vote registered within said module; and selector switch means positionable in first or second positions to effect operation of said second circuit means for use in either a single elective office or a group office.

7. A universal candidate module as defined in claim **6**, said second circuit means including indicator means operative upon closure of said second latch switch to indicate that a vote is registered within said module.

8. The universal candidate module as defined in claim **6**, said voter actuatable erase means comprising a normally open voter actuatable erase switch and a third latch coil energized upon closure of said erase switch, a third switch, an unlatch coil, said third switch upon energization of said third coil being closed to energize said unlatch coil which then cancels the holding effect of said holding coil permitting said second latch switch to open.

9. A universal candidate module as defined in claim **8**, said second circuit means including a holding coil for said first latch switch and a holding coil for said third switch, said selector switch means being operative to bypass said holding coils of said first and third switches when it is in a closed single office position and to place said holding coils of said first and third switches in elec-

trical circuit when it is in an open group office position.

10. A universal candidate module as defined in claim **9,** said second circuit means comprising a register coil adapted to be electrically connected to a central register at the end of an individual voting process and to cancel the holding effect of said holding coil for said second latch switch, thereby opening said second latch switch and returning said module to a voter operative condition.

11. A universal candidate module as defined in claim **10,** said second circuit means including indicator means operative upon closure of said second latch switch to indicate that a vote is registered in said module.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,744,713 Dated July 10, 1973

Inventor(s) Afton V. Martin et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 45 delete "and" after semicolon (;)

Column 6, line 54 change "dandidates" to --candidates--.

Column 11, line 47 change "latching" to --latch--.

Column 12, line 37 change "etxtending" to --extending--.

Column 14, line 31 change "latching" to --latch--.

Column 19, line 41 change "ode" to --diode--.

Column 20, line 34 insert --and-- after "282".

Column 20, line 52 change "face" to --faces--.

Column 20, line 63 change "assemlies" to --assemblies--.

Column 21, line 63 change "handel" to --handle--.

Column 22, line 27 delete --a-- after "of".

Column 24, line 66 change "rlay" to --relay--.

Column 25, line 49 correct the spelling of "solnoid" to --solenoid--.

Column 25, line 60 correct the spelling of "switdh" to --switch--.

Column 25, line 65 delete --m-- after "upper".

Column 25, line 66 insert --and-- after "upwardly".

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,744,713 Dated July 10, 1973

Inventor(s) Afton V. Martin et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 26, line 20 change "208" to --308--.

Column 28, line 5, correct the spelling of "befor" to --before--.

Column 29, line 39 insert --sensing-- after "B+".

Column 29, line 54 change "houls" to --should--.

Column 31, line 43 change "in" to --is--.

Column 33, line 41 change "bring" to --bridge--.

Column 35, line 24 change "procedure" to --procedures--.

Signed and sealed this 25th day of June 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents