Aug. 27, 1946. H. C. HARRISON 2,406,350

SWITCHING MECHANISM FOR SIGNAL SYSTEMS

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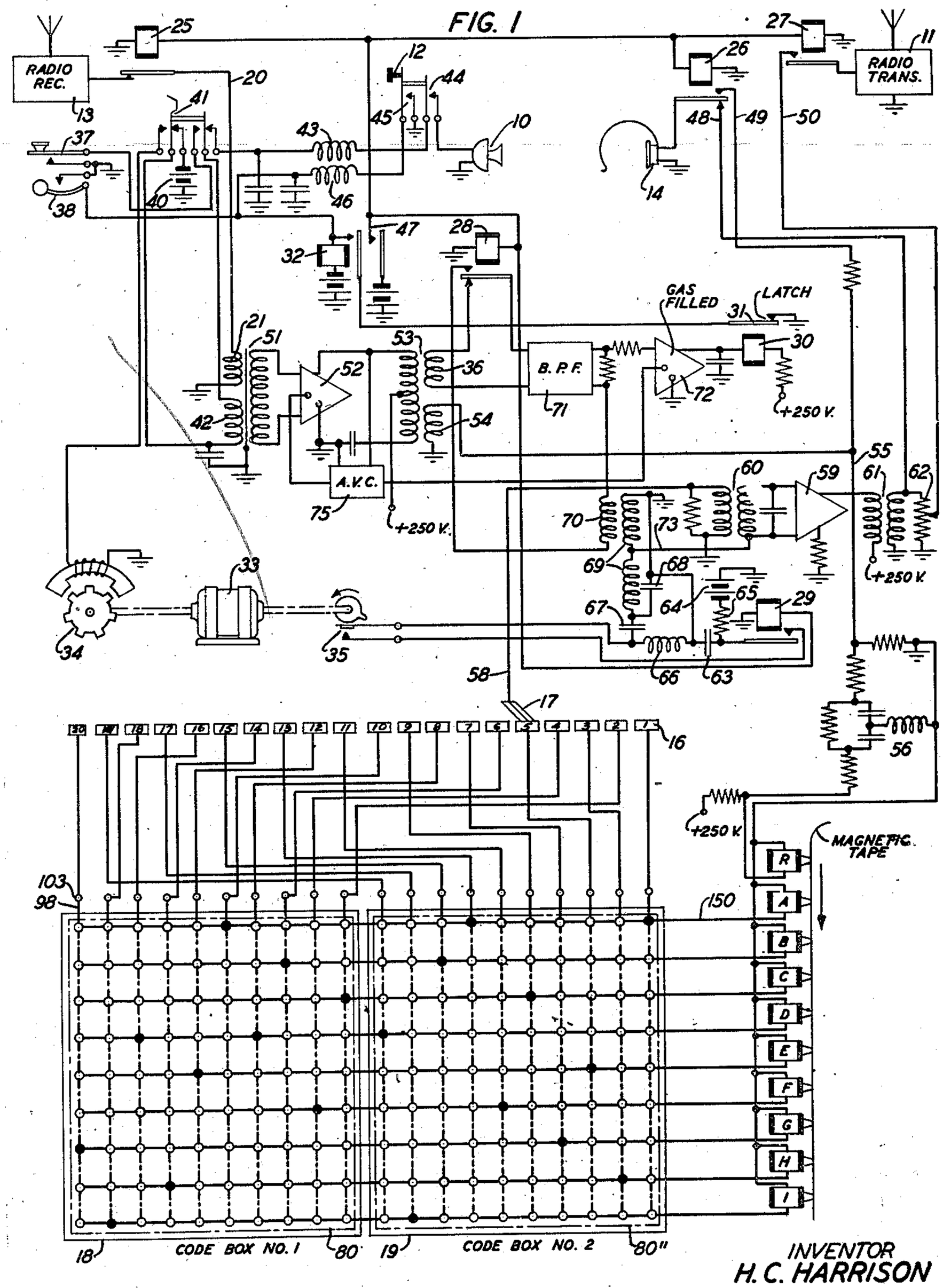
FIG. 1



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SWITCHING MECHANISM FOR SIGNAL SYSTEMS

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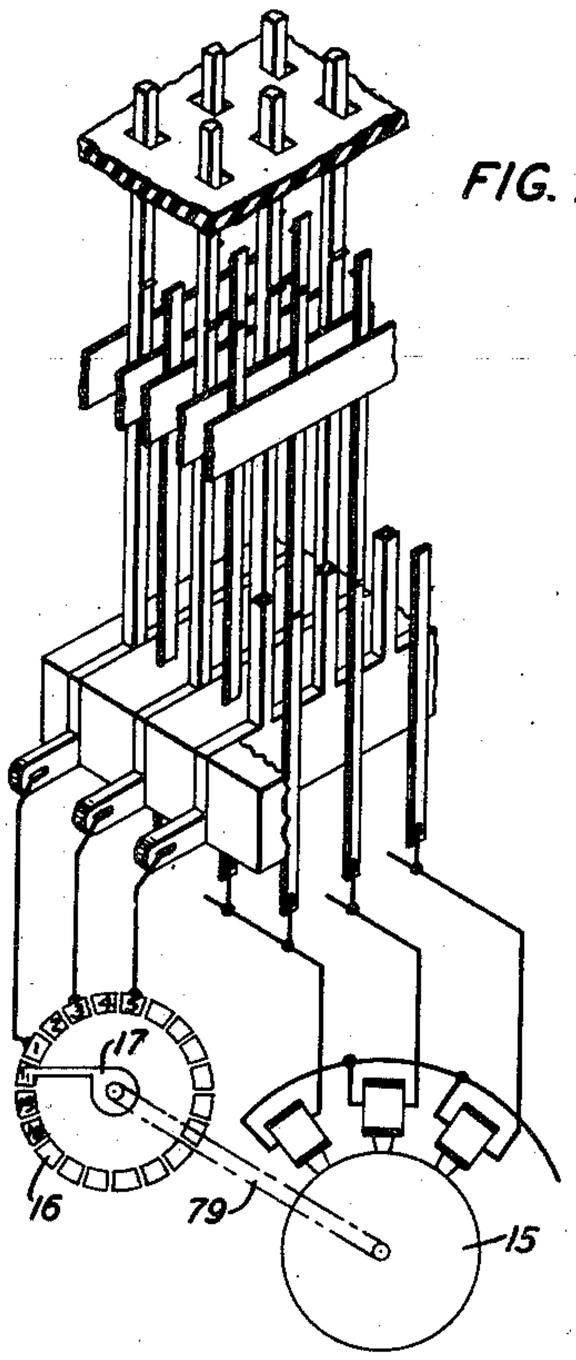

FIG. 2

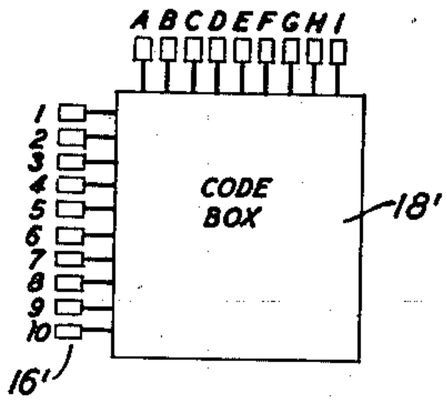

FIG. 3

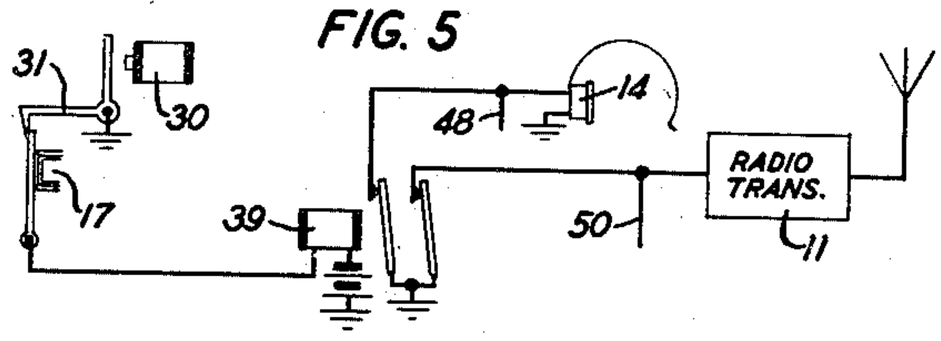

FIG. 5

FIG. 4

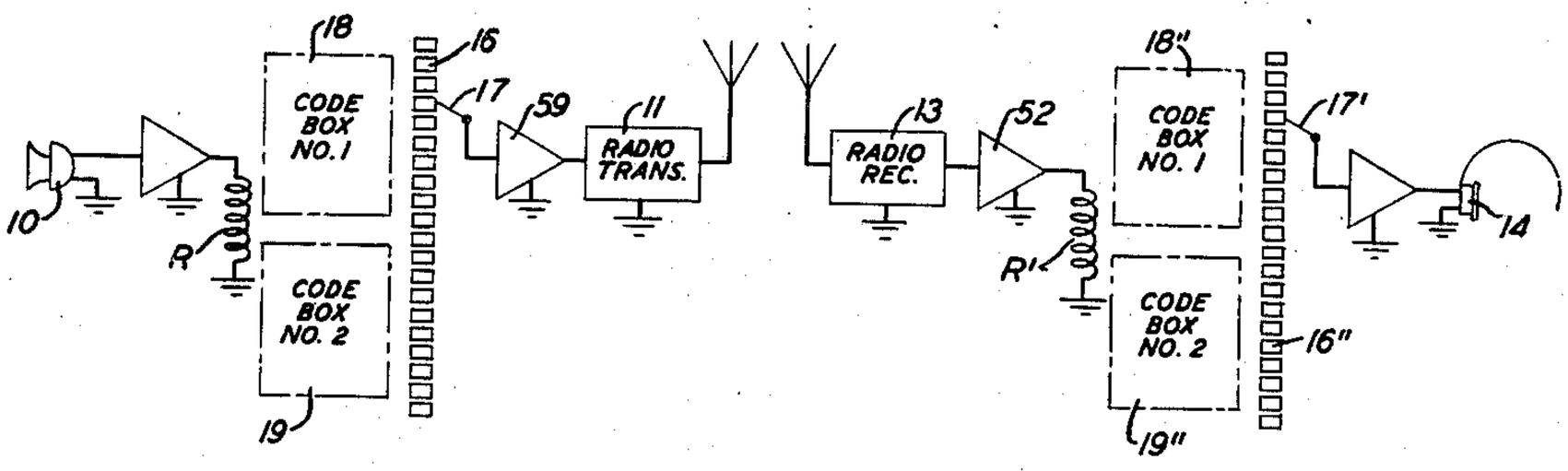

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FIG. 7

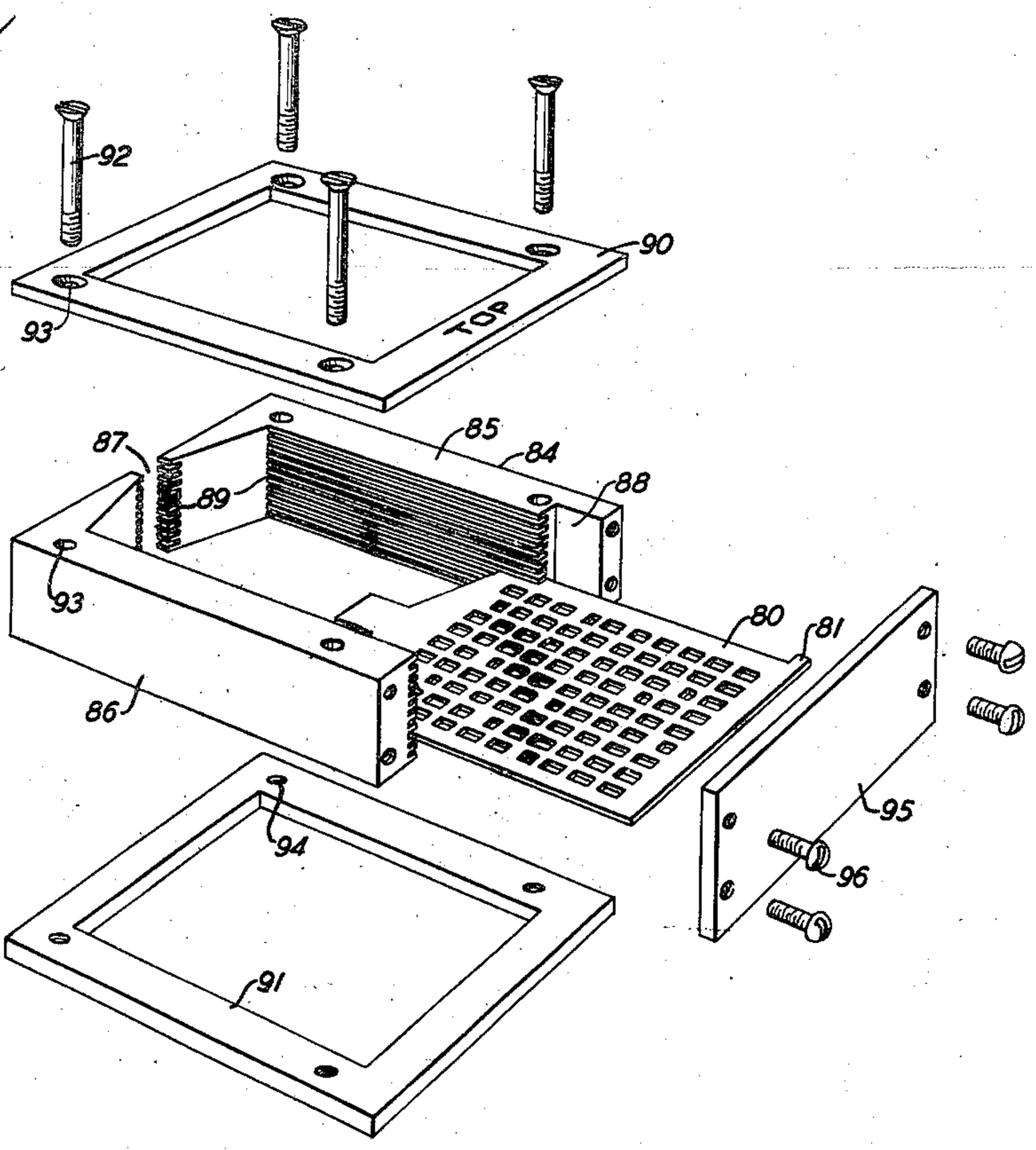

FIG. 8

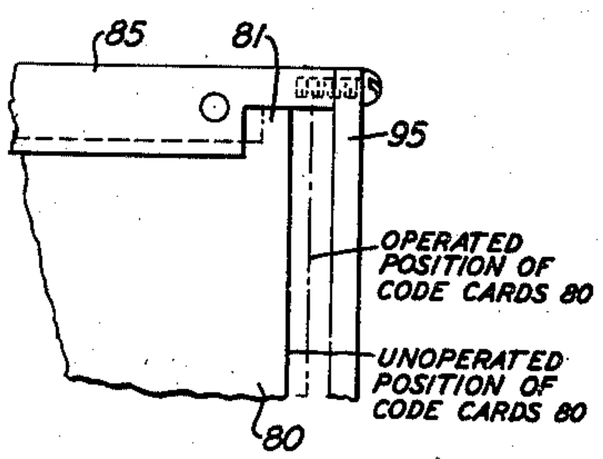

FIG. 6

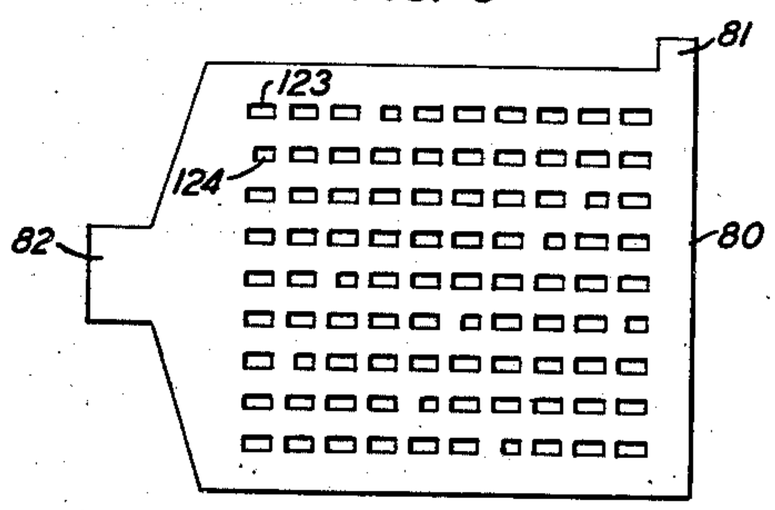

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FIG. 9

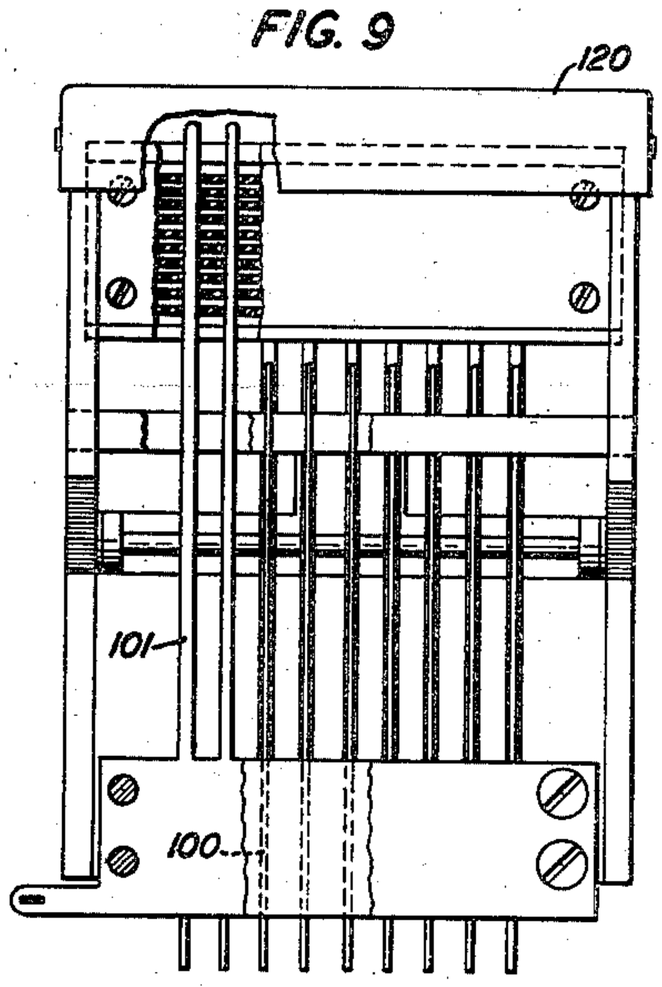

FIG. 10

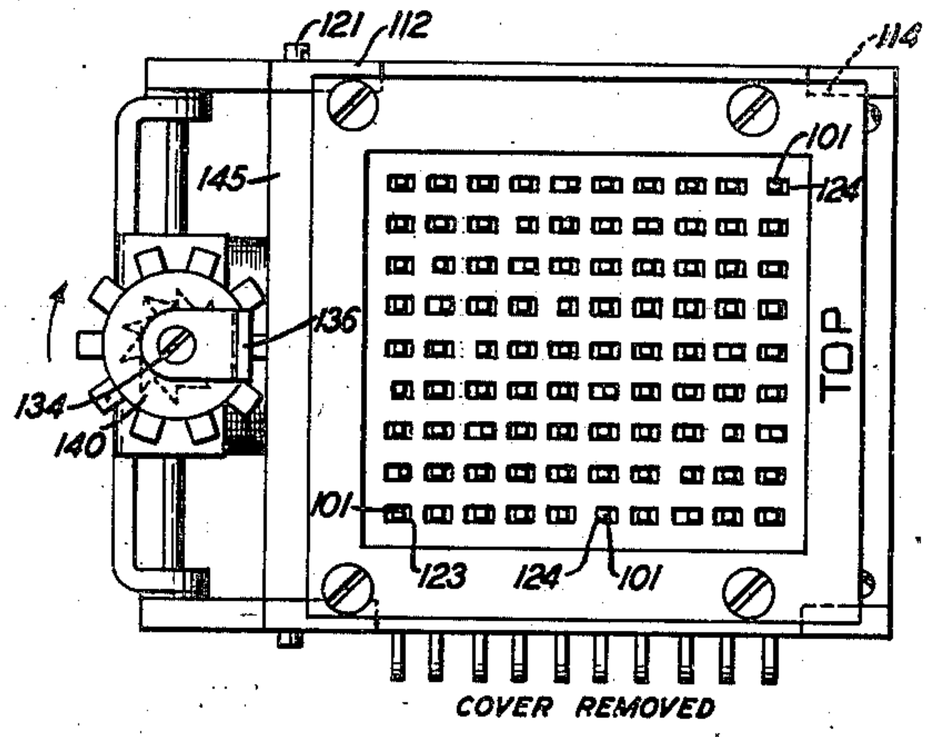

FIG. 19

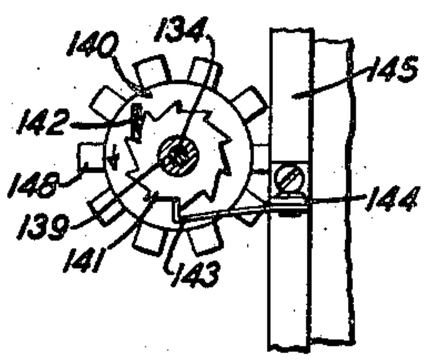

FIG. 20

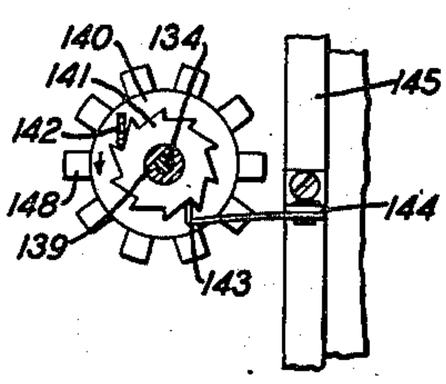

FIG. 11

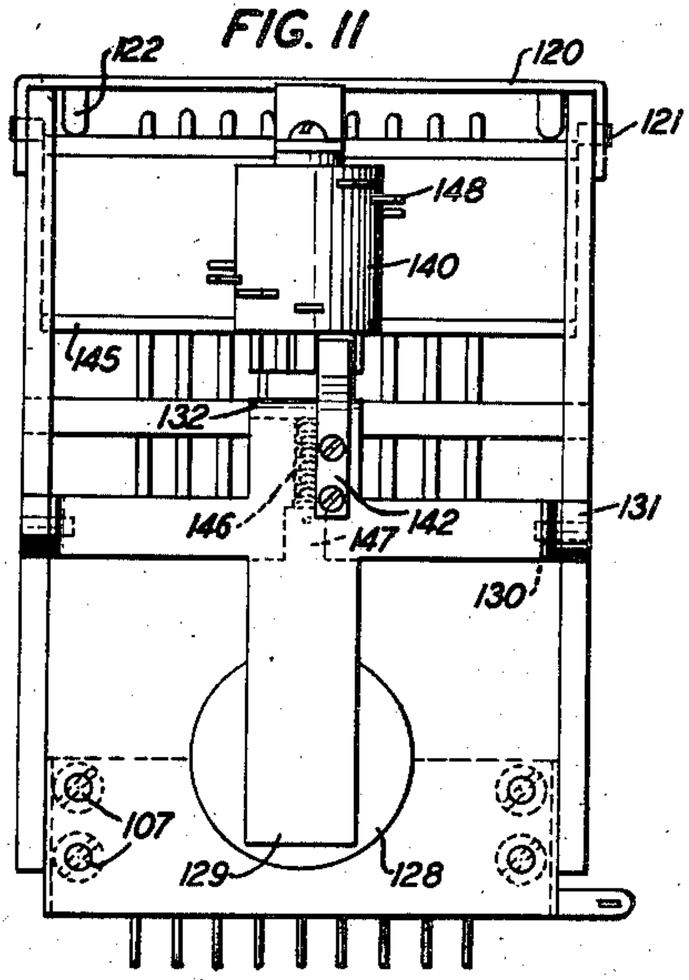

FIG. 12

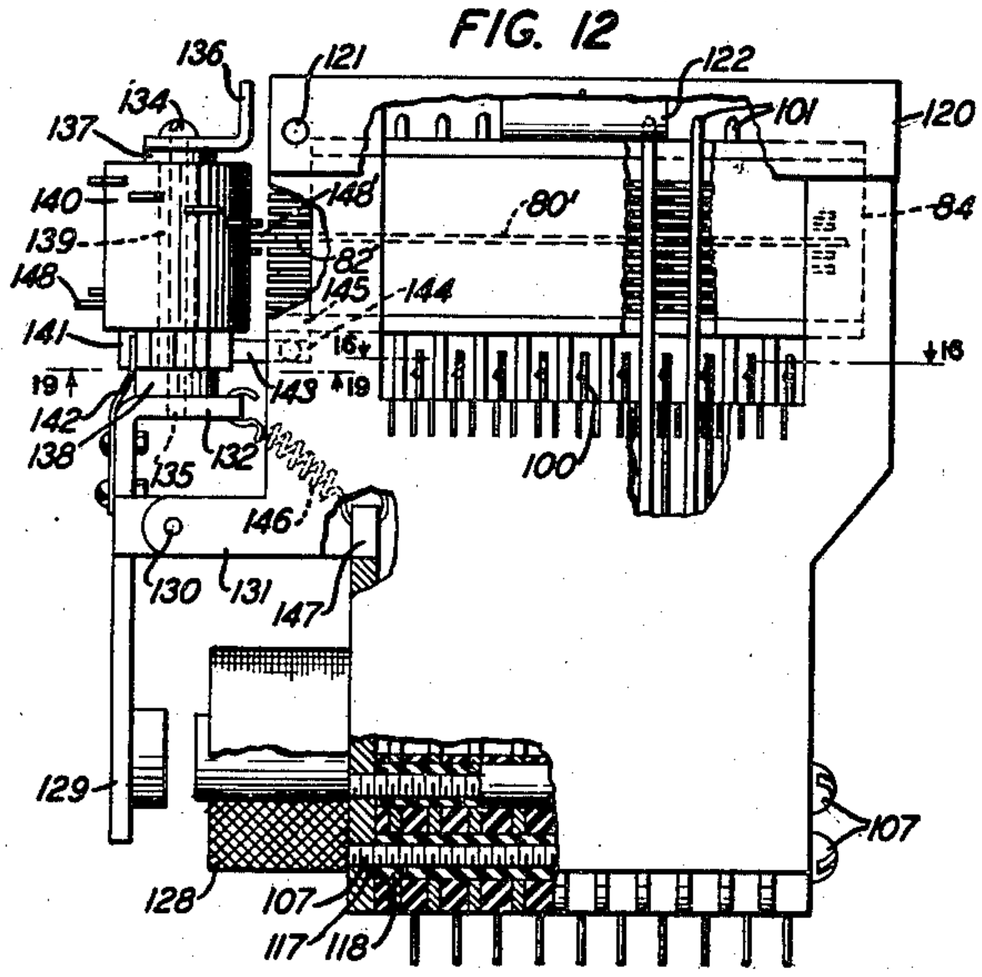

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FIG. 13

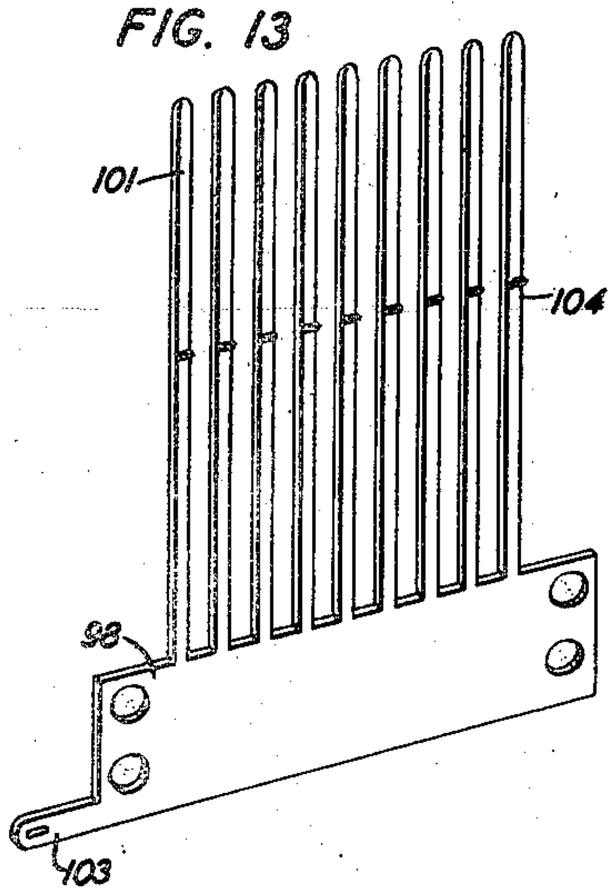

FIG. 14

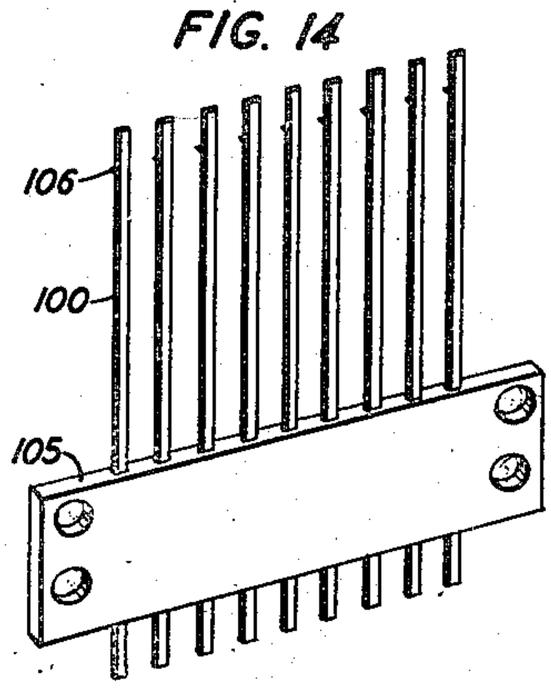

FIG. 15

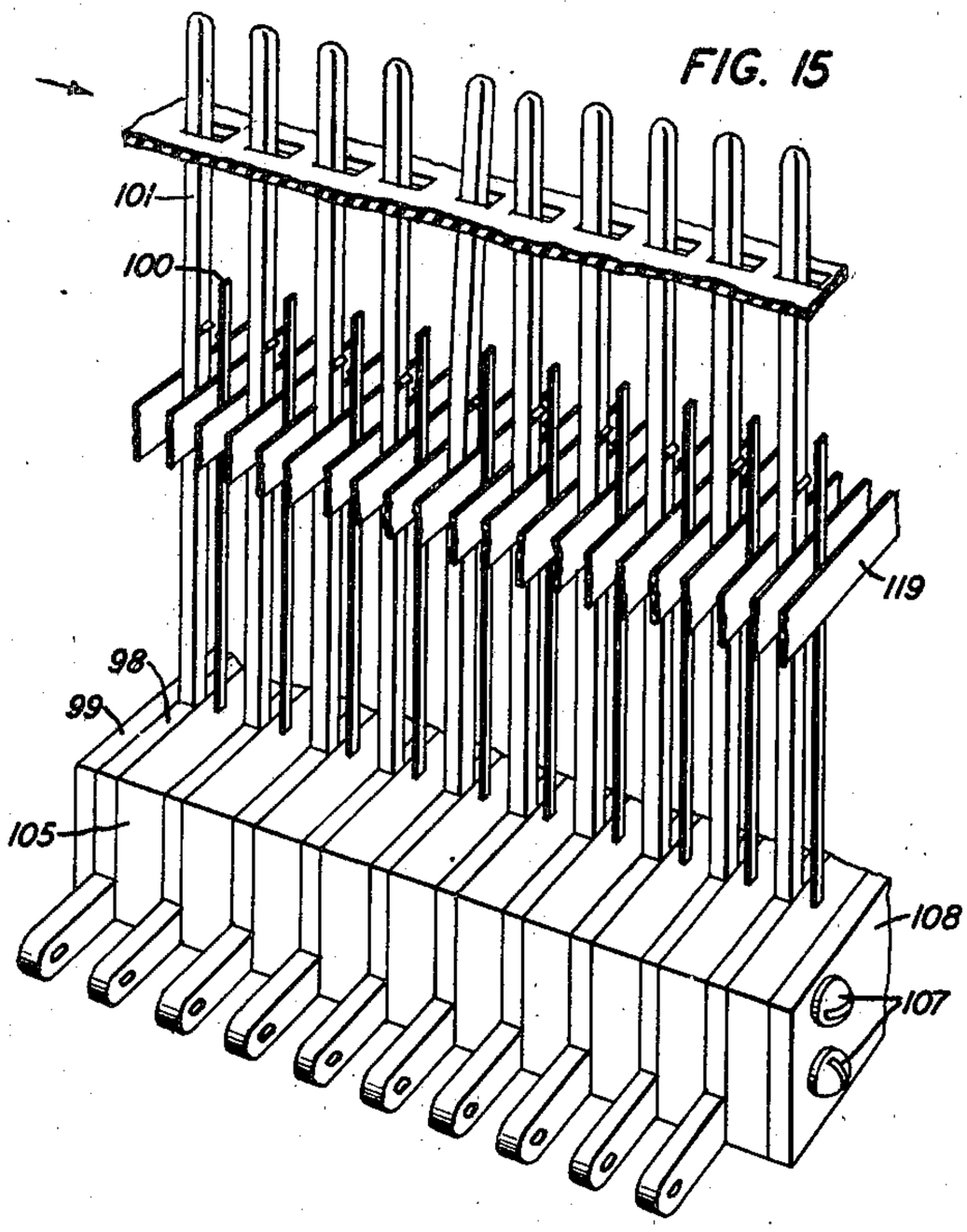

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FIG. 16

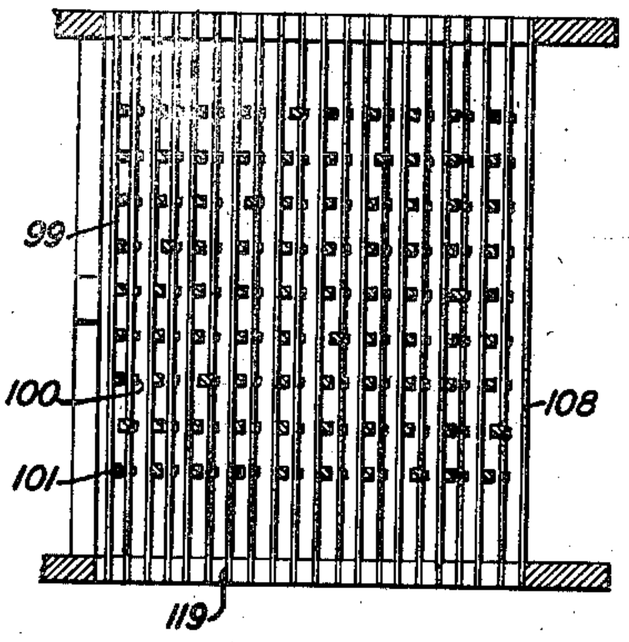

FIG. 17

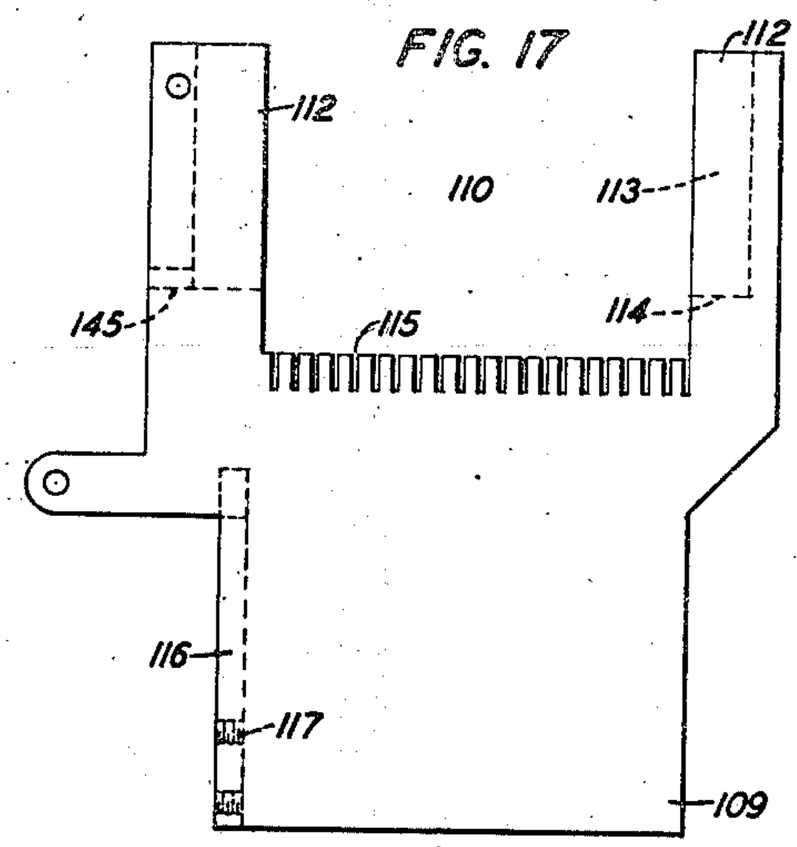

FIG. 21

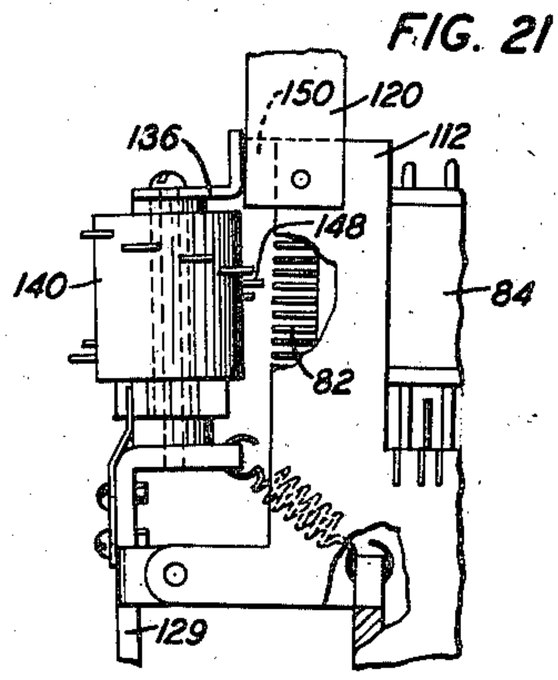

FIG. 18

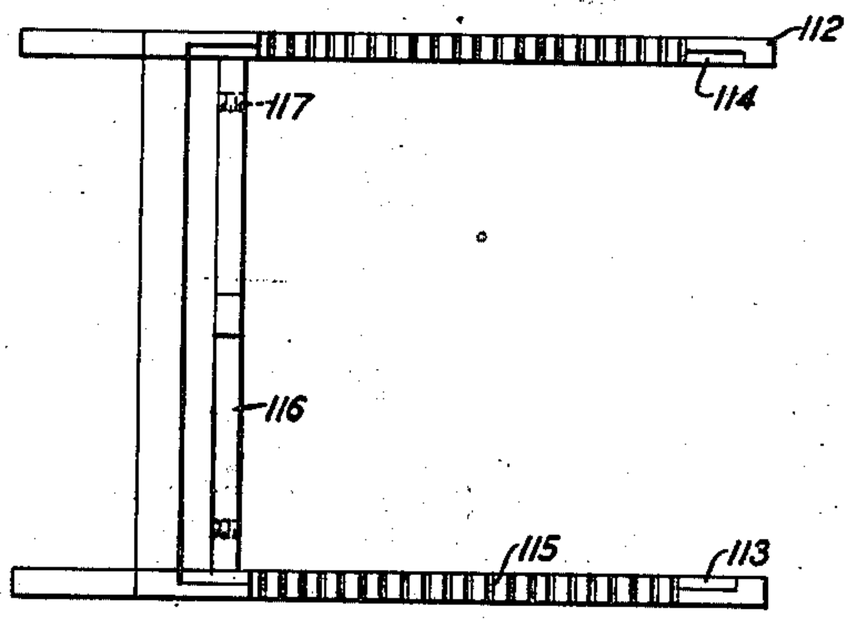

FIG. 22

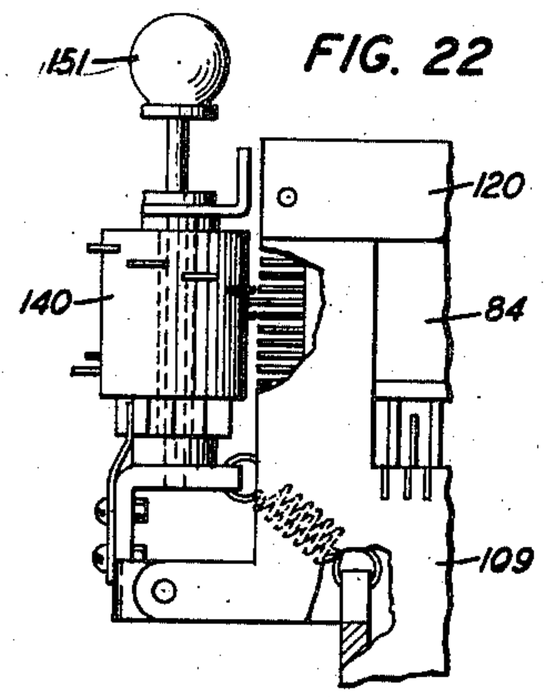

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FIG. 23

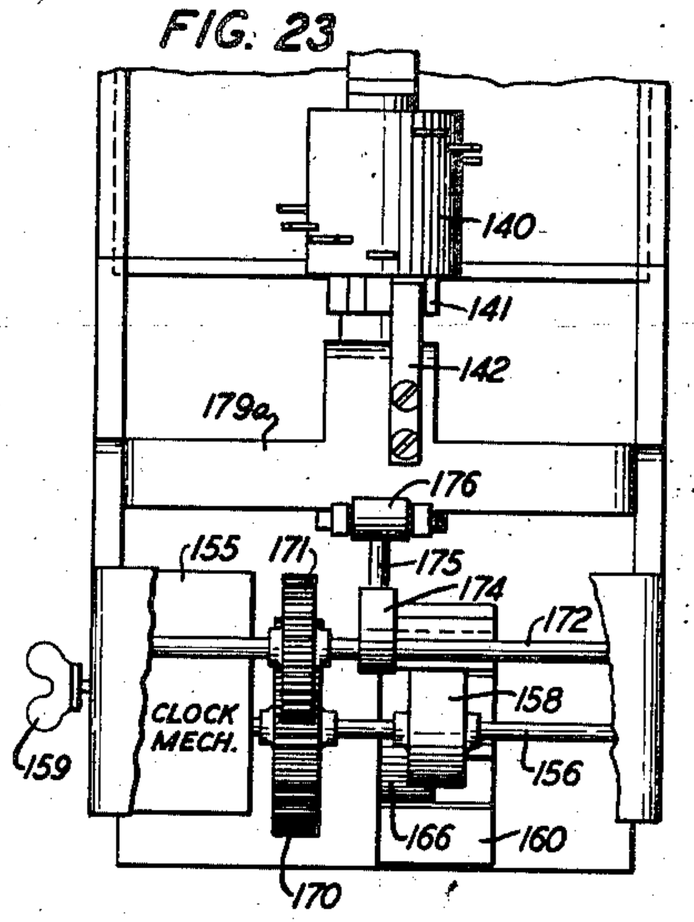

FIG. 24

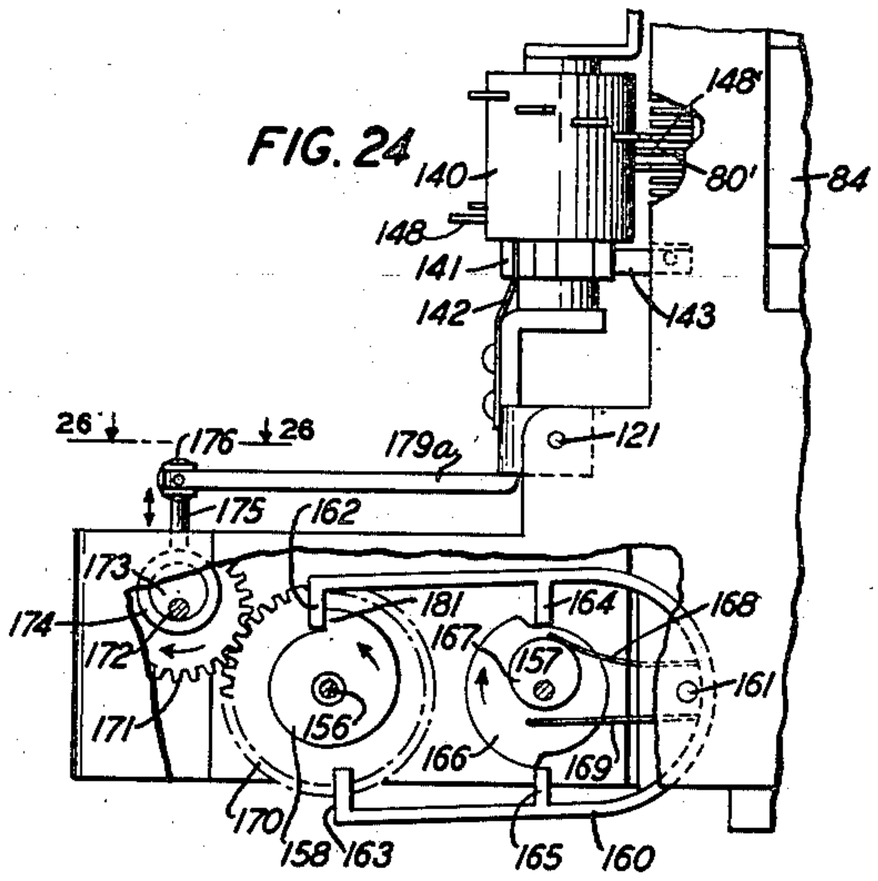

FIG. 25

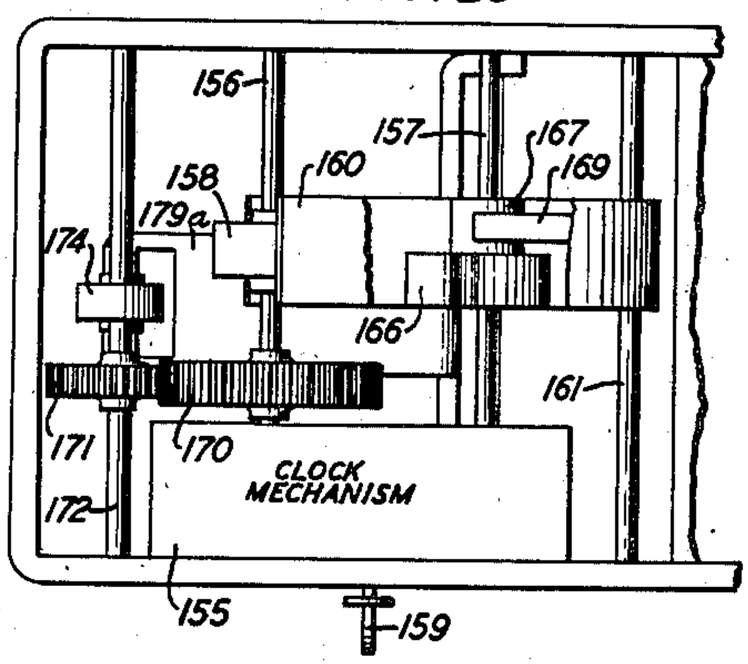

FIG. 26

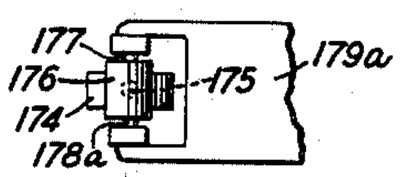

FIG. 27A

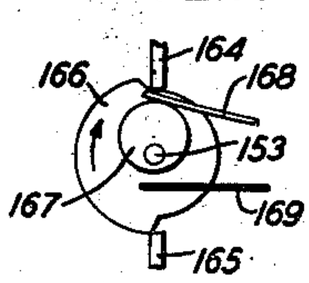

FIG. 27B

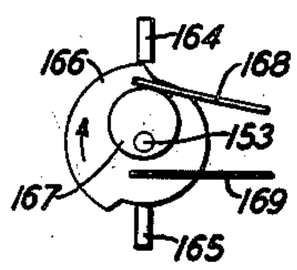

FIG. 27C

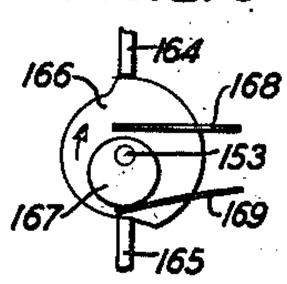

FIG. 27D

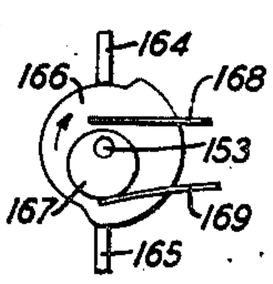

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FIG. 29

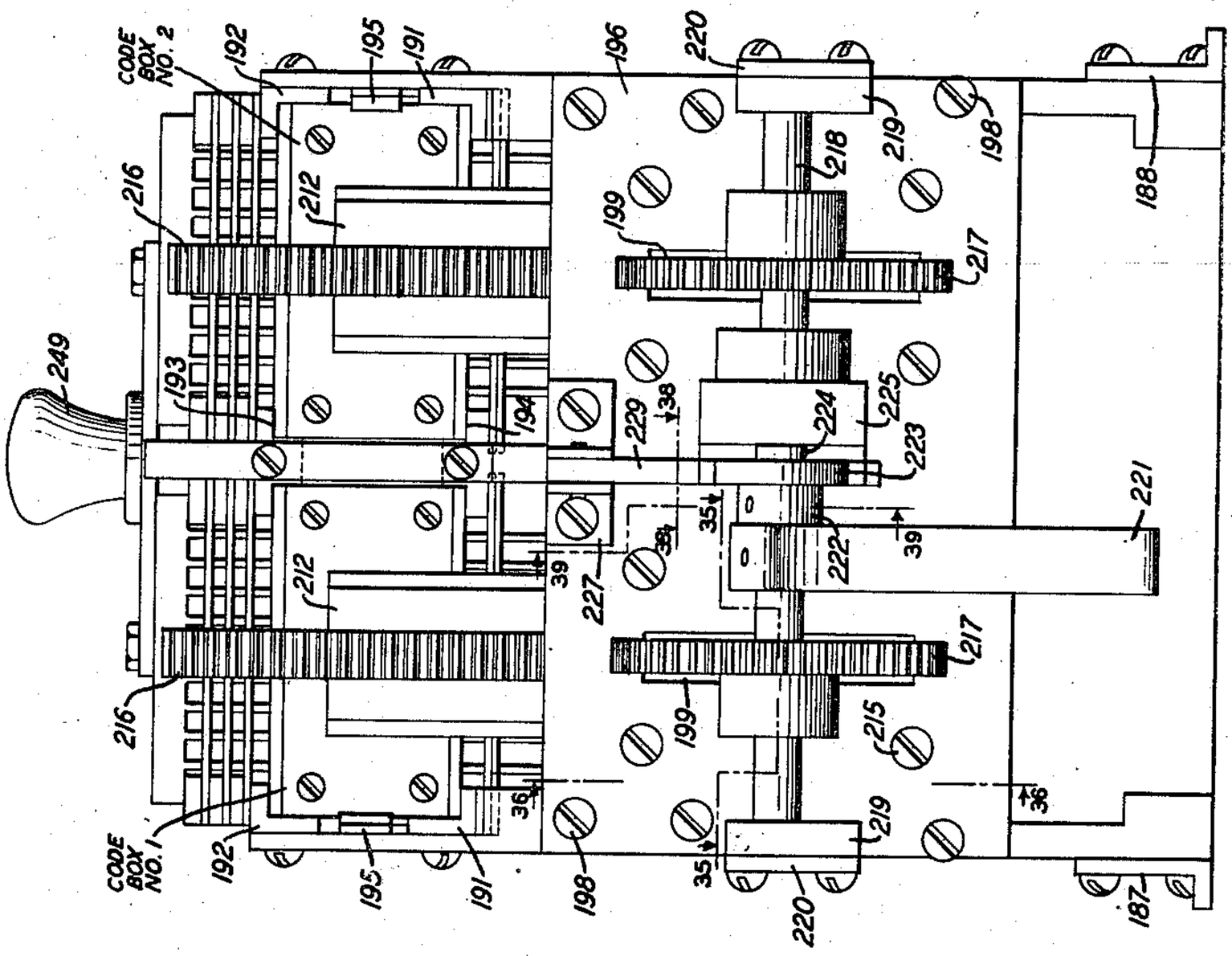

FIG. 28

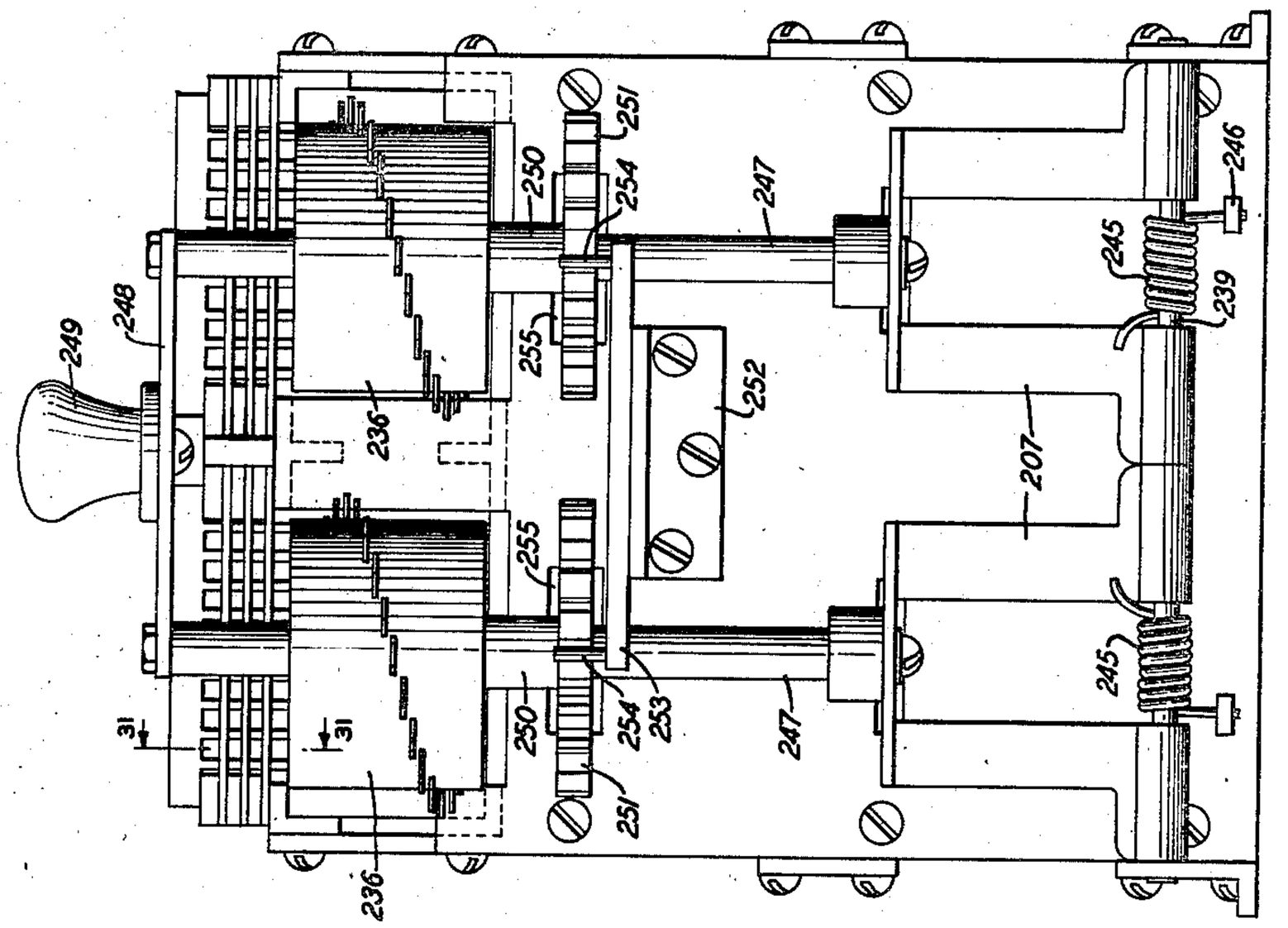

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FIG. 30

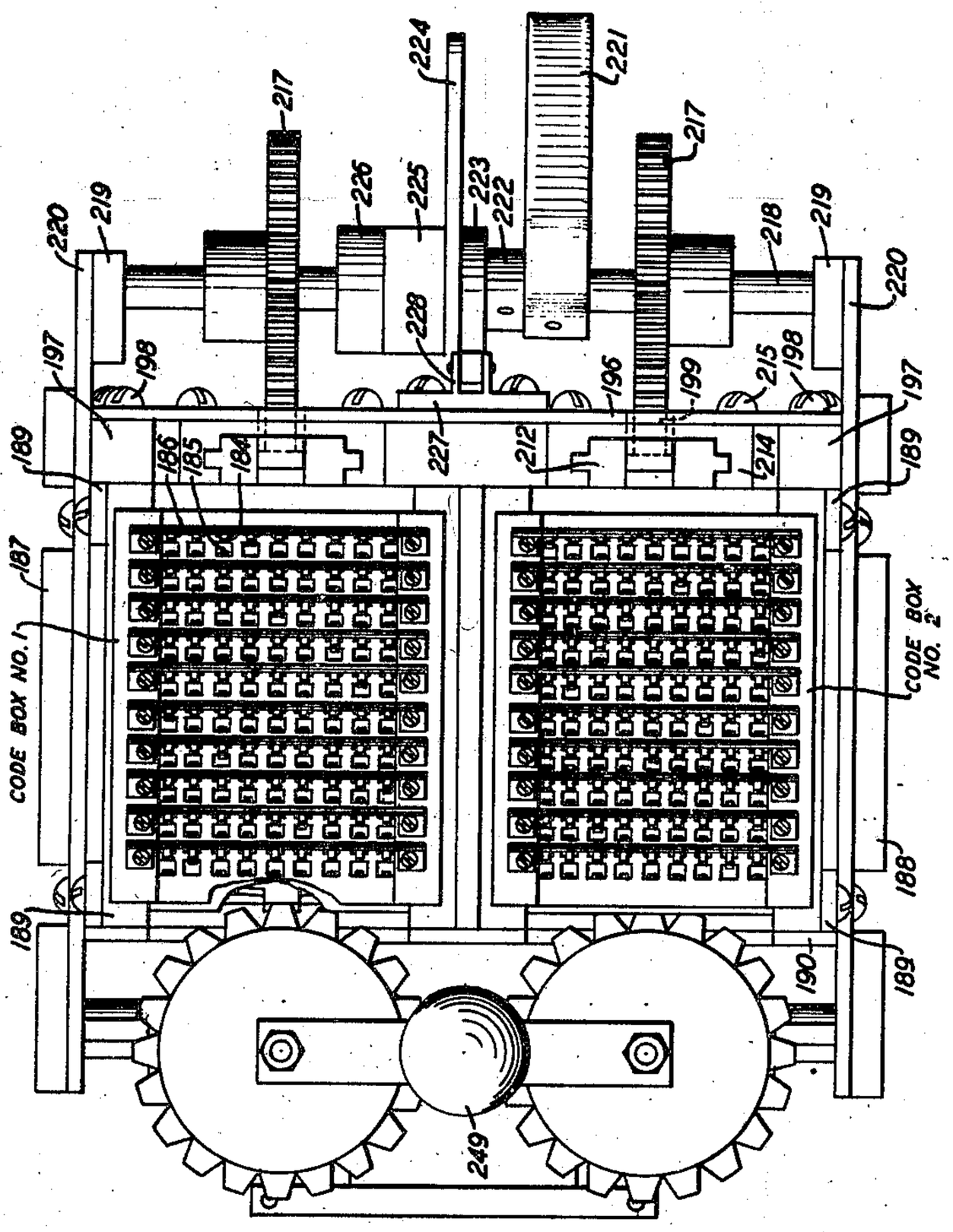

FIG. 31

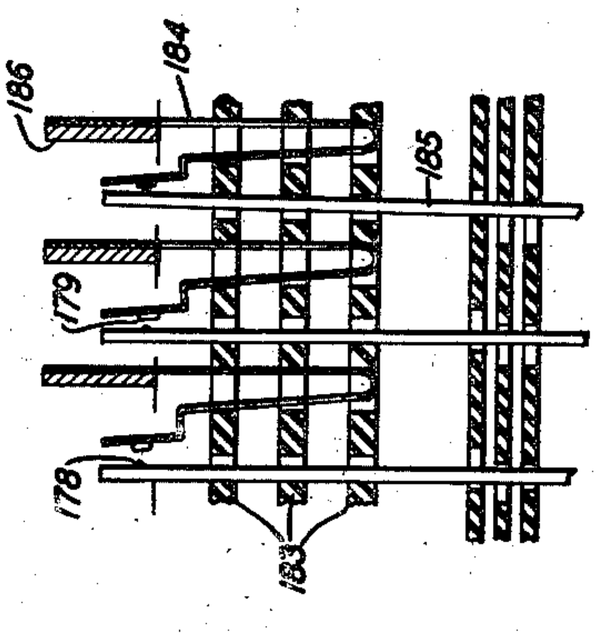

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FIG. 32

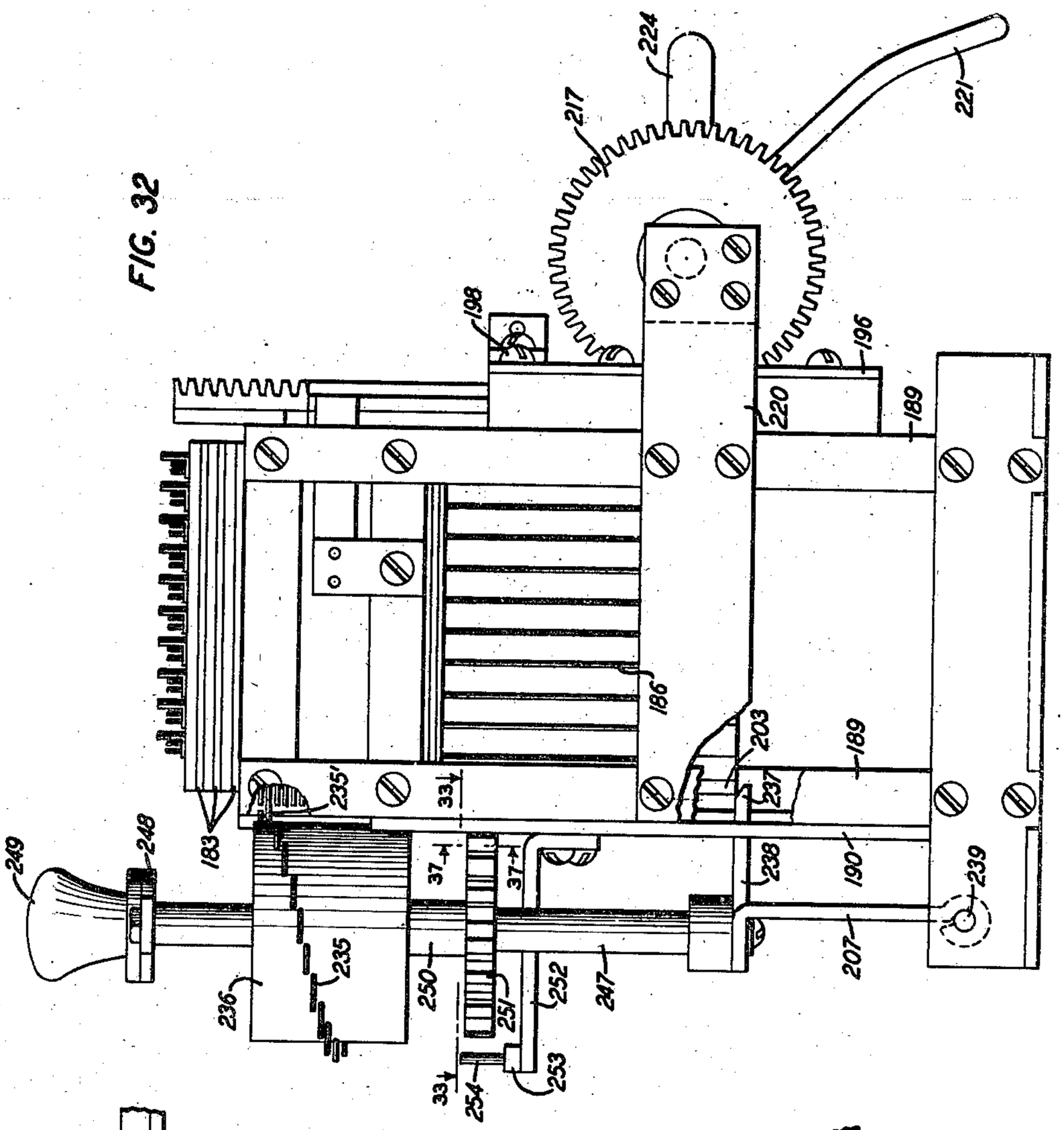

FIG. 33

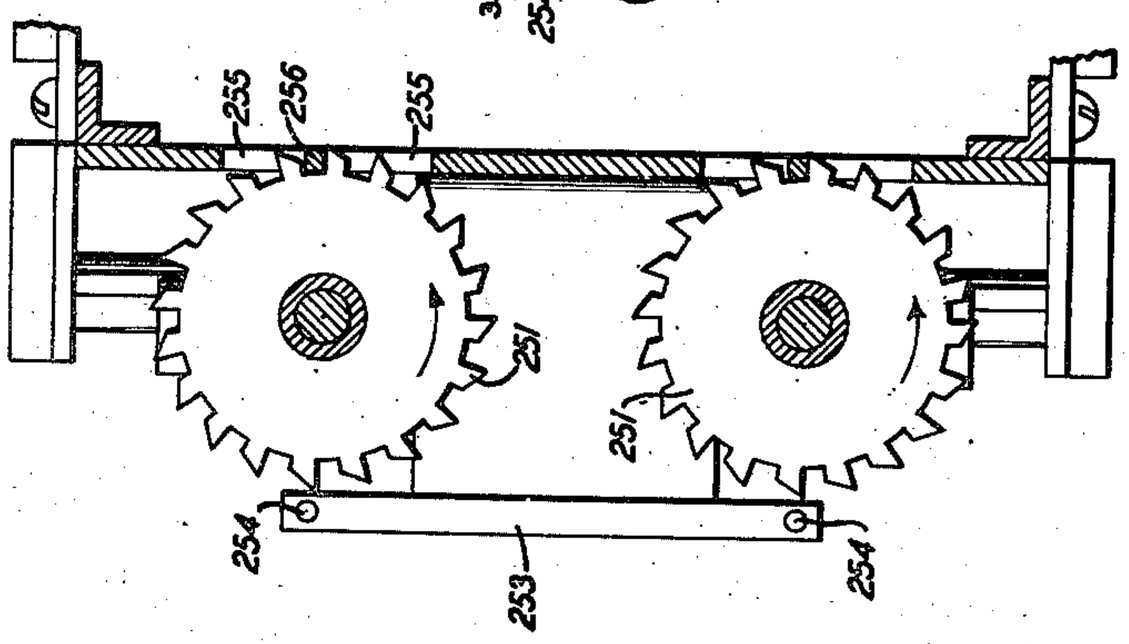

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FIG. 34

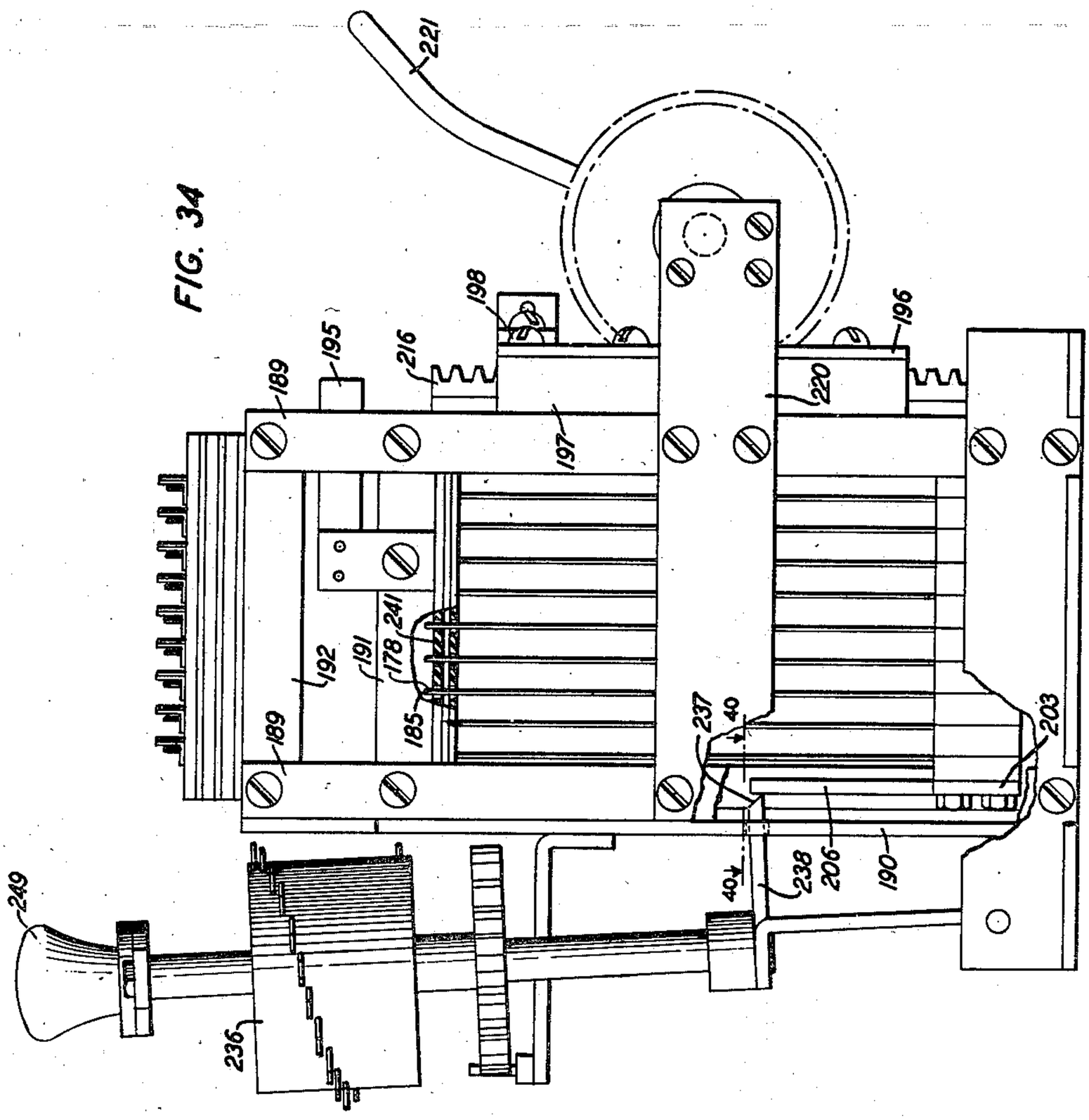

FIG. 40

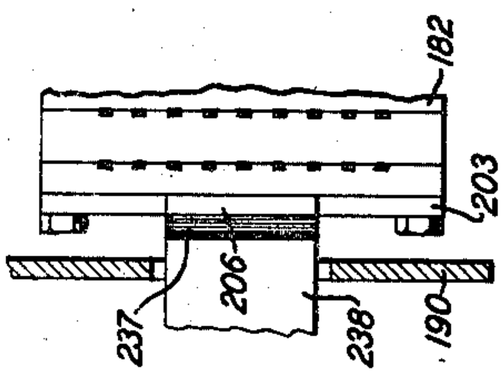

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FIG. 36

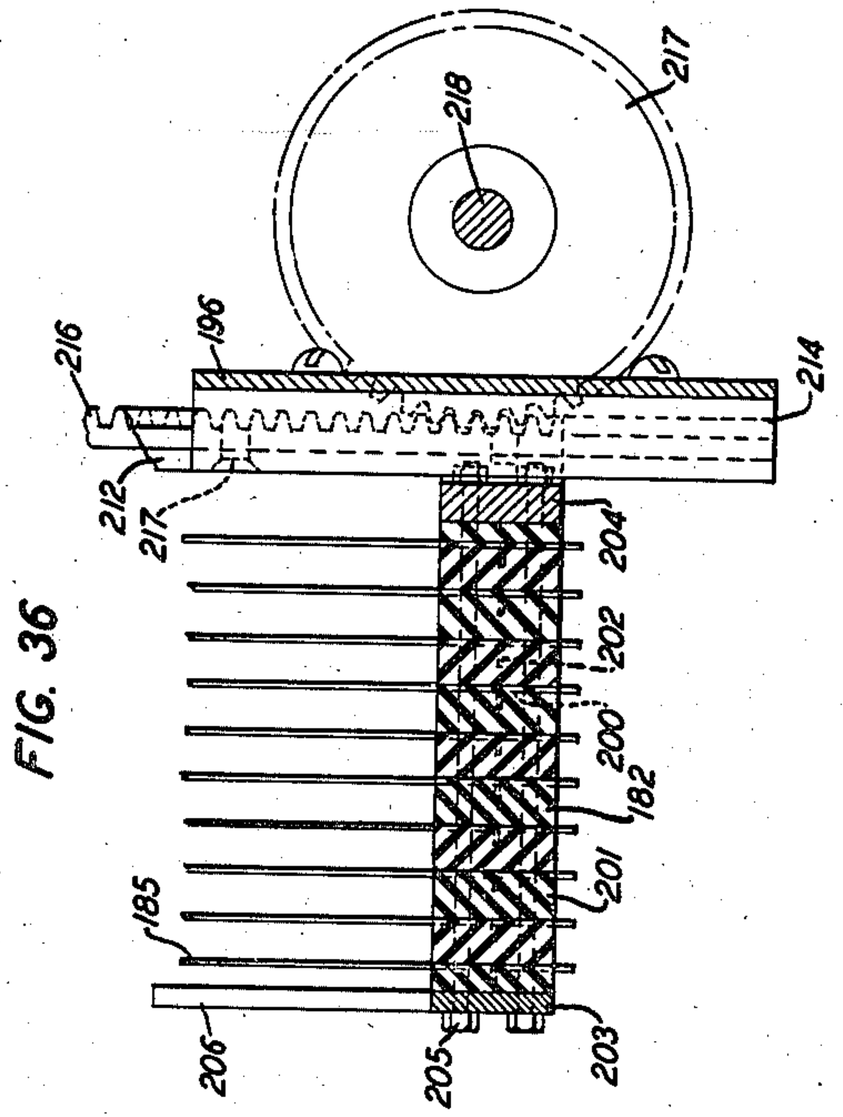

FIG. 35

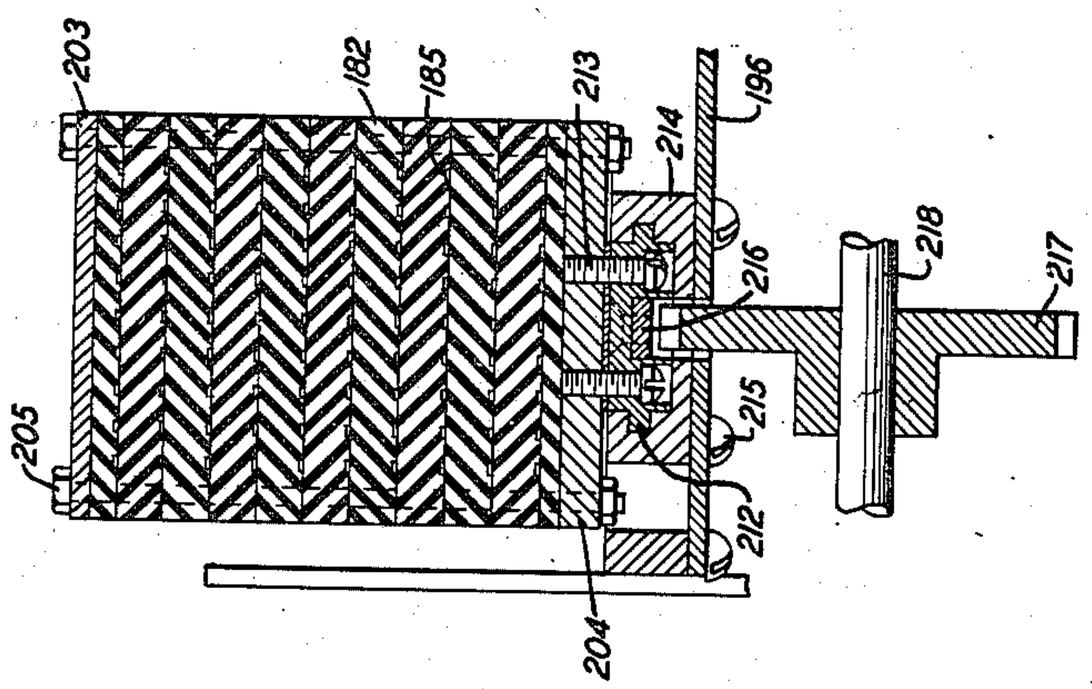

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FIG. 37

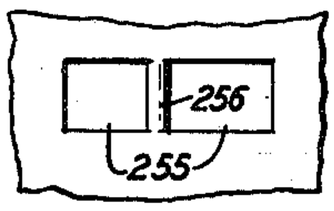


FIG. 38

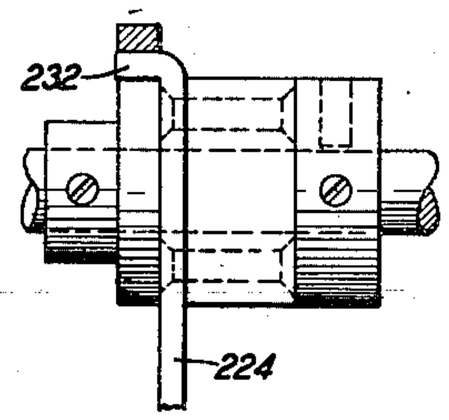


FIG. 39A

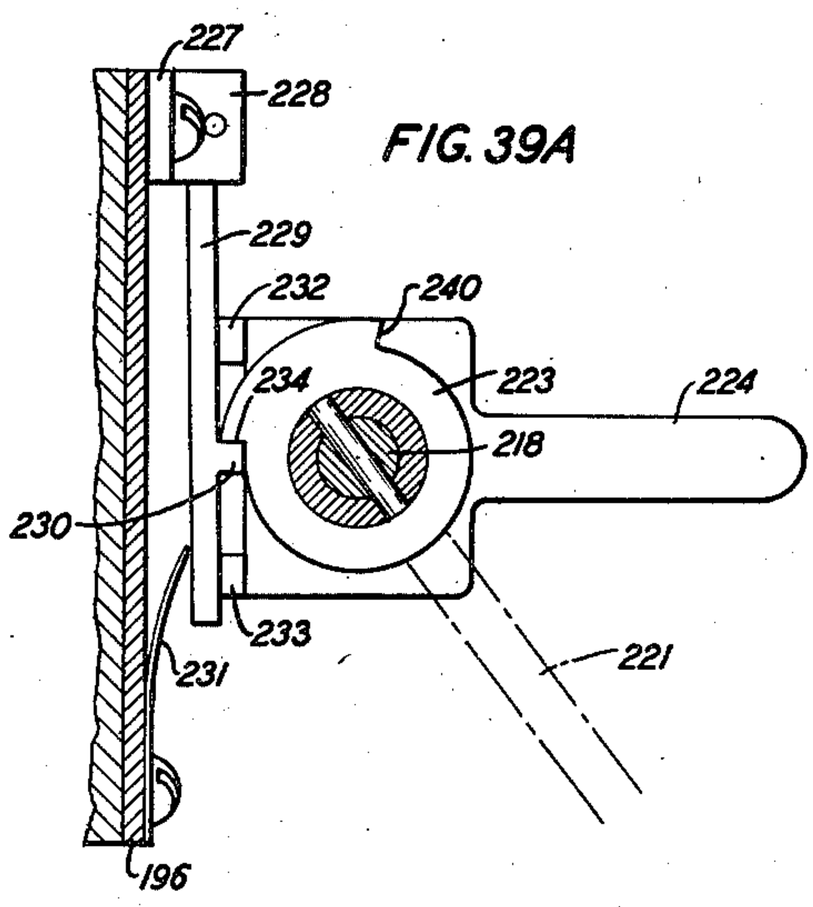


FIG. 39B

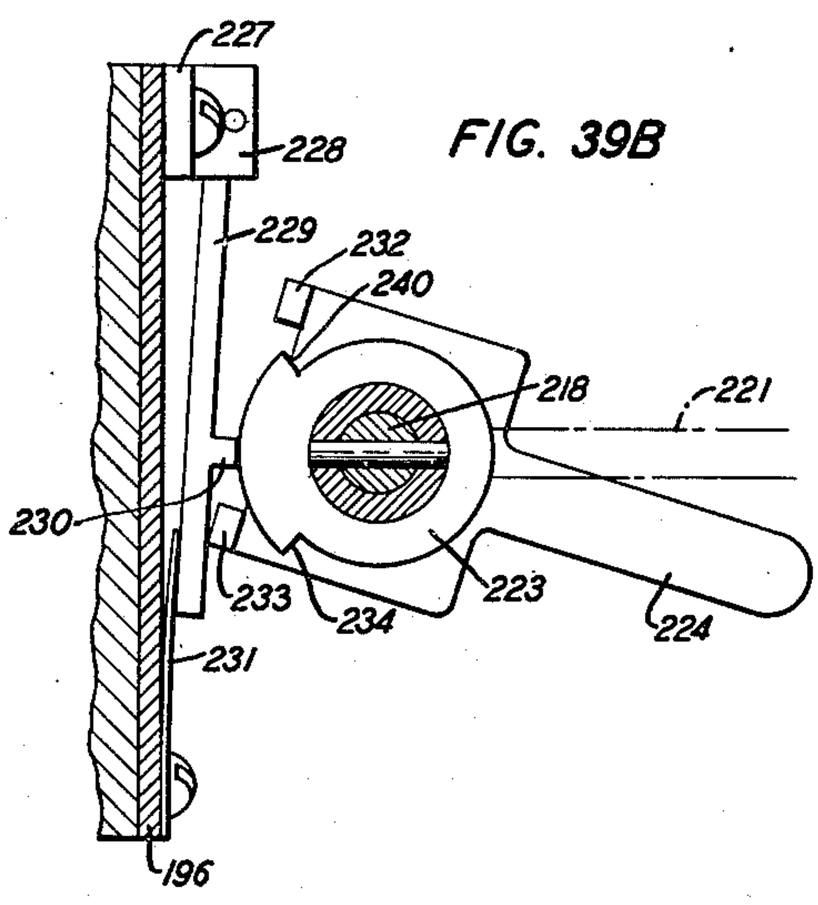


FIG. 39C

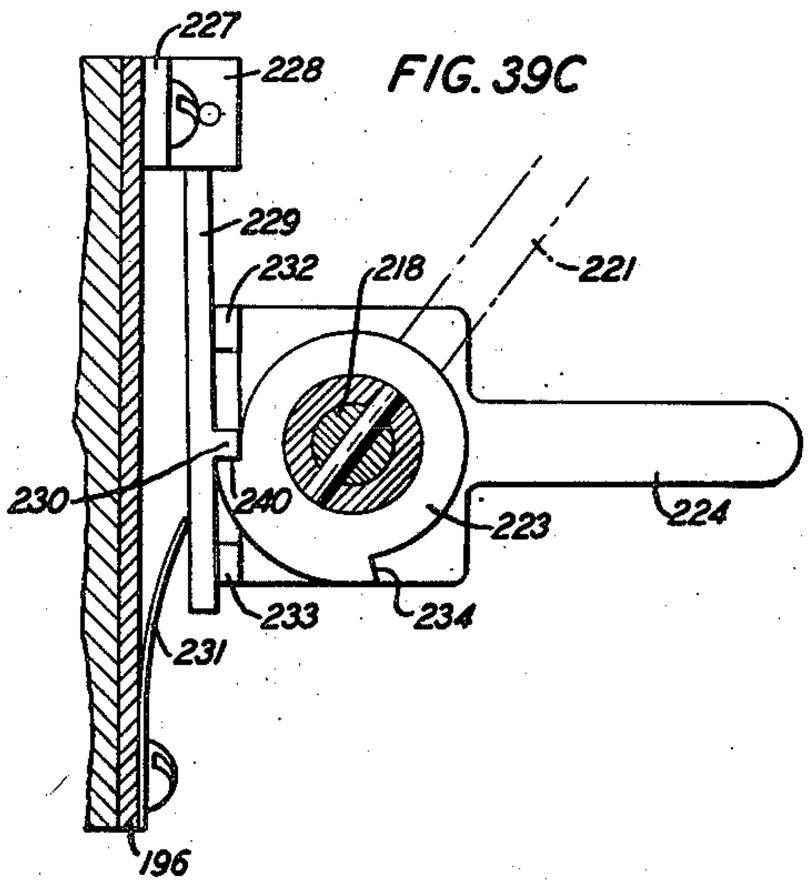
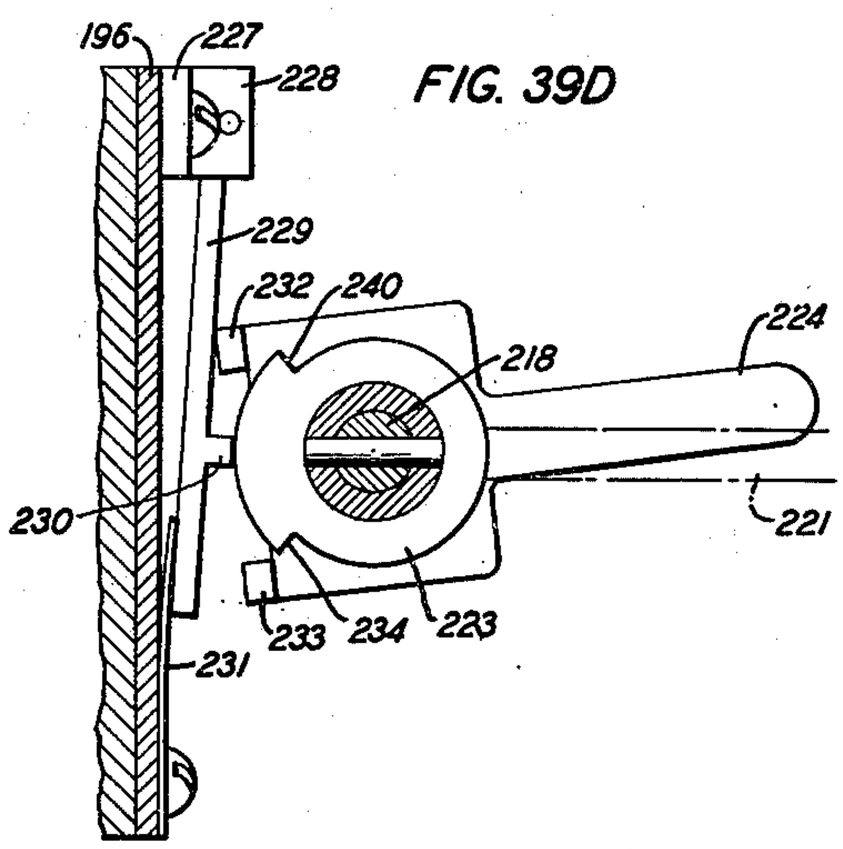


FIG. 39D



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Patented Aug. 27, 1946 2,406,350

UNITED STATES PATENT OFFICE

2,406,350

SWITCHING MECHANISM FOR SIGNAL SYSTEMS

Henry C. Harrison, Port Washington, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application July 25, 1944, Serial No. 546,447

14 Claims. (Cl. 179—1.5)

1

This invention relates to a speech privacy system in which the speech waves are divided into fragments on a time basis and the individual fragments are transmitted with different amounts of time delay in accordance with a code. Particularly, the present invention relates to a code changing apparatus for use in such privacy system so that one of a plurality of codes for varying the time delay between the individual speech fragments can be selected manually when desired or automatically at preselected time intervals.

As the security afforded by a fixed code privacy system cannot be relied on beyond the time period required by an unauthorized intercepter to break the code, it is desirable to be able to change the code from time to time. In the case of a mission of airplanes, for example, requiring a time in excess of the security time period, one or more changes of the code might be desirable during the mission. Under the stress of circumstances attending the mission the changing of codes might be neglected or overlooked entirely if it involved several hand manipulations which were cumbersome, particularly when they were to be performed by an operator with a gloved hand. Accordingly, the present invention contemplates code changing apparatus adapted for the automatic selection of individual codes at predetermined time intervals, or for the manual selection of individual codes by a single hand operation.

A general object of the invention is to provide for the expeditious selection of each of a plurality of individual codes in a speech privacy system.

In a speech privacy system of the type disclosed in the copending application of F. G. Buhrendorf, Serial No. 450,418, filed July 10, 1942, speech waves are recorded on a suitable medium, such as a moving magnetic tape, and are reproduced from this record by a plurality of reproducer magnets spaced along the medium such that the time order of sending out fragments of the speech waves can be varied. A rotary distributor comprising a plurality of interlaced sets of segments and a brush passing thereover breaks the recorded speech waves into fragments of definite length, each being of a small fraction of a second duration. A card perforated in accordance with a preselected code controls the effective connection of any reproducer magnet to any distributor segment of each interlaced set, and thereby varies the time delay between speech fragments. In receiving, each speech fragment is again delayed between the recording medium and distributor brush so as to be supplied to a speech wave translator in its proper time order.

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In a specific embodiment, which is intended for use with a speech privacy system of the above Buhrendorf type, the present invention is concerned with a switching mechanism associated with each interlaced set of distributor segments for varying the time sequence with which the speech fragments are supplied to the distributor brush, and comprises a plurality of normally open contact pairs each of which includes an elongated contact capable of being flexed at one end and a relatively fixed contact. The contact pairs are arranged in spaced relation in a plurality of vertical and horizontal rows such that each vertical row of fixed contacts is connected to a distributor segment of one interlaced set, and each horizontal row of flexible contacts is connected to one reproducer magnet. A plurality of cards each of which is provided with two different sizes of perforations, whose total number is equivalent to the total number of contact pairs but the smaller ones limited to the number of distributor segments in the one interlaced set, intermingled and arranged in vertical and horizontal rows corresponding to those of the contact pairs, is stacked on the upper ends of the flexible contacts.

The uppermost ends of these contacts are disposed in proximity of their associated fixed contacts which are also positioned above the top card of the stack. Each card touches the flexible contacts at the smaller perforations so that such contacts are flexed when the card is moved in a horizontal direction a predetermined distance. Thus, each card serves to connect the reproducer magnets to the distributor segments of the one interlaced set in a sequence in accordance with the coding of the smaller perforations alone. A device manually or automatically operated selects individual code cards in the stack and moves them the predetermined horizontal distance for effecting a different interconnection of the reproducer magnets and distributor segments of the one interlaced set. As there are two interlaced sets of distributor segments in the specific embodiment of the invention, the two switching mechanisms for such two interlaced sets are operated simultaneously for connecting any reproducer magnet to any distributor magnet of each interlaced set.

The invention will be readily understood from the following description taken together with the accompanying drawings in which:

Fig. 1 is a schematic circuit diagram of a complete two-way terminal of a speech privacy system with which the specific embodiment of the invention can be employed;

Fig. 2 is a fragmentary view, in perspective, of

the cross bar code switch and one perforated code card;

Fig. 3 shows in outline how a single code box would be connected in the system;

Fig. 4 is a block diagram showing how the apparatus of Fig. 1 would be disposed for four-wire transmission;

Fig. 5 shows a detail modification of a portion of the circuit of Fig. 1;

Fig. 6 is a plan view of one card perforated in accordance with one code;

Fig. 7 is an exploded perspective view of the code box for containing a stack of perforated code cards;

Fig. 8 is a fragmentary plan view of the right-hand end of the code box in Fig. 7 showing unoperated and operated positions of the code cards therein;

Fig. 9 is a rear view of a single code switching mechanism;

Fig. 10 is a plan view of a single code switching mechanism;

Fig. 11 is a front view of a single code switching mechanism;

Fig. 12 is a side elevational view, partly in section, of a single code switching mechanism;

Fig. 13 is a perspective view of one row of contacts in the cross bar switch of the specific embodiment of the invention in Figs. 1 and 2;

Fig. 14 is a perspective view of another row of contacts in the cross bar switch of the specific embodiment of the invention in Figs. 1 and 2;

Fig. 15 is a fragmentary perspective view showing the assembly of one row of contact pairs controlled by one operated code card;

Fig. 16 is a sectional view taken along the line 16—16 of Fig. 12;

Fig. 17 is a side elevation of the housing for a single code switching mechanism;

Fig. 18 is a plan view of the housing for a single code switching mechanism;

Fig. 19 is a sectional view taken along the line 19—19 of Fig. 12 showing the pawl and ratchet wheel in its final position after rotating the code card selecting drum one full step;

Fig. 20 is a view taken similarly to Fig. 19 but showing the pawl and ratchet in the position due to the energization cycle of the magnet coil;

Fig. 21 is a partial side elevational view showing how the card selecting drum is disengaged from the code cards to enable the changing of the code box without damaging the code cards;

Fig. 22 is a partial side elevational view showing the code card selecting drum provided with a finger grip for manual operation;

Fig. 23 is a front view of a modification operated by a clock apparatus;

Fig. 24 is a fragmentary side elevational view of the modification of Fig. 23;

Fig. 25 is a bottom view of the modification shown in Fig. 24;

Fig. 26 is a view taken along the line 26—26 of Fig. 24;

Figs. 27A, B, C and D show various operating positions of certain cams in the clock apparatus in Fig. 24;

Fig. 28 is a front view of a double code switching mechanism;

Fig. 29 is a rear view of a double code switching mechanism;

Fig. 30 is a plan view of a double code switching mechanism;

Fig. 31 is a sectional view taken along the line 31—31 of Fig. 28 showing the relation between

normally opened contact pairs and one closed contact pair;

Fig. 32 is a side elevational view of a double code switching line mechanism;

Fig. 33 is a sectional view taken along the line 33—33 of Fig. 32;

Fig. 34 is similar to Fig. 32, showing the condition for the insertion and removal of the code boxes in the double code switching mechanism;

Fig. 35 is a sectional view taken along the line 35—35 of Fig. 29;

Fig. 36 is a cross-sectional view taken along the line 36—36 of Fig. 29;

Fig. 37 is a sectional view taken along the line 37—37 of Fig. 32;

Fig. 38 is a sectional view taken along the line 38—38 of Fig. 29;

Figs. 39A, B, C and D are sectional views taken along the line 39—39 of Fig. 29, showing various positions of the locking cam, including the device for releasing and locking such cam; and

Fig. 40 is a sectional view taken along the line 40—40 of Fig. 34.

Referring to Fig. 1, the privacy system shown enables speech spoken into microphone 10 to be sent out in scrambled form over radio transmitter 11, and enables speech so transmitted when received on radio receiver 13 to be received as intelligible speech in headset 14. Transmission and reception could also be by wire as well.

The scrambling of the outgoing speech and the unscrambling of the incoming speech is accomplished by magnetic tape 15, commutator 16 (laid out in a straight line) traversed by brush 17, and the plurality of magnets associated with the magnetic tape and comprising recording magnet R, and reproducer magnets A . . . I. The usual erasing magnet is not shown. The commutator segments and reproducer magnets are interconnected through code boxes 18 and 19. Each of these boxes contains a plurality of cards perforated in advance in accordance with a preselected code and arranged in stacked relation. One card from each box serves to condition the system for transmitting and/or receiving scrambled speech in accordance with two codes interlaced with each other. The mechanism which selects individual cards in each code box and which constitutes the subject-matter of the present invention will be described in detail hereinafter.

The operation of the system shown in Fig. 1 will now be briefly described to provide such background as is necessary to a full understanding of the code card selecting mechanism constituting the present invention. Let it be assumed that the communicating parties have agreed on the codes that are to be used at a particular time and that perforated cards embodying such codes are selected in the code boxes 18 and 19 at each station, in accordance with the present invention to be explained later, of which stations there may be two or more. The sending of a start impulse from contacts 35 of the transmitting station releases all brushes 17 at all stations when brush 17 is on start segment 20. At each station a release magnet 30, when energized, releases latch 31, Figs. 1 and 5, and thereby allows the brushes 17 at all stations to start out on a revolution in phase with each other.

Assuming first that the station shown in Fig. 1 is to transmit scrambled speech and as such station is normally in the receiving condition the talking party presses button 12 to supply talking current from battery 40 via key 41, winding 42,

radio choke 43 and contact 44 of button 12 to microphone 10, and at the same time speaks thereinto. Contact 45 of button 12 closes an energizing circuit for relay 32 from battery, through the operating winding of relay 32 and radio choke 46 which relay operates and locks up through latch 31 to ground. The operation of relay 32 serves to supply energizing current from the battery associated with its outer armature and lead 47 to relays 25, 26, 27, 28 and 29, all of which operate to condition the system for the transmission of speech. Relay 25 disconnects receiving lead 20 from radio receiver 13. Relay 26 opens receiving branch conductor lead 48 leading to receiver 14 and closes sidetone lead 49 thereto. Relay 27 connects lead 50 to radio transmitter 11. Relay 28 opens the receiving circuit for the start pulse. Relay 29 closes the start pulse generating circuit which will be hereinafter pointed out.

Speech current from microphone 10 are applied through button 12, key 41, primary winding 42 of input transformer 51, amplifier 52, output transformer 53 including winding 54 and lead 55 to the recording magnet R. Filter 56 eliminates a signal band of frequencies of the order of 2000 cycles which frequency band is reserved for transmitting the starting pulse to be explained later. The speech currents are recorded on the moving magnetic tape 15 and then passed along to the reproducer magnets A . . . I. A portion of the speech originating in microphone 10 is diverted from the output of amplifier 52 via output transformer 53 including winding 54 and over lead 49 to the headset 14 so that the talking party can gauge the loudness of his speech input to the system via microphone 10.

The code boxes 18 and 19 permit cross-connections between any commutator segment and any reproducer magnet of each interlaced set so that as brush 17 sweeps over any given segment any preselected reproducer magnet can be connected at that time to the brush. By properly placing certain perforations in the code cards, as will be more fully explained later, the individual reproducer magnets A . . . I can be connected to the brush 17 in any order and at any given time in the cycle. Brush 17 is connected over lead 58, input transformer 60, amplifier 59, output transformer 61, and potentiometer 62 to radio transmitter 11. Amplifier 59 serves to amplify the scrambled speech.

Once each revolution of the brush 17, when it is in contact with short synchronizing commutator segment 20, the contacts 35 are closed. Since relay 29 is energized and therefore operated at this time, condenser 63 discharges through inductance 66 which forms a part of a filter also including condensers 67 and 68, and inductance 69. Condenser 63 was previously charged up from battery 64 through resistor 65. This filter generates a damped wave whose frequency is about 2000 cycles per second and which serves as the starting pulse above mentioned. One portion of the damped wave is applied through coil 69, 70, upper contact of relay 28, and filter 71 to the input of gas-filled tube 72. This tube breaks down on the first sufficiently large positive swing of its grid, and thereby causes the energization of tripping relay 30, Figs. 1 and 5, which releases the brush arm for another rotation. At the same time another portion of the damped wave is applied over lead 73 to amplifier 59 for transmission to the distant station.

Automatic volume control 75 serves to bias the

control grids of amplifier 52 and gas tube 72, varying as the level of the input varies, so as to maintain a substantially constant output level. The bias on the amplifier 52 controls the sensitivity of the gas tube 72, increasing or decreasing it as a function of signal level to maintain the time of release of the latch 31 independent of receiving level and to maintain the discrimination between signal and speech level approximately constant.

The system of Fig. 1 may also be used for sending tone telegraph by means of a key 37 when switching key 41 is thrown to the left. Tone for this purpose is derived from a pilot generator 34 driven from a motor 33. Side switch 38 associated with the telegraph key is closed to energize relay 32 when sending and is opened to deenergize relay 32 when receiving. The dot and dash telegraph signals are transmitted in scrambled form as in the case of transmitted speech.

When the talking party stops talking he releases button 12 thereby causing the system to revert eventually to the receiving condition. In due course relay 25 releases to reconnect lead 20 to the radio receiver 13 whereby incoming scrambled speech is now applied through primary winding 21 of input transformer 51 and amplifier 52 to the recording magnet R for recording on the magnetic tape 15. The reproducer magnets and commutator segments through the perforated code cards of code boxes 18 and 19 render intelligible the incoming scrambled speech. The intelligible speech is then applied through amplifier 59 and outer contact of deenergized relay 26 to headset 14.

In releasing, relay 29 disables the pulse generating circuit under control of cam operated contacts 35; and relay 28 connects secondary winding 36 of output transformer 53 of amplifier 52 to the 2000 cycle band-pass filter 71 so that the tripping tube 72 and relay 30 are placed under control of the 2000 cycle start pulses from the distant transmitting station. Band elimination filter 56 attenuates such pulses and thereby precludes them from reaching recorder magnet R.

Fig. 5 shows the tripping relay 30 arranged to prevent the release of latch 31 and thereby the brush 17 for another revolution, in the absence of starting pulse, in order to prevent false signaling by an enemy when the system of Fig. 1 is arranged for receiving normal speech. In Fig. 5 tripping relay 30, latch 31, brush 17 are shown together with relay 39 energized when the brush 17 is stationary and provided with contacts which shunt both radio transmitter 11 and receiver 14. Relay 39 is sufficiently slow so as not to close its contacts when brush 17 is stopped during normal operation. Speech can only be heard, therefore, if the brush 17 is operating normally. If the talking party fails to hear his own speech while he is talking he knows that his speech is not being transmitted. This could occur if the system fails for any reason to operate or if the brush 17 should accidentally fail to start but remains stationary for an abnormal time. The talking party is thus warned against sending out non-secret transmission and is enabled to distinguish between a received secret transmission and a false message.

Fig. 3 shows a single code box 18' employed with a ten-segment commutator 16' and nine-reproducer magnets A . . . I. The single code box 18' is constructed similarly to the individual code

boxes 18 and 19 of Fig. 1. In Fig. 4 there is illustrated a system whereby any number of stations can communicate with one another secretly by four-wire transmission. The circuit elements are identified in the drawings by the same reference characters as in Fig. 1, with prime works to indicate circuit elements that are required in duplicate. As two separate machines are required, this arrangement permits the use of a very great number of code combinations since the two codes used for transmitting can be entirely independent of the two codes used for receiving. The converse of the two codes used in the transmitting machine is set up on the receiving machine. The individual code boxes 18'' and 19'' are constructed similarly to code boxes 18 and 19. A complete description of the above may be had by referring to the copending application of F. G. Buhrendorf, supra.

In accordance with the present invention the interconnection of twenty commutator segments and nine reproducer magnets is controlled by code boxes 18 and 19, Fig. 1, each of which embodies a plurality of code cards formed with a plurality of perforations of suitable shape in two different sizes in accordance with a preselected code and arranged in stacked relation. In one illustration, for example, each code box included twenty code cards. Referring to Fig. 6, code card 80 is provided with ninety perforations arranged in ten vertical rows and nine horizontal columns. Each row corresponds to a commutator segment and each column to a reproducer magnet. Eight of nine perforations 123 in each row are of the same size, for example, $\frac{3}{16}$ inch x $\frac{1}{8}$ inch, and the ninth perforation 124 is of a smaller size, for example, $\frac{3}{32}$ inch x $\frac{1}{8}$ inch.

Each of eight horizontal columns contains one smaller perforation and the ninth column includes two smaller perforations. This is so for the reason that as nine reproducer magnets are to be connected to ten commutator segments of each interlaced set at least one reproducer magnet must be connected to two commutator segments. The preselection of codes is not influenced by the larger perforations but by the smaller perforations alone as will be pointed out hereinafter. The code card 80 also embodies a projection 81 on its upper right-hand edge and a tongue-like projection 82 substantially at the center of its left-hand edge. The functions of these projections will be mentioned later. The individual code cards are composed of a suitable electrical insulating material of proper dimensions which in one illustration comprises 20 mil phenol linen.

Code box 84, Fig. 7, comprises two complementary frames 85 and 86 arranged substantially in a U-shape so that its right-hand end is entirely open to allow the insertion of the individual code cards and its left-hand end is entirely closed except for a vertical center opening 87 which accommodates the tongue-like projections 82 of the individual code cards. The extreme right-hand end of the frame 85 embodies an L-shaped cutout portion 88 which receives the projections 81 of the individual code cards so as to insure the insertion of the individual code cards into the code box with the top side of the cards always up. The inner surfaces of the longitudinal sides of the frames 85 and 86 and the portions of both thereof in proximity of opening 87 are formed with recesses 89 to provide suitable spacing between adjacent code cards to permit their movement in a manner and for a purpose both of which will become apparent later.

Upper clamping member 90 and lower clamping member 91 maintain the frames 85 and 86 in assembled relation by machine screws 92. These project through suitable openings 93 in the upper clamping member 90 and frames 85 and 86, and are anchored in internally threaded openings 94 formed in the lower clamping member 91. Back plate 95 secured to the frames 85 and 86 by machine screws 96 encloses the code cards 80 within the code box 84. Referring to Fig. 8 it will be observed that a space intervenes between the right-hand edges of the code cards 80 in their normal position and the inner surface of the back plate 95. This is to permit sliding movement of the code cards in a manner that will be subsequently described.

Figs. 9, 10, 11 and 12 disclose a single code switching mechanism embodying ninety fixed electrical contacts 100 and ninety flexible contacts 101, one of which is associated with each fixed contact and flexed at one end by code cards 80 in a manner that will be subsequently described. Fig. 13 shows an electrically conductive member 98 formed with nine contacts 101 having their adjacent ends integral therewith and arranged in spaced relation in a vertical plane, and their opposite capable of being flexed and terminating in a horizontal plane. Thus the nine contacts 101 terminate effectively in a common contact 103. Each contact 101 includes on one surface a contact point 104 composed of a precious metal. Fig. 14 shows nine fixed contacts 100 having corresponding end portions mounted in spaced relation in a vertical plane in electrical insulating member 105. Thus approximately four-fifths of each contact 100 projects above the insulating member 105 and terminates in a horizontal plane and approximately one-fifth extends therebelow and terminates in a horizontal plane. Each contact 100 embodies on one surface a contact point 106 formed of a precious metal.

Ten contact assemblies of Figs. 13 and 14 are further assembled in alternate relation on a pair of elongated machine screws 107 which are vertically spaced at one end of the assembly as shown in Fig. 15. It is understood that a similar pair of screws is positioned at the opposite end of such assembly, Fig. 11. In Fig. 15 the extreme right-hand member 108 protects the extreme right-hand insulating member 105 from damage.

The assembly of Fig. 15 provides ninety fixed contacts 100 and ninety movable contacts 101, as will be seen more clearly later, arranged such that contact points 104 and 106 of the respectively associated contacts 101 and 100 are oppositely disposed and capable of engagement with each other.

Referring to Fig. 16, the associated pairs of contacts 100 and 101 comprise ten individual vertical rows and nine horizontal columns. As contacts 101 are longer than contacts 100, the former constitute ten vertical rows and nine horizontal columns which correspond to the previously described spacing of the perforations in the code cards 80. As hereinbefore pointed out, each vertical row of contacts 101 terminates in common contact 103, Figs. 11, 12, 13 and 15; and each contact 100 terminates individually in both rows and columns, Figs. 11, 12 and 14, except as hereinafter modified.

Figs. 17 and 18 show a U-shaped housing 109 having a cut-out portion 110 in each of its two horizontal side walls. This provides effectively the upper portion of support 109 with an upright

112 at each of four spaced points arranged in a rectangular manner. Each upright 112 contains a vertical recess 113 which terminates at its lowermost point in a shelf-like portion 114. Extending transversely of each of the horizontal side walls of housing 109 is a plurality of spaced grooves 115 arranged such that corresponding grooves in each side wall are oppositely disposed for a purpose that will appear subsequently. In the lower portion of front wall 116 of the housing 109 is a pair of vertically spaced and threaded openings 117 which pairs are horizontally spaced as shown in Fig. 18.

The contact assembly of Fig. 15 is mounted in the lowermost portion of the housing 109 as indicated in Figs. 9 and 12. To accomplish this, the extreme left-hand ends of the screws 107 are positioned in threaded openings 117 of housing 109. Also, each screw 107 is mounted in a tube 118 of electrical insulating material, Fig. 12. Positioned in each pair of aligned openings 115, Figs. 12 and 17, is an insulator strip 119 which serves normally to maintain associated contacts 100 and 101 of each pair out of engagement with each other, Figs. 15 and 16, and to control the movements of such contacts when engagement therebetween is being effected in a manner that will be presently explained. A cover 120, Figs. 9, 11 and 12, is pivoted on a pair of pins 121 secured by a drive fit in the uppermost portion of the two left-hand vertical uprights 112, Figs. 10 and 12.

The code box 84 assembled as shown in Fig. 7 is inserted in the housing 109, assuming cover 120 in Fig. 12 to be rotated 90 degrees in a counter-clockwise direction, by lowering vertically from a position thereabove. In arranging the code box for such insertion, the tongue-like projections 82 of the code cards 80 are disposed on the left, and the label "Top" on the code box is in its uppermost position. As the code box 84 is being lowered, the individual contacts 101 project into associated aligned openings of the code cards 80. This continues until the lowermost edges of the four corners of the code box are seated on the shelf-like portions 114, Figs. 10 and 12. Now the uppermost portions of all contacts 101 are disposed slightly above the top of the code box 84, and the uppermost portions of all contacts 100 are positioned slightly therebelow, Fig. 12.

The under surface of the cover 120 carries a pair of spaced gauges 122 which are arranged to seat on the uppermost surface of the code box 84, when the cover 120 is lowered and assuming the code box to be inserted properly into the housing 109. This enables the cover 120 to attain the position shown in Figs. 9, 11 and 12. However, when the code box 84 is improperly inserted into the housing 109, the gauges 122 will so engage the uppermost surface of the code box as to prevent the cover 120 from reaching the closed position, Figs. 9, 11 and 12. Such insertion will be immediately indicated to the operator who will then proceed to make whatever adjustment of the position of the code box is necessary in order to bring about the position of the cover 120 as shown in Figs. 9, 11 and 12.

When the code box 84 is properly inserted in the uprights 112 as shown in Fig. 12 at least eighty of the individual contacts 101 are out of engagement with the left-hand edges of the associated larger openings 123 of the code cards 80, Fig. 10, and at least ten of the individual contacts 101 are in engagement with the left-hand edges

of the associated smaller openings 124 of the code cards 80, Fig. 10.

In Figs. 11 and 12 a magnet coil 128 is suitably mounted at the center of the lower portion of the outer surface of the housing 109. Associated with this coil is the lowermost end of an armature 129 which extends upwardly in the form of a cross whose horizontal arms at their opposite ends are mounted on pivots 130. These are secured to a pair of spaced horizontal arms 131 formed integral with the respective horizontal sides of housing 109. The uppermost portion of the vertical section of the armature 129 terminates in a 90-degree portion 132 extending inwardly towards the housing 109.

In Figs. 12 and 19 a screw 134 has its threaded end portion accommodated in a threaded opening 135 provided in a 90-degree portion 132 whereby the screw 134 is vertically mounted thereon. On the upper end of screw 134 is positioned an angle member 136 whose function will be mentioned later. Immediately underneath this member is washer 137, and adjacent the opposite end of screw 134 is a further washer 138. Intermediate these two washers is a bearing 139 which is freely rotatable on screw 134. A drum 140 is rigidly secured to the bearing 139 for rotation therewith. Intermediate the lower end of drum 140 and above washer 138 is a ratchet wheel 141 secured to the drum for rotation therewith.

A flexible pawl 142, Figs. 12 and 19, is suitably mounted on the right-hand side of the front surface of the uppermost end of the vertical portion of armature 129, Fig. 11, so that its free end engages one tooth of the ratchet wheel 141. A flexible pawl 143 has its free end engaging another tooth of the ratchet wheel 141 and its opposite end secured to one side of angle iron 144. This is secured to a transverse member 145 extending between the extreme left-hand portions of the two left-hand vertical uprights 112, Figs. 10 and 12, and is suitably attached thereto. A coiled spring 146, Figs. 11 and 12, connects 90-degree portion 132 of armature 129 to a projection 147 formed integral with the mid-point of the uppermost portion of the front wall of framework 109.

A plurality of lugs 148 is spaced in helical fashion on the periphery of drum 140 such that individual lugs can be brought into alignment with individual code cards in code box 84 in a horizontal plane. The number of such lugs corresponds exactly with the number of code cards 80 included in the code box 84 so that one lug will be capable of engaging the tongue-like projection 82 of one associated code card 80 when the code box 84 is properly inserted in the U-shaped support 109. For example, in Fig. 12, lug 148' engages tongue-like projection 82' on code card 80' and actuates this particular code card in a right-hand direction. The larger openings 123 of code card 80' do not affect the positions or movements of the springs 101 projecting therethrough. However, the code card 80' at the left-hand edge of its smaller openings 124, flexes in a right-hand direction. the upper ends of the associated contacts 101 projecting therethrough and engaging therewith until the contacts 101 engage the contacts 100 associated therewith. Thus a circuit associated with each pair of engaging contacts 100 and 101 is completed for a purpose that will become apparent later. As at least ten smaller openings are contained in each code card 80', this means that at least 10 discrete circuits will be completed.

When it is desired to complete circuits in ac-

cordance with the smaller perforation 124 of the next succeeding code card in the code box, the magnet coil 128 is energized from a suitable source of electrical current, not shown. This causes armature 126 to rotate in a counter-clockwise direction about its double pivots 130, against the force of coiled spring 146. This, as shown in Fig. 12, causes lug 143' to be withdrawn from engagement with tongue-like projection 82' of code card 80'. Thereupon, code card 80' is caused to return to its normal position in code box 84' under the influence of the force exerted by the ten contacts 101 engaging the left-hand edge of the smaller openings 124 in code card 80'. At the same time pawl 143 actuates the ratchet wheel 141 in a clockwise direction, Fig. 10, and thereby the drum 140 in the same direction, or both of them in a counter-clockwise direction in Fig. 19, to bring the next succeeding lug into alignment with the tongue-like projection of the next succeeding code card. Pawl 142 engages the next succeeding tooth of ratchet wheel 141 to prevent further rotation of the drum 140 as armature 129 is rotated in the counter-clockwise direction. Fig. 19 shows the position of ratchet wheel 141 in its normal position, either after or before it has been stepped; and Fig. 20 shows the position of the ratchet wheel 141 after being stepped once but is not yet returned to its normal position of Fig. 19.

When the energizing current for magnet coil 128 is interrupted, coiled spring 146 moves the armature in a clockwise direction to return the drum 140 to its normal position. Now, the next succeeding lug engages the next succeeding code card to move the latter to the right to accomplish the completion of ten further electrical circuits in the manner above explained regarding lug 148' and code card 80'. This operation may be repeated as often as desired so that each code card in the code box may be used one or more times. In connection with the helical spacing of the lugs 148 on the periphery of drum 140, it will be understood that such spacing is so arranged that the lug associated with the top code card in the code box comes into operative position after the lug associated with the last code card in the code box has been operated. This permits a continuous selection of successive code cards. Obviously, such selection may commence and terminate with a preselected code card.

Fig. 21 shows an arrangement for preventing damage to the tongue-like projections 82 on the individual code cards 80 by at least one lug 148 on the drum 140 scraping along such projections as the code box 84 is being inserted into the U-shaped support 190 and/or removed therefrom. Such arrangement comprises angle member 136 positioned on top of drum 140 with its vertical portion in proximity of cover 120 but not in engagement therewith when the code box 84 is properly inserted in housing 109 as shown in Fig. 12. However, when the code box 84 is to be removed, the cover 120 is rotated 90 degrees to the position illustrated in Fig. 21 at which position the inside surface of cover 120 engages both left-hand uprights 112. When necessary the inside of cover 120 can be built out by a liner 150 of appropriate thickness in proximity of each upright 112. In Fig. 21, cover 120 engages angle iron 136 in such manner as to tilt drum 140 in a counter-clockwise direction and thereby to disengage one of its lugs 148 from the tongue-like projection 82 of one of the code cards 80 in the code box 84. This obviates the danger of damage to the tongue-like projections on all code cards as the code box is raised and lowered in housing 109.

In the operation of Fig. 1, it will be understood that the individual code boxes 18 and 19 are provided in accordance with the switching mechanism of Figs. 2 and 6 through 21, and that the same or a different combination of code cards 80 arranged in the same or a different relation is embodied in each of the code boxes. Referring to Fig. 1, it is indicated that, for the purpose of this explanation, stacks of code cards 80 and 80'' are embodied in code boxes No. 1 and No. 2 respectively. In Fig. 1, for simplicity, code cards 80 and 80'' from respective code boxes No. 1 and No. 2 are shown in their operated positions after being actuated, by lugs 148 on drum 140 in the manner previously explained in left-hand directions as indicated by the arrows at the lower edges of both code cards 80 and 80''.

In Fig. 1 individual commutator segments 1 through 20 are connected to terminals 103 each of which comprises an integral part of conductive member 98, Fig. 13. Thus, each vertical bar 98 in both code boxes embodies ten electrical contacts 101. Also, in Fig. 1, each horizontal column of each code box includes nine individual contacts 100, Fig. 14. A lead 150 connects individual reproducer magnets A . . . I to all contacts 100 in one of the horizontal columns of such contacts. The actual connection of the reproducer magnets and commutator segments through the contacts 100 and 101 will be clear from the diagrammatic illustration in Fig. 2, in which the brush arm 17 and magnetic tape 15 are connected by a shaft 79 for driving them.

As the coding is influenced only by the smaller perforations 124 only in the code cards as previously mentioned, engagement is effected in Fig. 1 between the precious metal contacts 104 and 106 of ten pairs of engaging contacts 101 and 100 respectively, in each of code boxes 18 and 19 as schematically illustrated by the solid dots. In Fig. 1 each reproducer magnet A . . . I is connected to at least one odd numbered commutator segment and at least one even numbered segment, and at least one reproducer magnet is connected to two different odd numbered segments and another reproducer magnet is connected to two even numbered segments as indicated in the following table. This is generally illustrated in Fig. 2 with reference to code box 19 shown in Fig. 1, as above mentioned.

Commutator segment	Reproducer magnet
1	A
2	C
3	H
4	F
5	E
6	B
7	G
8	D
9	C
10	A
11	F
12	E
13	A
14	H
15	B
16	D
17	I
18	I
19	D
20	G

Obviously, one code box can be employed in Fig. 3, and four code boxes in Fig. 4.

Fig. 22 shows a code card selector adapted for

manual operation, and is similar to the electrical code card selector of Fig. 12 except the magnet coil 128 and the lower portion of the armature 129 associated therewith are eliminated, and in their places is substituted a finger grip 151 mounted on the top of drum 140. This grip enables manual performance of the same function as that achieved by the magnet coil and armature operated thereby. Obviously, as in the case of Fig. 28, two or more code changing drums could be stepped by a single finger grip, or a single magnet coil and armature for that matter.

Figs. 23, 24 and 25 show a code card selector operated by a clock mechanism, otherwise the arrangements of these figures are identical with those illustrated in Fig. 12. Referring to Figs. 23, 24 and 25 a clock mechanism 155 is connected to shafts 156 and 157 such that shaft 156 is continuously urged to rotate in a counterclockwise direction as indicated by the arrow but is permitted to rotate intermittently under control of a braking cam 158 which is keyed to the shaft 156 and whose operation will be described later, and such that the shaft 157 is slowly rotated in a clockwise direction at a predetermined speed. The shafts 156 and 157 are driven by suitable coiled springs, not shown, embodied in the clock mechanism 155 and operating in the familiar manner. Wing nut 159 serves to wind such springs in the clock mechanism.

A U-shaped member 160 pivoted at 161 is disposed substantially in a vertical position, and embodies oppositely disposed vertical projections 162 and 163 engageable with braking cam 158, and oppositely disposed vertical projections 164 and 165 engageable with code changing cam 166 on shaft 157. Also mounted on this shaft but in an eccentric manner is a cam 167. Engageable with substantially diametrically opposite portions of cam 167 are the adjacent free ends of a pair of leaf springs 168 and 169 whose opposite adjacent ends are fixedly mounted in U-shaped member 160 but on opposite sides of the pivot 161. A gear 170 mounted on shaft 156 engages gear 171 mounted on shaft 172 on which member 173 is eccentrically mounted.

A collar 174 slidably positioned on eccentric member 173 is formed with an integral vertical projection 175 which terminates in a cylindrical portion 176, Fig. 23, provided with coaxial integral shaft portions 177 and 178*a*, Fig. 26. These portions extend coaxially from the opposite sides of portion 175. Rotatably disposed on the free ends of the shaft portions 177 and 178*a* is the bifurcated end of a member 179*a*, Fig. 26, pivoted at 121 and carrying drum 140, Fig. 24. This, as in the case of drum 140 in Figs. 12 and 22, carries a plurality of spirally disposed lugs 148, a ratchet wheel 141 and pawls 142 and 143 associated therewith.

In the operation of Figs. 23, 24 and 25, the clock mechanism 155 is arranged such that the shaft 157 rotates cam 166 through 180 degrees during a preselected period of time. This causes the certain lug 148′ on drum 140 to select the code card 80′ in code box 84 to perform a switching operation in the manner and for the purpose described hereinbefore in connection with Fig. 11. For example, the clock mechanism 155 can be adjusted to obtain a change of code cards 80 every fifteen or thirty minute period or other period, longer or shorter, as desired.

Referring to Figs. 24 and 27A, a U-shaped member 160 is shown in the position resulting

from its next previous operation due to cams 166 and 167 attaining certain rotary positions under control of clock mechanism 155 which is about to effect another operation of U-shaped member 160. The free end of leaf spring 168 is flexed and under tension due to its resting substantially on the highest peripheral portion of cam 167 relative to pivot 161 while leaf spring 169 is entirely disengaged from the latter cam. The force of the flexed leaf spring 168 tends to urge U-shaped member 160 in a clockwise direction but is precluded from doing so because its projection 165 is still resting on the higher peripheral surface of cam 166.

As the clock mechanism 155 rotates cam 166 to the position shown in Fig. 27B, projection 164 is just raised to the higher peripheral surface of cam 166, and projection 165 is just dropped to the lower peripheral surface of cam 166. This permits flexed leaf spring 168 to rotate U-shaped member 160 in a clockwise direction on its pivot 161. This disengages projection 162 from face 181 of cam 158 whereupon shaft 156 is permitted to rotate in a counter-clockwise direction and carry gear 170 with it in the same direction. This gear rotates gear 171 in a clockwise direction as indicated by the arrow which rotation also moves shaft 172 in a clockwise direction. Now, eccentric member 173 is rotated in a clockwise direction in the collar 174. This causes a substantially downwardly vertical movement of both projection 175 and its terminating cylindrical portion 176 whose shaft portions 177 and 178*a* allow the bifurcated end portion of member 179*a*, Fig. 26, to rotate thereon. The member 179*a* is now rotated in a counter-clockwise direction on its pivot 121 to move drum 140 away from the code box 84 in a vertical plan. This causes pawl 143 to actuate ratchet 141 and thereby rotate drum 140 in a plane perpendicular to such vertical plane until the next succeeding lug 148 is presented for engagement with the next succeeding code card 80 in code box 84 as hereinbefore explained regarding Figs. 12, 19 and 20.

Shaft 156 in Fig. 24 is permitted to rotate until face 181 of cam 158 engages projection 163 of U-shaped member 160 whereupon further rotation of shaft 156 is arrested. Due to a ratio of 2 to 1 between the number of teeth of gears 170 and 171, these gears are rotated by the rotation of shaft 156 until the cylindrical portion 176 carrying the shaft portions 177 and 178*a*, Fig. 26, attains its lowermost vertical position and thereafter is returned to the normal position shown in Fig. 24. During the time required for such movement of cylindrical portion 176, the member 179*a* is rotated in a counter-clockwise direction in a vertical plane to step the drum 140 one step, and thereafter in a clockwise direction in the same vertical plane to return the drum 140 to the normal position of Fig. 24, and thereby to move the next succeeding code card in a horizontal plane as previously pointed out.

As clock mechanism 155 continuously rotates shaft 157, cams 166 and 167 are also continuously rotated until they attain the positions shown in Fig. 27C at which the U-shaped member 160 is about to be operated again. Now the free end of leaf spring 169 is flexed and under tension due to its resting substantially on the highest peripheral portion of cam 167 relative to pivot 161 while leaf spring 168 is completely disengaged from this cam. The force of flexed leaf spring 169 tends to urge U-shaped member 160 in a counter-clockwise direction but is prevented from so doing

because its projection 164 is still resting on the higher peripheral surface of cam 166.

As clock mechanism 155 rotates cam 166 to the position illustrated in Fig. 27D, projection 164 is just lowered to the lower peripheral surface of cam 166 and projection 165 is just raised to the higher peripheral surface of cam 166. This permits flexed leaf spring 169 to rotate U-shaped member 160 in a counter-clockwise direction to the position shown in Fig. 24. This disengages projection 163 from face 161 of cam 158 whereupon shaft 156 is permitted to rotate in a counter-clockwise direction until face 161 is engaged by projection 162. This enables gears 170 and 171 to cause drum 140 to rotate another step to present its next succeeding lug 148 for engagement with the next succeeding code card 80 in code box 84 as previously described.

Figs. 28, 29, 30, 32 and 34 show a unitary switching mechanism embodying both code boxes Nos. 1 and 2 of Fig. 1, each of which comprises a code box 84, Fig. 7, assembled with a plurality of stacked individual code cards 80, Fig. 6, and ninety U-shaped flexible contacts 184 and ninety slidable contacts 185, Fig. 31. The contacts 184 and 185 are associated in pairs arranged in ten vertical rows and nine horizontal columns, Fig. 30. In Figs. 30 and 31 the nine contacts 184 in each vertical row have their corresponding ends connected in spaced relation to one conductive bar 186, their U-shaped portions positioned in appropriate perforations provided in a plurality of horizontally spaced insulating cards 183, and their free ends, including their precious metal contact points 179, disposed in engageable relation with respect to precious metal contact points 178 on the uppermost ends of contacts 185 which are maintained in such relation by other perforations in the cards 183. Thus, there are ten vertical bars 186, each having nine space contacts 183, which are equivalent in both function and number to the conductive members 98 of Figs. 10, 12 and 15; and one card controlled contact 185 associated with each contact 184, each contact 185 being equivalent in both function and number to the contacts 100 of Figs. 10, 12 and 14. However, there is this difference that in Figs. 28, 29, 30, 32 and 34 the contacts 184 are relatively fixed in position, moving only to the extent permitted by their flexible structure, and the contacts 185 are card controlled in their movements in so far as engagement with their associated contacts 184 is concerned. The manner of effecting such engagement will be discussed in detail hereinafter. In Fig. 30 it will be understood that each vertical bar 186 is connected to one terminal 103 associated with individual comutator segments and each horizontal column of contacts 185 is connected by each lead 150 to individual reproducer magnets as shown in Fig. 1.

Referring to Figs. 28, 29, 30, 32 and 34, a pair of spaced angle-like base members 187 and 188 support four angle elements 189 in upright positions in spaced relation. To the outer faces of the two left-hand members 189 in Figs. 30, 32 and 34 a cover plate 190 is suitably attached; and to the upper portions of the inside surfaces of each of the left-hand and right-hand pairs of members 189, Figs. 28 and 29, is horizontally secured a pair of oppositely disposed angle members 191 and 192. Intermediate these two pairs of members 191 and 192 is horizontally positioned a pair of oppositely disposed T-shaped members 193 and 194, Fig. 29. The members 191, 192, 193 and 194 support code boxes Nos. 1 and 2, when

they are properly inserted in the arrangement shown in Fig. 29. A spring clip 195 having one end suitably attached to each of members 191, Figs. 29 and 34, and the opposite end free to engage the outer ends of individual code boxes serves to retain them in position. Each opposite end of each clip 195 is provided with a suitable finger grip, not shown, to enable an expeditious operation thereof.

In Figs. 29, 30, 32 and 34, a plate 196 is positioned against the outer surface of a pair of elongated insulator blocks 197, 197 each of whose opposite surfaces is disposed substantially at the mid-portions of the outer faces of one of the two right-hand upright members 189. A plurality of screws 198 support this plate and associated blocks on the two right-hand members 189, 189. The plate 196 is provided with a pair of elongated openings 199, 199 spaced in parallel relation for a purpose that will subsequently appear.

In Figs. 35 and 36, the ninety movable contacts 185 are arranged such that nine contacts are disposed in nine vertically parallel grooves 200 formed in individual phenol fiber strips 201, and each contact 185 is held in place by a transverse pin 202. Thus, the contacts 185 are arranged such that nine of them are in spaced relation in each of ten vertical rows so as to correspond in number and position substantially with the contacts 184, Figs. 30 and 31. The contacts 185, strips 201, and pins 202 are assembled in a unitary structure 182 between end plates 203 and 204 by means of a plurality of bolts 205. End plate 203 has an integral vertical projection 206, Fig. 40, at the mid-point thereof for a purpose that will be explained later. In Fig. 36 it will be noticed that the individual contacts 185 project slightly below the underface of the fiber strips 201 and terminate in a horizontal plane for the purpose of attaching leads, not shown, thereto and project above the upper surface of the fiber strips 201 to an extent that will be subsequently identified and terminate in a horizontal plane.

In Figs. 30, 35 and 36, a member 212 attached rigidly to end plate 204 by machine screws 213 is positioned for slidable movement in a guide member 214 which is rigidly attached to the plate 196 by a plurality of machine screws 215. A rack 216 is firmly secured to the slidable member 212 by machine screws 217. At this point it should be understood that one contact assembly 182, Figs. 35 and 36, is utilized for each of code boxes Nos. 1 and 2 in Figs. 1 and 30. In Figs. 29, 30, 35 and 36, a pair of pinions 217, 217 are so spaced on a shaft 218 that corresponding peripheral portions project through openings 199 to engage certain teeth thereof with certain teeth of the rack associated with the respective contact assemblies 182. Both pinions are keyed to the shaft 218 which is rotatably supported at its opposite ends in a pair of bearings 219, 219 suitably secured to the inside surfaces of the right-hand ends of a pair of transverse members 220, 220. These are secured to the upper and lower pairs of angle members 189 at a point which is immediately below the mid-points thereof.

In Figs. 29, 30, 32 and 34 a finger grip 221 is keyed to shaft 218 at a point which is slightly spaced from the right-hand side of the left-hand pinion 217. Adjacent the right-hand side of finger grip 221 on shaft 218 and keyed thereto is a collar 222 formed integrally with a locking cam 223 on whose immediate right-hand side is a finger grip 224 rotatably mounted on shaft 218. This finger grip is rigidly attached to a block

225 which is also rotatably mounted on shaft 218 and which has immediately adjacent thereto on its right-hand side a collar 226 rigidly attached to shaft 218 for restricting the rotation of finger grip 224 substantially to the same vertical plane. Directly to the rear of locking cam 223 and suitably attached to the outer surface of plate 196 at a point thereabove is a member 227, Figs. 29 and 39, formed with a bifurcated portion 228, Fig. 30, in which is pivoted the top of an elongated member 229 extending downwardly and formed with an integral projection 230, Fig. 39, located at a point just below the mid-point thereof and extending in the direction of locking cam 223. At the rear of the lowermost portion of the member 229, Fig. 39, is the upper end of a leaf spring 231 whose opposite end is rigidly anchored in the plate 196. As shown in Figs. 38 and 39, the opposite end of finger grip 224 is formed with spaced integral angle portions 232 and 233 engageable with the member 229 for a purpose that will later appear.

Figs. 29 and 32 show the contact assembly 182 elevated to its uppermost position such that the uppermost ends of individual contacts 185 are disposed oppositely to corresponding portions of associated contacts 184, Figs. 30 and 31. Accordingly, the individual contacts 185 project through the vertically aligned openings in the code cards of each of the code boxes, Nos. 1 and 2, which are understood to be inserted in the switching mechanism in a manner that will be subsequently explained, and which are held therein by the respective locking springs 195. As shown in Fig. 29 each code box is supported between associated angle members 191 and 192 and portions of T-shaped members 193 and 194. The finger grips 221 and 224 occupy the relative positions shown in Fig. 39A so that the slidable members 212 carrying their associated racks 216 have been actuated by the respective pinions 217 under control of finger grip 221 to occupy their uppermost positions as shown in Fig. 29. Both contact assemblies 182 are locked in their uppermost positions as shown in Fig. 39A in which face 234 of locking cam 223 engages the upper surface of projection 230 of pivoted member 229 which is being urged in a counter-clockwise position by the leaf spring 231. Such engagement of the locking cam 223 and member 229 precludes counter-clockwise rotation of shaft 218 which directional rotation, as will be pointed out presently, is necessary to effect any lowering movement of the contact assemblies 182. Accordingly, the contacts 184 and 185 are maintained in engageable position under control of the code cards regardless of shocks or similar abrupt movements in which the switching mechanism might be involved.

The replacement of the particular code boxes now inserted in the switching mechanism with other code boxes can be accomplished as follows. Both grips 221 and 224 are grasped by the fingers on one hand and squeezed together, whether the direction of movement of the contact assemblies 182 is to be up or down. The first movement, which is that of grip 224, causes projection 233 on grip 224 to engage the lowermost portion of pivoted member 229, Fig. 39A, and tend to move the latter in a clockwise direction on its pivot. As the member 229 is rotated, it disengages its projection 230 from face 234 of locking cam 223 so that the shaft 218 can now be rotated in a counter-clockwise direction under control of finger grip 221. Since one lug 235' on each card selecting drum 236 is normally engaging one code card in one of the code boxes as shown in Fig. 32,

it is necessary to move these drums away from the respective code boxes, that is, in a counter-clockwise direction before the lowering movement of the contact assemblies 182 is commenced. Referring to Fig. 32, the lowermost portion of clamping plate 203 of the contact assembly 182, Fig. 36, engages the uppermost portion of a beveled end portion 237 formed on a member 238 whose opposite end is formed integral with the support 207 for code card selecting drums 236. This support is pivoted on a shaft 239 and will be more fully described subsequently.

As the shaft 218 is being rotated in a counter-clockwise direction by the same rotation of finger grip 221 to commence the lower movement of both contact assemblies 182, plate 203 sliding on beveled portion 237 moves the member 238 in a left-hand direction, Fig. 32, and thereby causes the disengagement of card selecting drums 236 from code cards. Further rotation of shaft 218 in the counter-clockwise direction causes both pinions 217 to move in the counter-clockwise direction and thereby lower their racks 216 associated with the respective pinions. This causes both members 212 to slide downwardly in their respective guides 214 and carry both contact assemblies 182 therewith. This continues until a clicking sound indicates the engagement of face 240 of locking cam 223 with the undersurface of projection 230 on the pivoted member 229 which is being urged in counter-clockwise direction by spring 231 whereupon the shaft 218 is firmly locked in such position, Fig. 39C. Now the finger grips 221 and 224 occupy the relative positions shown in Fig. 39C. As shown in Fig. 34, the uppermost ends of individual contacts 185 carrying the precious metal contact points 178 lie slightly above the uppermost surface of a pair of spaced insulating cards 241; and vertical projection 206 on clamping plate 203 engages the lowermost portion of beveled edge 237 of member 238, which has been actuated in a left-hand direction as above mentioned, and thereby maintains the card selecting drum 238 out of engagement with the code cards. In Fig. 34, the uppermost ends of contacts 185 and rack 216 are sufficiently below the lowermost surfaces of the code boxes, Nos. 1 and 2, so as to enable horizontal sliding movements of the individual boxes out of and into the respective supporting members 191, 192, 193 and 194, after suitable actuation of clips 195, Fig. 29.

The contact assembly 182, Figs. 35 and 36, can be elevated to its uppermost position after the code boxes have been locked in position in the switching mechanism by the respective springs 195, by squeezing together both finger grips 221 and 224 which now occupy the initial relative positions shown in Fig. 39C. In Fig. 39D the first movement of grip 224 causes projection 232 thereof to engage an upper portion of pivoted member 229 and tend to move it in a clockwise direction on its pivot. This disengages projection 230 from cam face 240 so that the shaft 218 can now be rotated in a clockwise direction under control of finger grip 221. Such rotation of the shaft 218 moves both pinions 217 in a clockwise direction thereby actuating the respective racks 216 and associated members 212 in an upward direction until a clicking sound indicates the engagement of cam face 234 with the upper surface of projection 230, Fig. 39A, whereupon the shaft 218 is locked in such position. Now finger grips 221 and 224 occupy the relative positions shown in Fig. 39A.

In Figs. 28 and 32 the lower end of each support 207 for individual card selecting drums 236 is bifurcated, and the ends of both legs applied to shaft 239 for rotation thereon. Intermediate these two legs is a spring 245 coiled on the shaft 239 and having one end held rigidly at a point 246 on the plate 190 and its opposite end engaging one leg of support 207. The effect of such spring is to urge the support 207 in a clockwise direction. Extending vertically upwardly from the upper end of support 207 is a shaft 247 which has its lower end rigidly attached thereto and the portion in proximity of its upper end arranged to support in a rotatable manner, which will be presently explained, one card selecting drum 236. A link 248 connects the uppermost ends of both shafts 247, and the mid-point thereof carries a finger grip 249. To the under surface of each cord selecting drum 236 is connected one end of a sleeve 250 mounted rotatably on the shaft 247 and joined at its opposite end to a ratchet wheel 251 which is also rotatably mounted on the shaft 247. Thus, each card selecting drum 246, and associated sleeve 250 and ratchet wheel 251 are rotatable as a unit on the shaft 247. Directly below both ratchet wheels 251 and at the center of plate 190 is mounted an angle member 252 whose outer end carries a transverse member 253 provided at each of its opposite ends with a fixed pawl 254. Substantially in horizontal alignment with each ratchet wheel 251 are a pair of equal openings 255, 255 separated by a strip 256 formed in the plate 190, Figs. 33 and 37. Each pawl 254 and strip 256 associated therewith is slightly offset along a diagonal for the purpose of stepping each ratchet wheel 251 and thereby each card selecting drum 236 associated therewith in preselected equal amounts of rotary movements that will now be explained.

The periphery of each drum 236 is provided with a plurality of helically disposed and equally spaced lugs 235 which serve to move individual code cards for effecting such combination of commentator segments and reproducer magnets, Fig. 1, from a time delay standpoint in the manner hereinbefore explained regarding drum 140 and associated lugs 148, Fig. 12. When it is desired to select the next succeeding code card in both code boxes, the operator places the appropriate fingers of one hand on the handle 249, Figs. 28 and 32, and rotates both supports 207 in a counterclockwise direction on shaft 239. This rotation is continued until the uppermost portions of the beveled faces of corresponding teeth in both ratchet wheels 251 engage respective pawls 254, and such faces slide therealong until both pawls 254 are lodged in the respective slots intervening between that particular ratchet tooth and the next succeeding ratchet tooth to arrest the counter-clockwise rotation of both supports 207. During the time interval that both beveled faces were sliding along the fixed pawls 254, a predetermined amount of rotary movement was imparted to both card selecting drums 236. Now the finger grip 249 is released and both supports are rotated in a clockwise direction under the influence of the respective springs 245, Fig. 28, until the uppermost portions of the beveled faces of corresponding teeth in both ratchet wheels 251 engage the strips 256 and such faces slide along the respective strips 256, Fig. 33, which are effectively pawls, until both these strips are disposed in the respective slots between the particular ratchet tooth and the next succeeding ratchet tooth whereupon the clockwise rotation of both supports 207 is terminated. During the time interval that the beveled faces were sliding along the fixed strips 256, a further predetermined amount of rotary movement was imparted to both card selecting drums 236. The sum of both such predetermined amounts of rotary movement is just sufficient to move the next succeeding lug 235 or both card selecting drums 236 to engage the next succeeding code cards in the respective code boxes, Nos. 1 and 2 in Fig. 29.

What is claimed is:

1. In combination in apparatus for interconnecting signal circuits under control of a plurality of discrete cards perforated in accordance with preselected codes, a source of signals, a first group of circuits connected in a fixed manner to said signal source, a transmission line, a second group of circuits connected in a fixed manner to said line, and switching means for varyingly interconnecting said first and second circuit groups to cause the signals to be applied to said second circuit group and thereby to said line in an order which is different from the order in which the signals appear in said first circuit group, comprising a plurality of cards each of which embodies perforations of two different sizes arranged in accordance with a preselected code, a plurality of normally opened pairs of contacts connected to both said first and second circuit groups and associated operatively with the perforations of said cards, and means for selecting discrete cards and causing them to close different groups of said contacts in accordance with the smaller perforations of each card and thereby to interconnect changeably said first and second circuit groups for varying the order in which said signals are applied to said line.

2. In combination in apparatus for interconnecting signal circuits under control of a plurality of discrete cards perforated in accordance with preselected codes, a source of signals, a first group of circuits connected in a fixed manner to said signal source, a transmission line, a second group of circuits connected in a fixed manner to said line, switching means for changeably interconnecting said first and second circuit groups to cause the signals to be applied to said second circuit group and thereby to said line in an order which is different from the order in which the signals appear in said first circuit group, comprising a plurality of normally opened pairs of contacts connected to said first and second circuit groups and having a number equal to the product of the number of circuits of said first group multiplied by the number of circuits of said second group, means formed with a plurality of groups of perforations, each of which groups has at least a number of perforations equal to the number of circuits in said second group and arranged in accordance with a preselected code for selectively closing certain pairs of said contacts and thereby changeably interconnecting said first and second groups to vary the order in which the signals are applied to said line, and means for selecting individual perforation groups and causing them to close said certain pairs of contacts.

3. In a signal system, a signal circuit, means for recording signals on a moving medium, reproducers spaced along said medium and a rotary distributor comprising a plurality of segments and having a brush moving over said segments for connecting said reproducers individually to said circuit, the combination of such system with

means for varying the order of connecting said reproducers to said segments, comprising a plurality of normally opened pairs of contacts connected to said reproducers and said segments and having a number equal to the product of the number of said reproducers multiplied by the number of said segments, means having a plurality of groups of perforations, each of which groups has a number of perforations equivalent at least to the number of said segments and arranged in accordance with a preselected code, for selectively closing certain pairs of said contacts and thereby varying the order of connecting said reproducers to said segments, and means for selecting each perforation group and causing such group to close said certain pairs of contacts.

4. In a signal system including a signal circuit, means for recording signals on a moving medium, reproducers spaced along said medium, and a rotary distributor comprising a plurality of segments and having a brush moving over said segments for connecting said reproducers individually to said circuit, the combination of such system with means for varyingly connecting said reproducers to said segments, comprising a plurality of cards each of which embodies a group of perforations of two different sizes of which the smaller ones are distributed in accordance with a preselected code arranged in stacked relation such that corresponding perforations of each group are in vertical alignment, a pair of normally opened contacts associated with each perforation such that one contact projects through the aligned perforations of each group, certain of said one contacts being actuated to engage the other contacts associated therewith in the same pairs in response to the displacement of the group of smaller perforations of each card for effectively connecting individual reproducers to said distributor segments in the sequence of the preselected code when each card is moved a predetermined distance relative to the other cards in the stack, and means for selecting individual cards in the stack and moving them the predetermined distance.

5. The secrecy system specified in claim 4 in which said rotary distributor comprises a plurality of interlaced sets of segments and said connecting means is individual to each interlaced set of segments so that any reproducer can be connected to any distributor segment in each set thereof.

6. In combination with a speech privacy system comprising means to record speech signal waves upon a suitable record medium, speech reproducers spaced along said medium, a rotary distributor arranged with a plurality of groups of segments, a first group of conductors, each of which is connected to one of said reproducers, and a plurality of groups of additional conductors each of which groups is connected to one segment group such that individual additional conductors are connected to individual segments, means individual to each group of segments for connecting any first conductor to any additional conductor in each group thereof, comprising a plurality of normally opened pairs of contacts each of which pairs has one contact connected to one additional conductor and the other contact connected to one first conductor, means for causing engagement between certain pairs of said contacts and thereby connecting any first conductor to any additional conductor in accordance with preselected codes, comprising a plurality of groups of perforations of a predetermined size each of which

groups has a number of perforations equivalent to the number of additional conductors in one group thereof and is arranged in accordance with a preselected code for closing the certain pairs of contacts whereby any first conductor can be connected to any additional conductor, and means for selecting individual perforation groups and causing such groups to close said certain pairs of contacts.

7. In combination with a speech privacy system comprising a transmission circuit, means for recording speech waves upon a suitable medium, reproducers spaced along said medium for dividing the speech waves into fragments, a rotary distributor comprising a plurality of segments arranged in interlaced sets and having a brush moving over the segments for applying the speech fragments with different amounts of time delay to said transmission circuit, a circuit connected to each distributor segment in each interlaced set, and a circuit connected to each reproducer, a switching mechanism associated with each interlaced set of distributor segments for controlling the connection of any of said reproducer circuits to any of said distributor segment circuits of each interlaced set, comprising a plurality of normally opened pairs of elongated contacts of two different lengths of which pairs each longer contact is connected to one of said distributor segment circuits and each shorter contact is connected to one of said reproducer circuits, said contact pairs being arranged in a plurality of similar rows one for each distributor segment and a plurality of other similar rows one for each reproducer, a plurality of cards each of which is formed with spaced perforations of two different sizes for accommodating said longer contacts, the smaller perforations in each card being intermingled with the larger perforations in accordance with a preselected code and having a number equal to the number of distributor segments in one interlaced set, said cards being arranged in a stack with corresponding perforations in vertical alignment and disposed on the longer contacts such that each longer contact projects through one vertical alignment of perforations and such that each longer contact substantially touches each card at the smaller perforations and is flexed to engage its associated shorter contact when each card is moved a certain distance relative to the other cards in the stack and thereby to close the respective contact pairs for connecting any of said reproducer circuits to any of said distributor segment circuits of each interlaced set in accordance with the preselected code of smaller perforations, and means for selecting individual cards and moving them the certain distance.

8. The combination according to claim 7 in which said selecting and moving means comprise a magnet coil, an armature pivoted substantially at its mid-point and having one end operatively associated with said magnet coil, a drum rotatably mounted on the opposite end of said armature and positioned in proximity of said perforated cards, a plurality of lugs disposed helically on the periphery of said drum and spaced such that each lug can be disposed in horizontal alignment with one perforated card, a ratchet and pawl arrangement operatively associated with said drum for rotating said drum in equal steps so that each lug is disposed in alignment with one card upon each successive energization and deenergization of said magnet coil.

9. The combination according to claim 7 in

which said selecting and moving means comprise a member pivoted on a horizontal axis, a drum rotatably mounted on one projection of said member and positioned in proximity of said perforated cards, a plurality of lugs disposed helically on the periphery of said drum and spaced such that each lug can be disposed in horizontal alignment with one perforated card, a ratchet and pawl arrangement for rotating said drum in individual steps each of which is equal to the amount required for disposing each lug in alignment with individual perforated cards, and a clock-operated device connected to another projection of said member for rotating said member on its pivot at preselected time intervals and thereby causing said pawl and ratchet to rotate said drum in the individual steps.

10. In a two-way privacy system for signals including a signal receiver, a signal transmitter, means for applying signals in scrambled fragments to said transmitter, means for unscrambling the scrambled signal fragments received by said receiver, said scrambling and unscrambling means including a common rotary distributor comprising a plurality of sets of interlaced segments and having a brush moving thereover, means for recording signals on a moving magnetic tape and reproducers spaced along said tape, the combination of such system with a switching mechanism connected to each interlaced set of distributor segments for varying the sequence with which signal fragments from said tape are supplied to said brush, comprising a plurality of pairs of normally opened elongated contacts arranged in vertical and horizontal rows, one contact of each pair being longer than the other, circuit means for connecting the longer contacts of each vertical row to one distributor segment, other circuit means for connecting the shorter contacts of each horizontal row to one reproducer, a plurality of cards formed with perforations of at least two different sizes each of which cards embodies the smaller perforations in number equivalent to the number of distributor segments in one set thereof, said perforations being arranged in a plurality of vertical rows corresponding to the vertical rows of said longer contacts and accommodating said longer contacts therein, said cards being stacked on the uppermost ends of said longer contacts such that the top card at least aligns with the uppermost ends of the longer contacts and the bottom card lies above the uppermost ends of the shorter contacts and such that the longer contacts substantially engage each card in proximity of the smaller perforations and is flexed by each card to engage the shorter contact associated therewith in the same pair and thereby to connect any of said reproducers to any of said segments of each interlaced set in a sequence determined by the coding of the smaller perforations upon movement of each card to a predetermined extent in a horizontal plane, and means for moving individual cards to the predetermined extent.

11. In combination with a secrecy system including a signal circuit, means for recording signals on a moving medium, reproducers spaced along said medium, and a rotary distributor comprising a plurality of sets of segments and having a brush moving over said segments for connecting said reproducers individually to said circuit, a switching mechanism associated with each set of distributor segments for connecting any reproducer to any distributor segment in each set thereof, comprising a plurality of pairs of normally opened pairs of contacts, each of which pairs has one elongated contact which is flexible at its upper end and the other contact is relatively fixed in engageable relation with such upper contact end, said contact pairs being arranged in spaced relation in a plurality of vertical and horizontal rows such that each vertical row of fixed contacts is connected to one distributor segment and each horizontal row of flexible contacts is connected to one reproducer, a plurality of cards each of which is provided with two different sizes of perforations intermingled in accordance with a preselected code and arranged in vertical and horizontal rows corresponding to the respective rows of contact pairs, said smaller openings being equivalent in number to the number of distributor segments in one set, said cards being vertically stacked in proximity of the upper ends of said elongated contacts with corresponding perforations in vertical alignment such that each elongated contact projects through one group vertically aligned perforations and such that each elongated contact substantially touches each card at each of the smaller perforations and is flexed to engage the fixed contact associated therewith and thereby closes the respective contact pairs for connecting any of said reproducers to any distributor segment of each one set thereof after each of said cards is moved a predetermined distance relative to the other cards in the stack, and means for moving individual cards the predetermined distance.

12. The combination defined in claim 11 in which each of said vertical rows of relatively fixed contacts comprises a conductor bar positioned above the stack of perforated cards, a plurality of further flexible contacts are distributed in vertical alignment along said bar so that one contact lies in each of the horizontal rows and so that each contact is disposed in proximity of each opening in each card, one end of each further flexible contact is rigidly affixed to said bar, and the opposite end of each further flexible contact is disposed in engageable relation with the upper end of the elongated contact associated therewith in the same pair.

13. The combination according to claim 11 in which said switching mechanism includes said relatively fixed contacts disposed above the stacked cards, a unitary support for the spaced elongated contacts, said elongated contacts being arranged in said support such that corresponding ends of contacts terminate substantially in the same horizontal plane above said support and other corresponding ends in the same horizontal plane below said support, and means for elevating said support until the upper end of each of said elongated contacts is disposed above the stacked cards in proximity of the fixed contact constituting the same contact pair, and for lowering said support until the upper end of each of said elongated contacts is positioned below the stacked cards.

14. The combination recited in claim 11 in which said card moving means comprises a shaft pivotally mounted at one end, a drum rotatably mounted on the other end of said shaft, a plurality of lugs disposed helically on the periphery of said drum and spaced such that each lug can be disposed in horizontal alignment with one perforated card, a ratchet wheel affixed to said drum for rotation therewith, and a pair of pawls each of which is disposed on one of two substantially diametrically opposite sides of said ratchet wheel each of said pawls lying in a different vertical

plane such that one pawl serves to rotate said ratchet wheel and thereby said drum one predetermined amount as said shaft carrying said drum is moved in one rotary direction on its pivot and such that the other pawl serves to rotate said ratchet wheel and thereby said drum a further predetermined amount in the same direction as said shaft carrying said drum is moved in the opposite rotary direction on its pivot, said one and further predetermined amounts of rotary movement of said drum being sufficient to dispose successive individual lugs on said drum substantially in horizontal alignment with successive individual perforated cards in the stack.

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