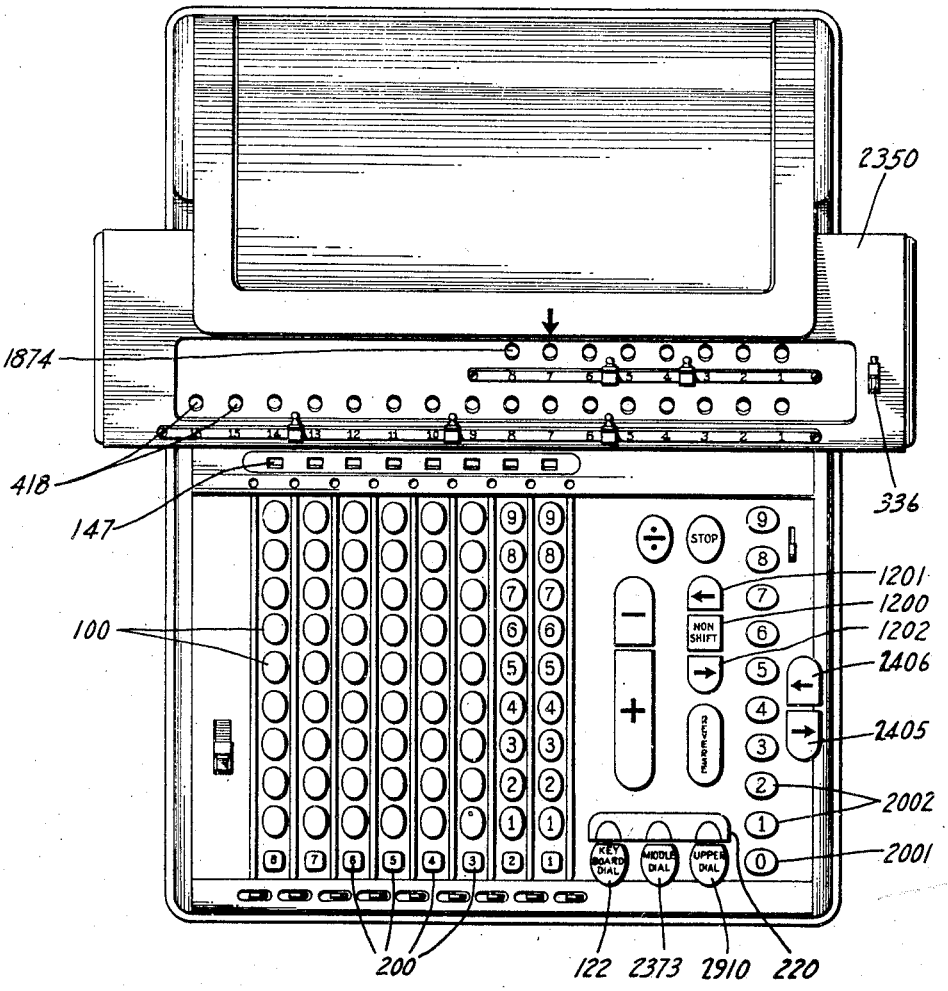
Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

Filed Sept. 20, 1943 12 Sheets-Sheet 1

FIG. 1.



INVENTOR.
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BY Taylor and Savage.

ATTORNEYS

Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

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FIG. 2.

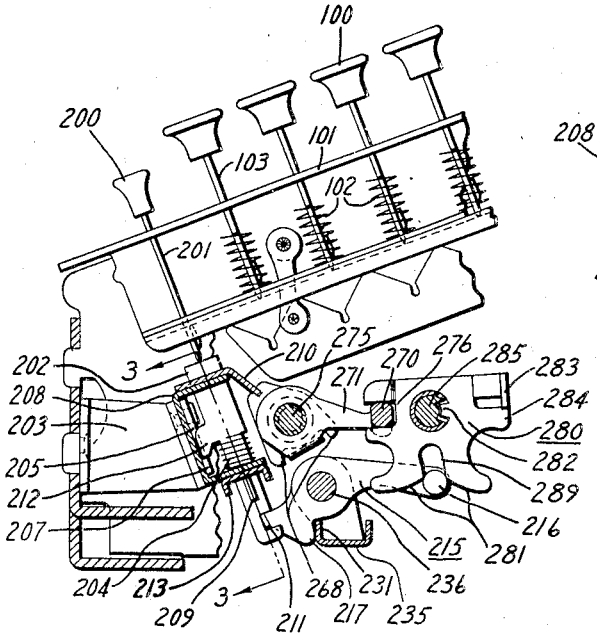


FIG. 3.

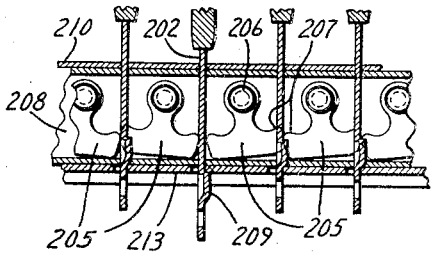


FIG. 4.

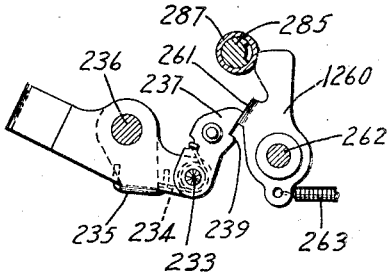


FIG. 5.

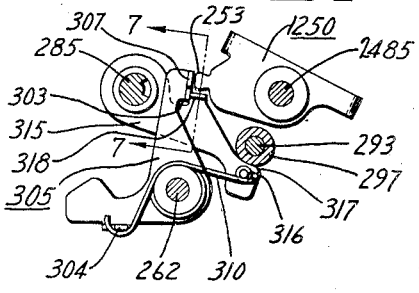
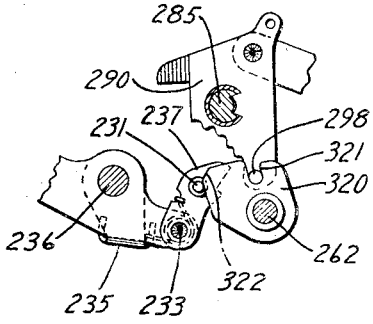


FIG. 6.



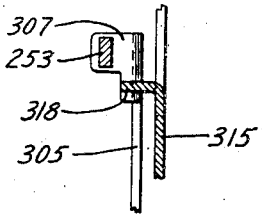


FIG. 7.

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Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

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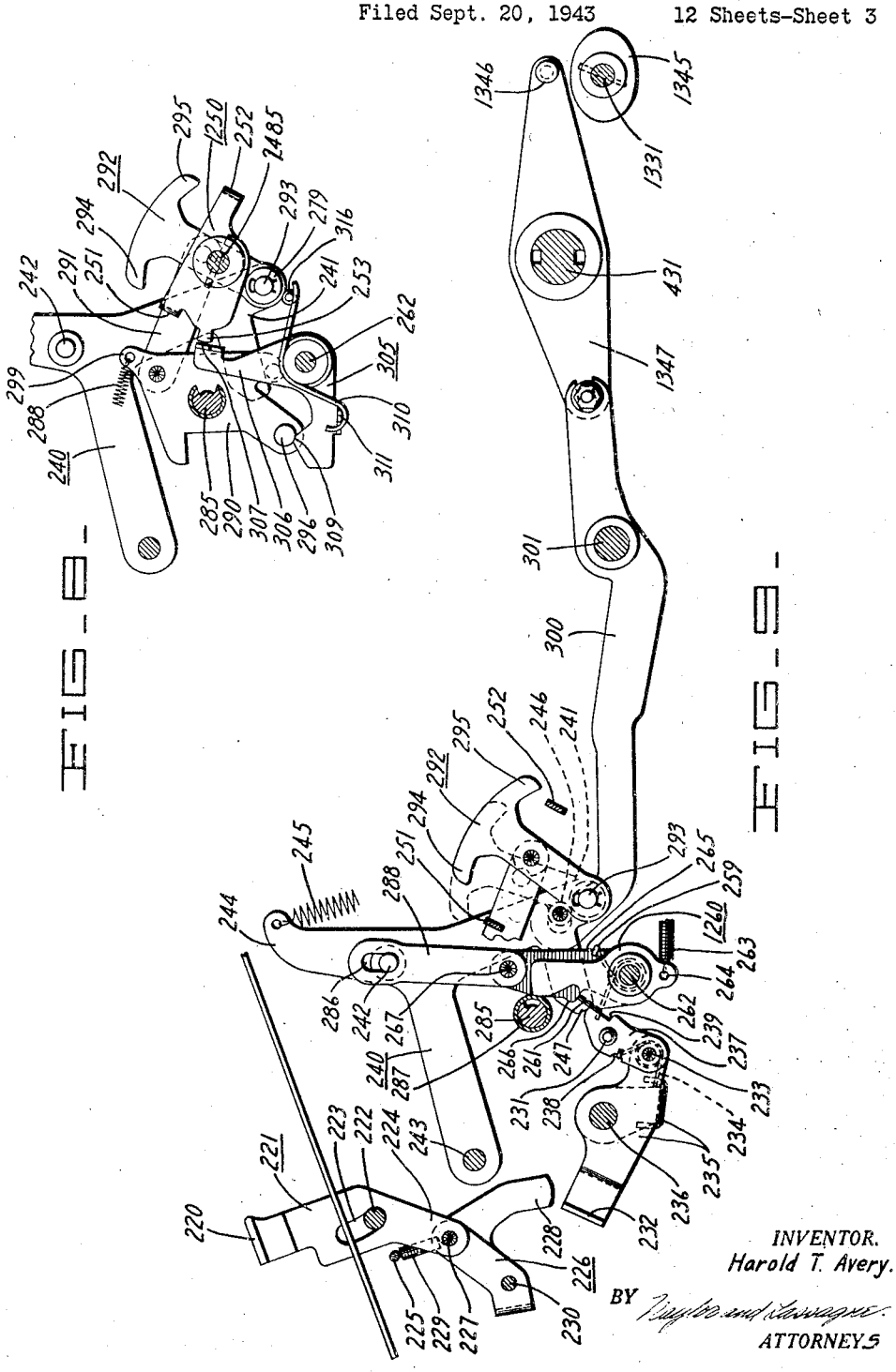

INVENTOR.
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ATTORNEYS

Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

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FIG_10_

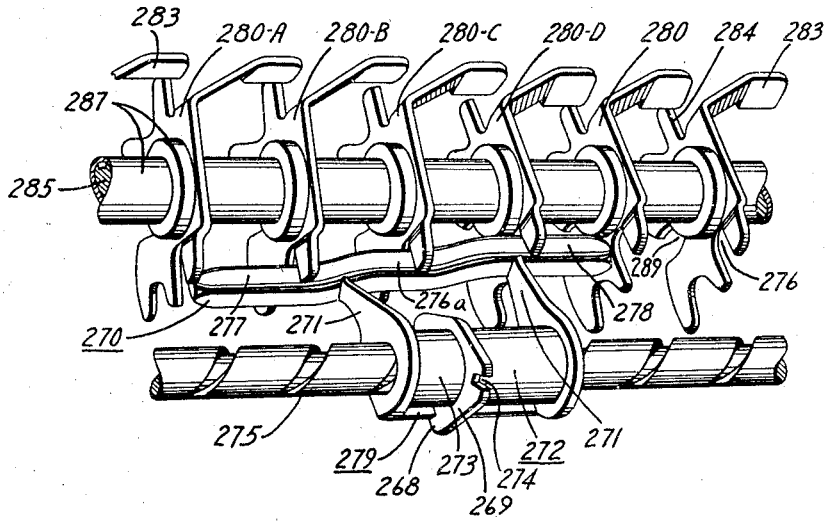
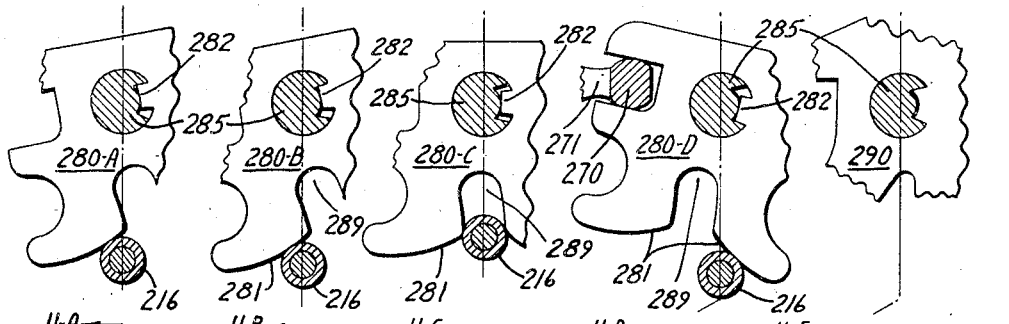


FIG_11A FIG_11B FIG_11C FIG_11D FIG_11E



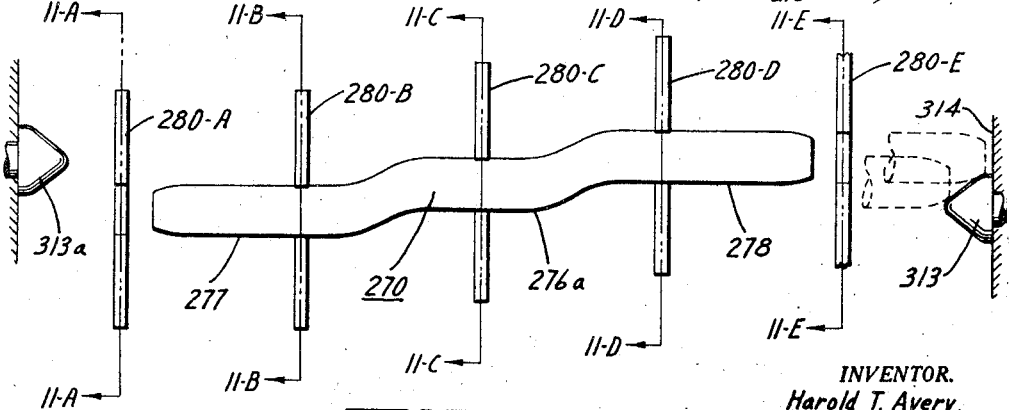


FIG_12_

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Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

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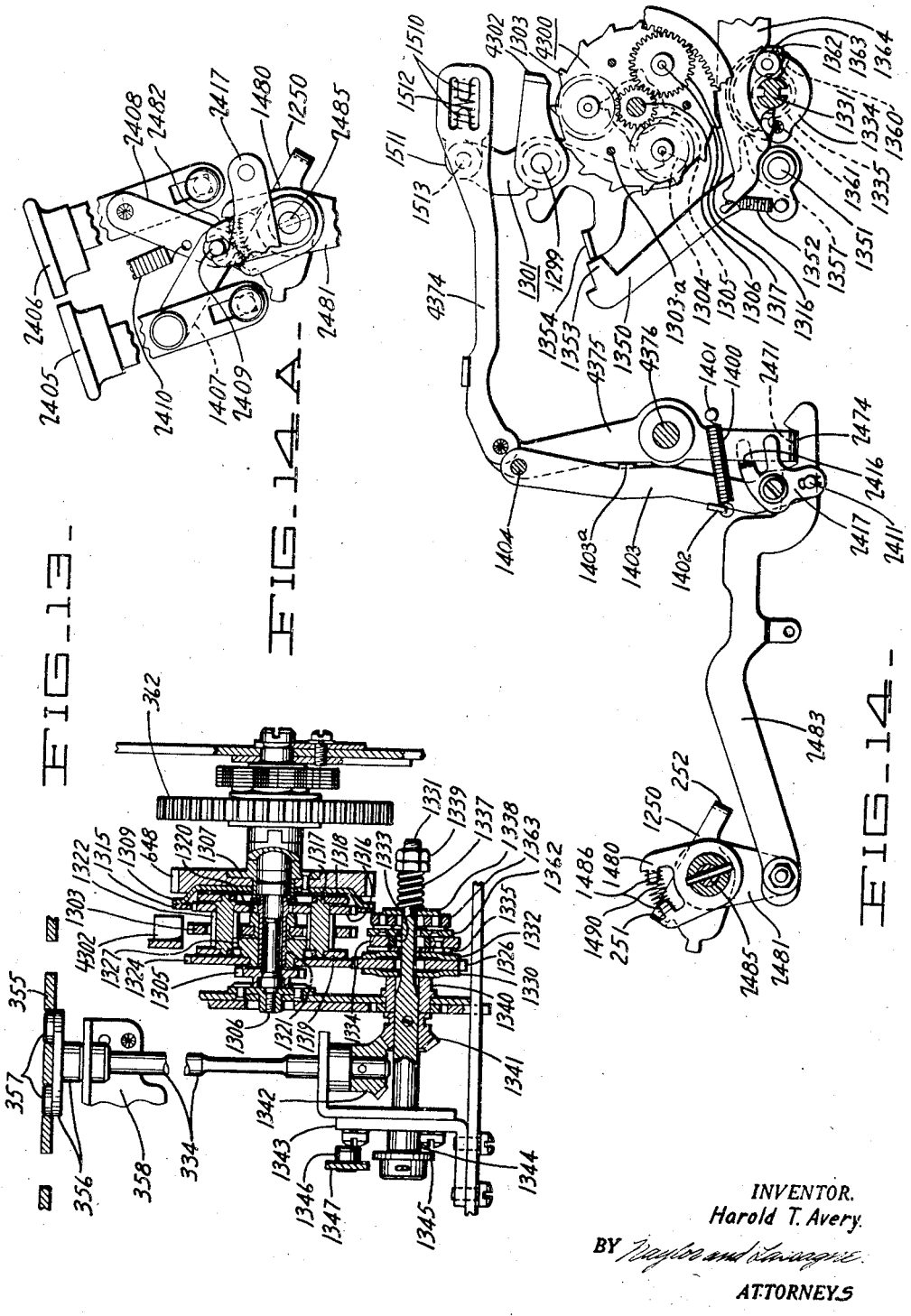

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CLUTCH MECHANISM FOR CALCULATING MACHINES

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FIG-15-

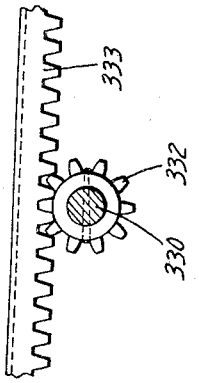

FIG-16-

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Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

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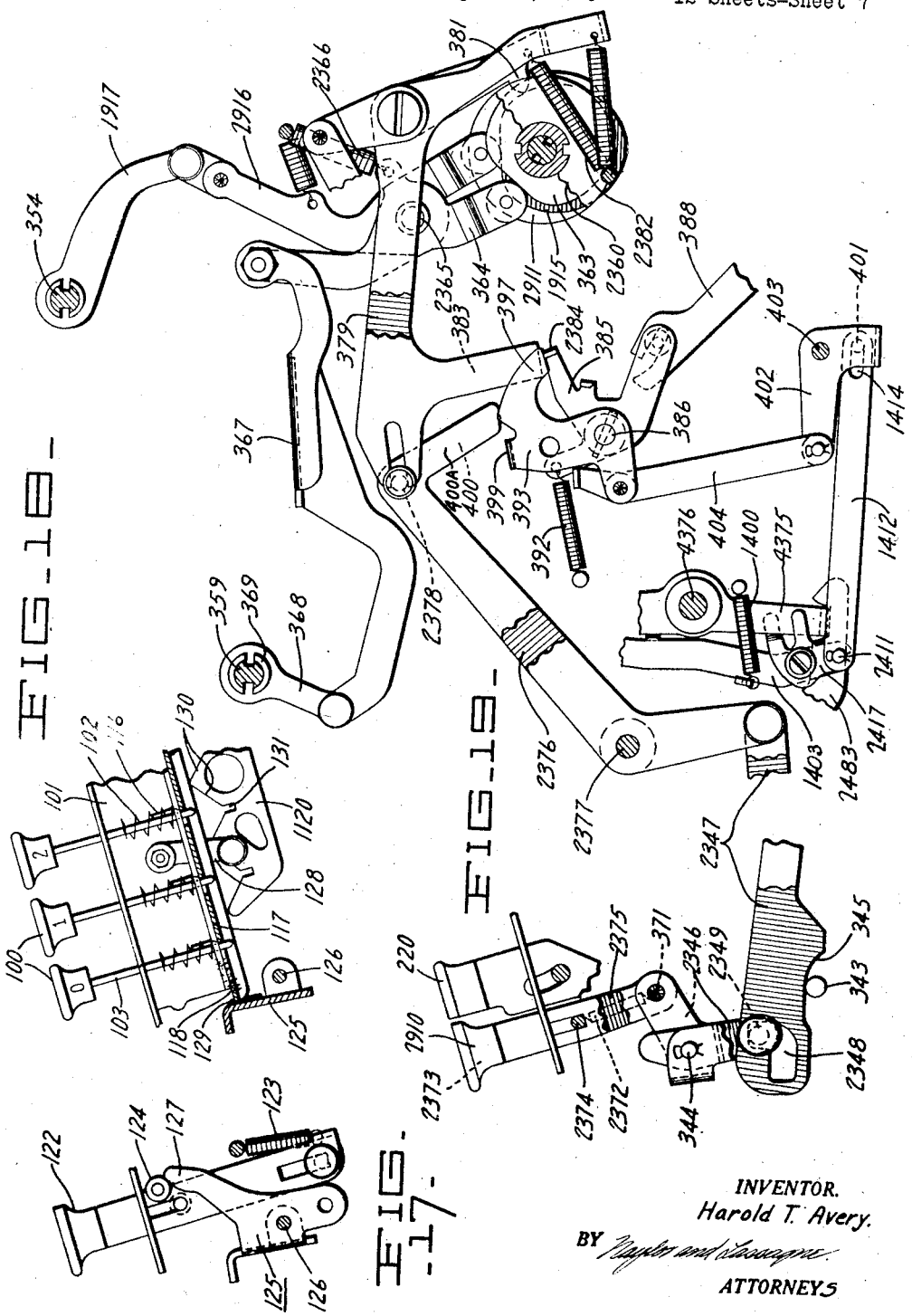

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CLUTCH MECHANISM FOR CALCULATING MACHINES

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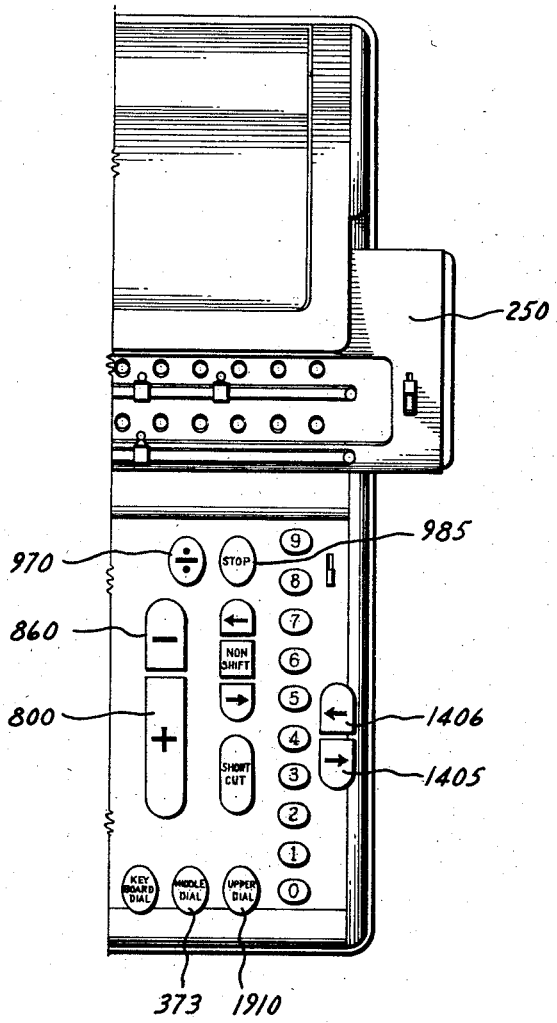
FIG. 20



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Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

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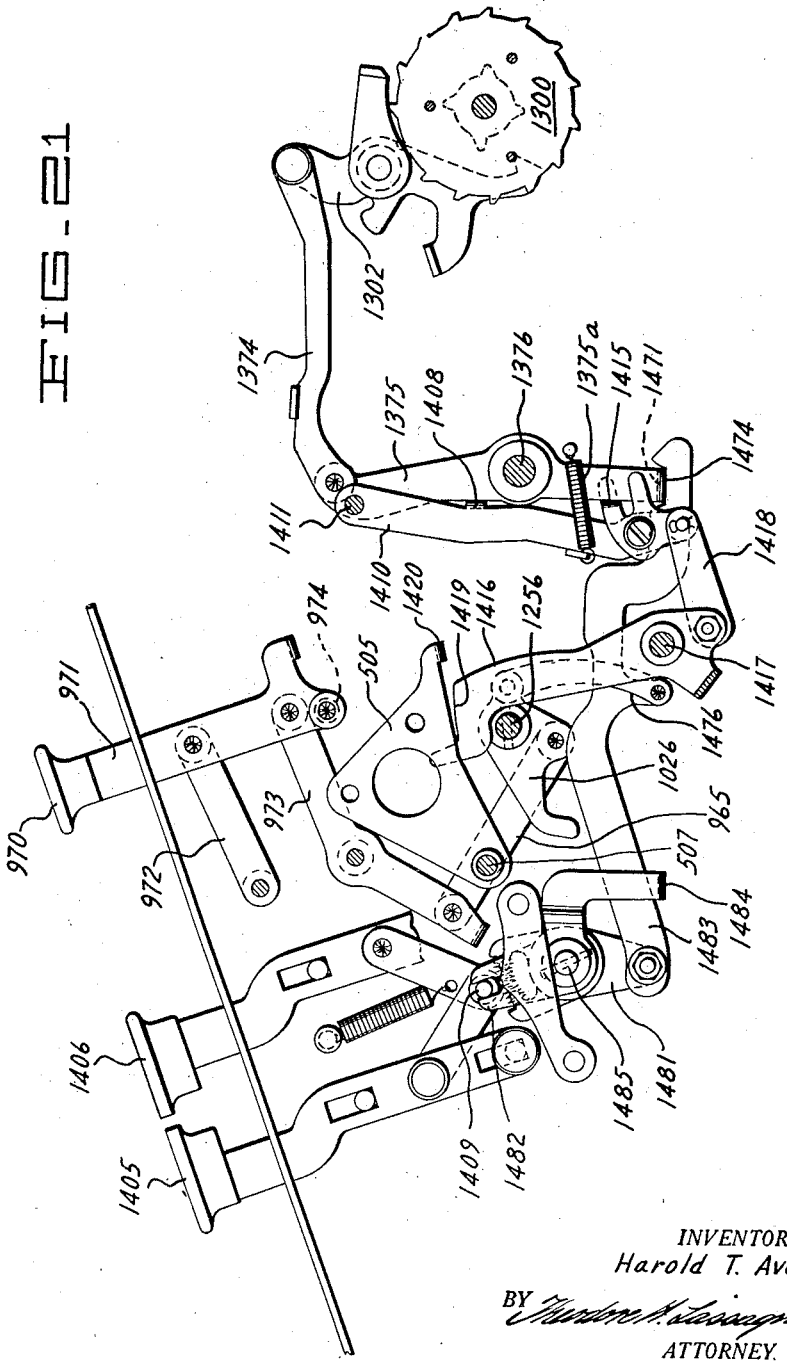
FIG-21



INVENTOR.
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Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

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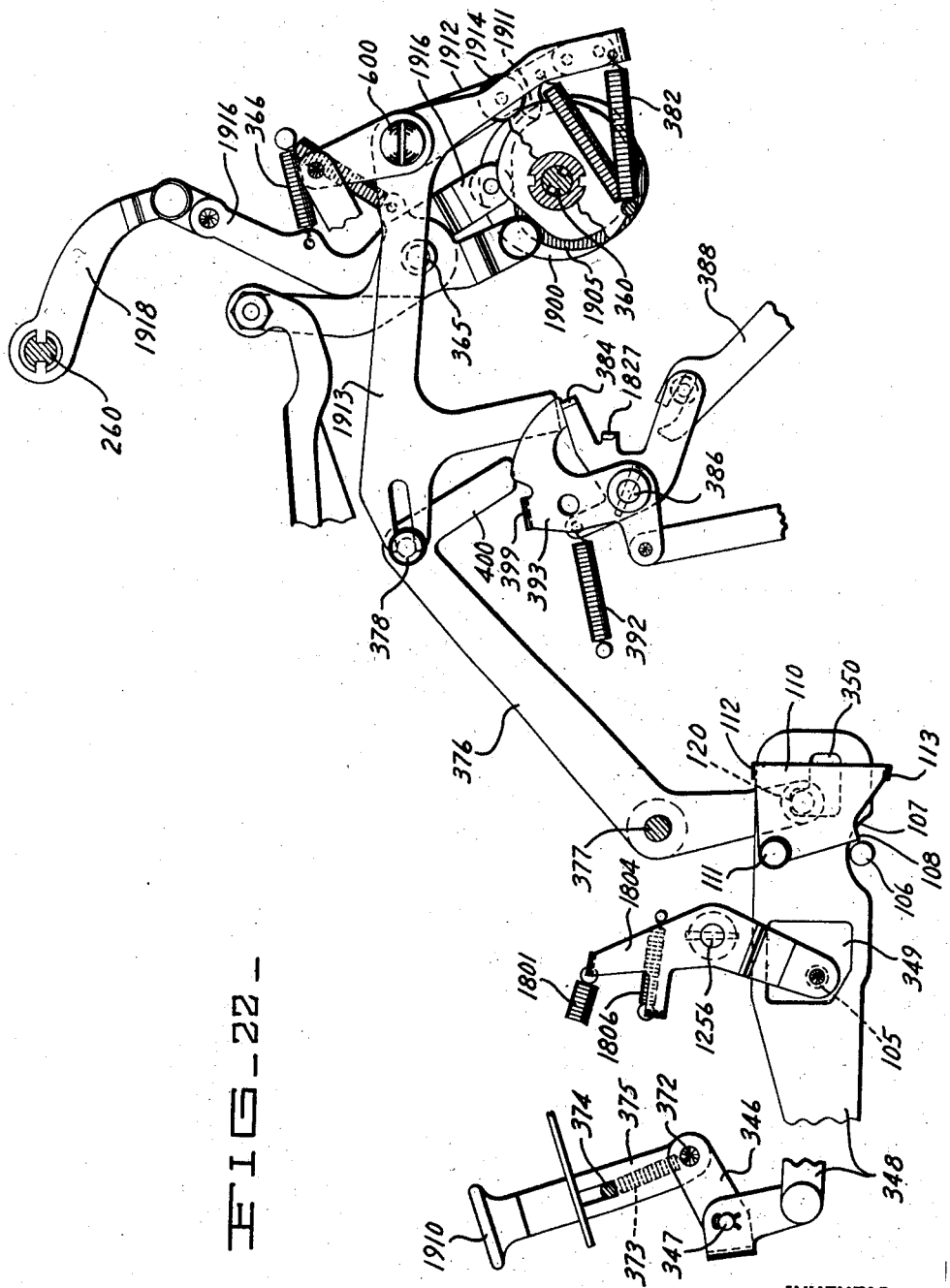

FIG-22-

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Dec. 19, 1944. H. T. AVERY 2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

Filed Sept. 20, 1943 12 Sheets-Sheet 11

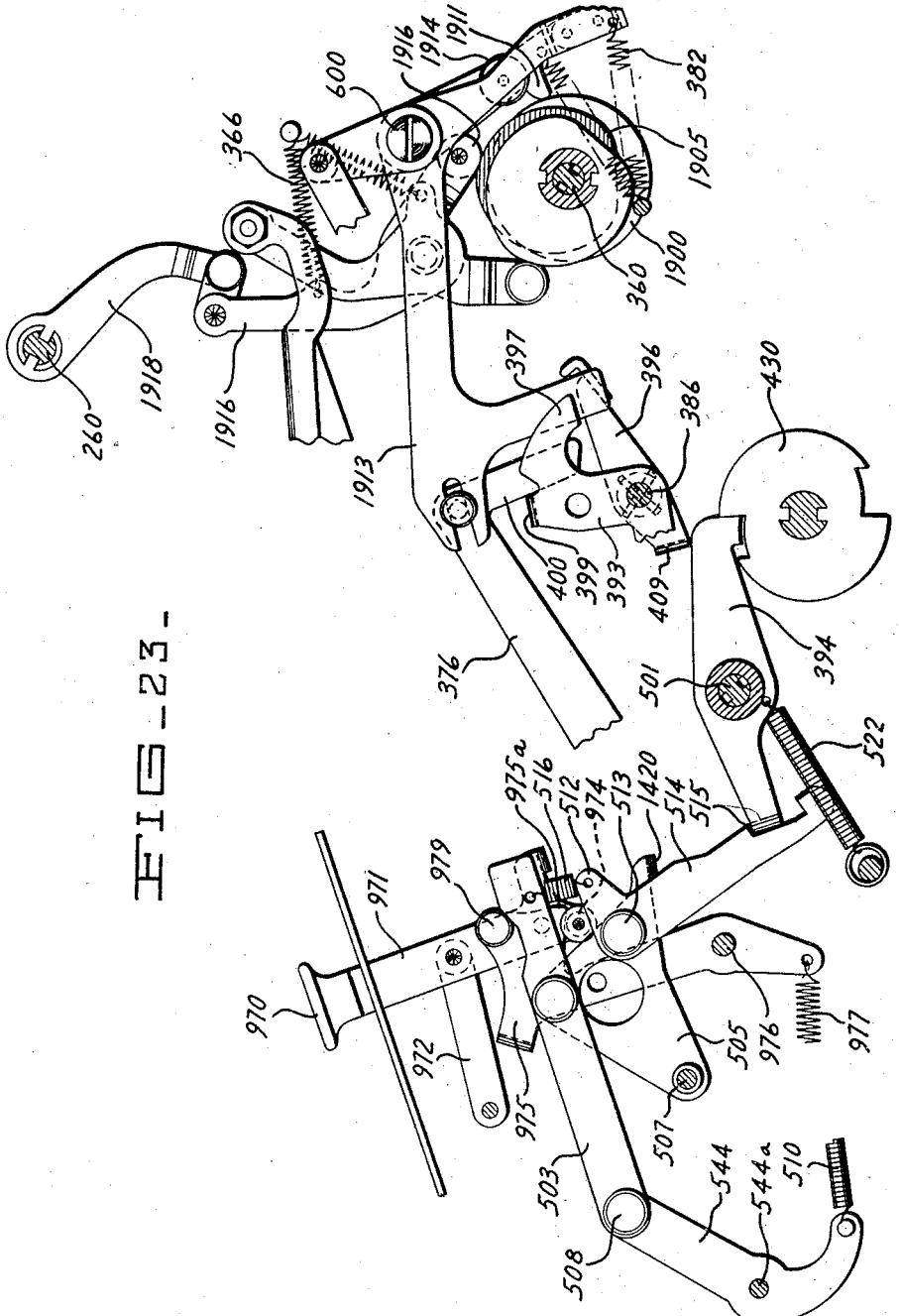

FIG-23-

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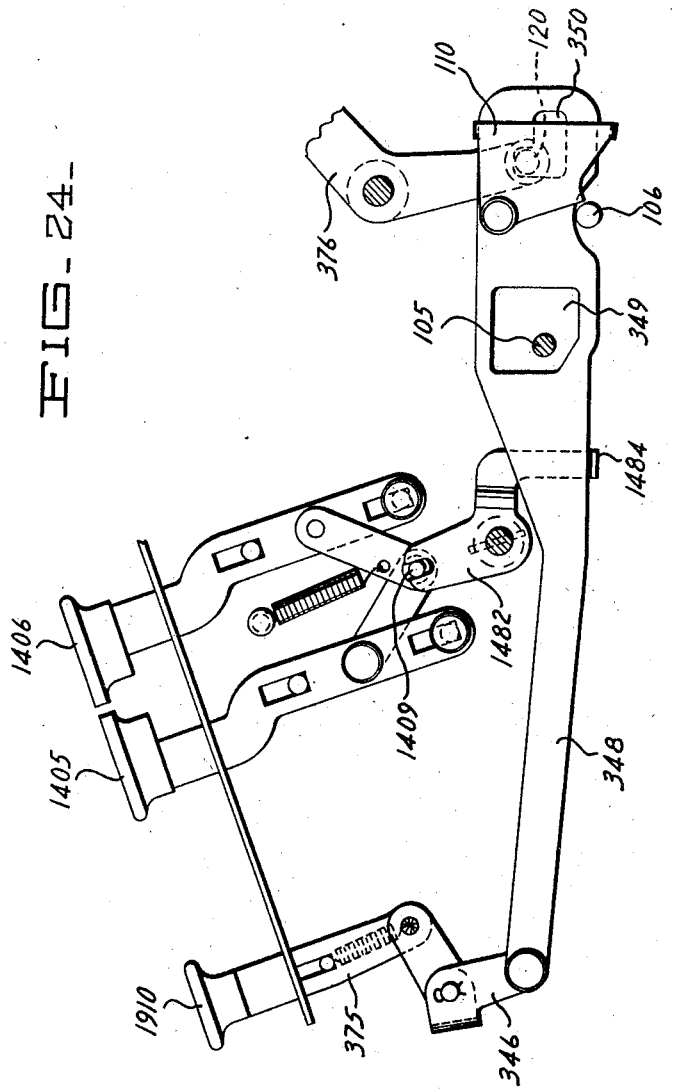
CLUTCH MECHANISM FOR CALCULATING MACHINES

Filed Sept. 20, 1943 12 Sheets-Sheet 12

FIG. 24.



INVENTOR.
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BY Thurston K. Swanson
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Patented Dec. 19, 1944 2,365,325

UNITED STATES PATENT OFFICE

2,365,325

CLUTCH MECHANISM FOR CALCULATING MACHINES

Harold T. Avery, Oakland, Calif., assignor to Marchant Calculating Machine Company, a corporation of California

Application September 20, 1943, Serial No. 503,056

15 Claims. (Cl. 192—48)

The present application is a continuation-in-part of the Avery application Serial Number 213,195, filed June 11, 1938, for calculating machines and of the Avery application Serial Number 237,437, filed October 28, 1938, for clutch mechanism for calculating machines.

The present invention relates to clutch control devices for calculating machines and the like, and more particularly to an improved arrangement of such control devices whereby a plurality of mechanisms driven by separate clutches may be caused to operate sequentially in response to a single mechanical or manual operation such as the depression of a key or a plurality of juxtaposed keys.

The invention in its broad aspects is particularly applicable in several forms to calculating machines having a plurality of clutches which must act sequentially to condition the machine for calculations and institute the performance of such calculations. In certain applications, for instance, it is desirable to clear the quotient register as an incident to the initiation of an automatic division operation. This is accomplished, according to the present invention, by utilizing the automatic division starting key both to initiate operation of a clutch acting to clear the register and also to release a spring device for initiating operation of a second clutch acting to cause initiation of the calculation; restraining the actual initiation of operation of the second clutch by interlocking devices which are effective during the time the first clutch is in operation. In other applications, for instance, it is desirable to make possible the simultaneous depression of a plurality of keys, such as register clearing and carriage shifting keys, so as to require only a single manual stroke by the operator, and yet to insure that the individually operable clutches controlled by such keys will act sequentially rather than simultaneously. This is accomplished, according to the present invention, by arranging all, or at least all but one of such keys to release spring devices for initiating operation of their respective clutches; restraining the actual initiation of operation of all but one of said clutches by interlocking devices released sequentially but effective while any clutch is in operation.

It is therefore a principal object of the invention to provide improved means for effecting automatic sequential operation of a plurality of clutch driven mechanisms.

A further important object is to render such automatic sequential operation responsive to a single control movement.

A further important object is to make possible selectively either independent or automatic sequential operation of a plurality of clutch driven mechanisms.

Other objects and advantages of the invention will appear from the following detailed description of specific embodiments of the invention, reference being had to the accompanying drawings forming a part of this specification in which drawings:

Figure 1 is a plan view of a machine embodying one form of the invention, showing the location of the tabulator keys and the master tabulator key in relation to the clear keys for restoring the several registers to zero.

Figure 2 is a longitudinal section, as viewed from the right side of said machine, showing part of the standard key section, the complete tabulator key section and the mechanism controlled thereby to position the control levers.

Figure 3 is a detailed sectional view, taken on the line 3—3 of Figure 2 showing the interlocks between the tabulator key stems.

Figure 4 is a longitudinal section, as viewed from the right, showing the tabulator operating bail and link, provided to initiate a shift.

Figure 5 is a detailed sectional view, from the right side of said machine, showing the mechanism for maintaining the shift mechanism in operation until the desired carriage position is reached and the restraining latch, which disables said mechanism when a directional shift key is operated.

Figure 6 is a detailed sectional view from the right showing the means for disabling the tabulator shift initiating mechanism when the carriage is in its tabulated position.

Figure 7 is an enlarged sectional view taken on line 7—7 of Figure 5.

Figure 8 is a detailed sectional view from the right, showing the mechanism for determining the direction of the shift, and related mechanism.

Figure 9 is a longitudinal section, as viewed from the right, showing the master tabulator key and linkage operated thereby to trip the main operating lever, and means for recocking said operating lever.

Figure 10 is an enlarged perspective view of the tabulator control levers and their relative position to the tabulator controller.

Figures 11A, 11B, 11C, 11D, and 11E are schematic sectional views, taken on the lines 11A, 11B,

11C, 11D, and 11E of Figure 12, showing the several positions of the control levers in relation to the shaft to which they are keyed.

Figure 12 is a schematic view showing the relation of the control levers to the tabulator controller and the means for stopping the shift when the carriage reaches its extreme end positions.

Figure 13 is a detailed sectional view of the planetary shift clutch and its connection to the carriage.

Figure 14 is a view in elevation of the right side of the planetary shift clutch and its linkage to the tabulator operating arm.

Figure 14A is a fragmentary view in elevation showing the two directional shift keys and the means operable thereby controlling the mechanism shown in Figure 14.

Figure 15 is a detailed sectional view taken on the line 15—15 of Figure 16.

Figure 16 is a fragmentary view, in elevation, of the left side of the machine, showing the driving means from the carriage to the tabulator worm shaft.

Figure 17 is a detail section, as viewed from the right, showing the keyboard dial clear key, and its associated clear bail.

Figure 18 is a detail section, as viewed from the right, showing the clear bail and means for releasing the numeral keys of the keyboard.

Figure 19 is a longitudinal section, as viewed from the right, showing the counter and product dial clear keys, and the control exerted thereby, over the clear clutches, and the interlocking means between the clearing and shifting control mechanisms.

Figure 20 is a partial top exterior view of a machine embodying a second form of the invention, showing the various control keys and associated mechanism;

Figure 21 is a right side view of the division and shift keys and associated mechanism employed in said second form of the invention.

Figure 22 is a right side view of one of the clear keys and the control connections to the clear clutch, together with the connection between the division key linkage and the clear clutch control mechanism employed in said second form of the invention.

Figure 23 is a right side view of the division key and clear clutch structures employed in said second form of the invention, the clear clutch being in approximately mid-cycle position so as to illustrate the operation of the interlocks and associated mechanism; and

Figure 24 is a right side view of the shift keys and one of the clear keys as embodied in said second form of the invention, illustrating the means for disabling the clear clutch controls.

The invention as embodied in the machine illustrated in Figures 1 to 19, inclusive, will first be described in detail.

Carriage shifting mechanism

The controlling mechanism embodying the present invention to be hereinafter described is designed to control carriage shifting mechanism of the type used in the commercially known "Marchant" calculating machines. It is, therefore, desirable to give a brief description of the operation of this carriage shifting mechanism before an explanation of the novel controls therefor.

An electric motor (not shown) is connected through suitable gears and shafts to gear 362 (Figure 13) to drive the shift clutch, said gear being rotatably mounted on shaft 1306 which is positioned between the center and right side frames of the machine described in the Avery Patent Number 2,271,240 issued on January 27, 1942. Gear 648, used to drive unrelated mechanisms, is also rotatably mounted on shaft 1306 by a flanged sleeve 1307 which is keyed to the hub of gear 362 and secured by rivets to gear 648, the same rivets affixing a dished ring gear supporting disc 1309 to the said gear 648.

The shift clutch comprises an internal ring gear 1315 secured to the supporting disc 1309 and in mesh with three planetary gears 1316 (Figures 13 and 14) riveted to each of three shafts 1317, respectively, which extend through clearance holes provided in a ratchet wheel 1303 and have end bearings in plates 1318 and 1319; said plates and said ratchet wheel being secured together as a rigid unit by studs 1303a. The gears 1316 mesh also with a sun gear 1320 formed upon one end of a sleeve 1321, to the opposite end of which is keyed a second ratchet wheel 1305. Gear teeth 1322 formed on the shafts 1317 mesh with a second sun gear 1327 to which is secured gear 1324 by which power is transmitted from the shift clutch to the shift drive train.

This shift clutch may be operated to transmit power to the shift drive train selectively rotating the same in either direction. Gear 362 is always rotated when the motor is running, thereby driving gear 648 and ring gear 1315 so that planetary gears 1316 and their associated gears 1322 normally revolve idly about sun gear 1327. If the ratchet wheel 1303 is held, however, as when a dog 4302 (Figure 14) is rocked into engagement therewith, revolution of the planetary gears 1316 and gear 1322 about sun gear 1320 and 1327 is prevented and said planetary gears function as idlers to transmit the drive to the sun gear 1327 and its associated gear 1324. If, however, the other ratchet wheel 1305 is held by the dog 1304 (Figure 14), being rocked into engagement therewith, sun gear 1320 (Figure 13) will be held stationary and the planetary gears 1316 and gear 1322 will all rotate about their own centers and revolve about sun gear 1322, thereby driving the gear 1324 in the opposite direction. Furthermore, if the clutch control dog 1301 is in its neutral position, shown in Figure 14, wherein neither dog 4302 or 1304 is engaged, the differential merely idles and there is no drive to the shifting mechanism.

The direction of rotation of the gear 1324 determines the direction of the shift of the carriage. The gear 1326 meshing with gear 1324 is rotatably mounted on shaft 1331 (Figure 13) between friction discs 1330 and 1332 keyed to said shaft. A sleeve 1333 also is mounted on shaft 1331 and supports a cam 1334 thereon while a disc 1335 is keyed to the shaft 1331. A disc 1362 (see also Figure 14) on which are two rollers 1363 used to function with centralizer 1364, is also keyed to the shaft 1331 and spring 1337 is compressed between washer 1338 and lock nuts 1339 on the threaded end of said shaft. This construction provides for a friction drive connection between gear 1326 and shaft 1331 effected by the discs 1330 and 1332, which are pressed against the gear 1326 by spring 1337 bearing against the washer 1338, the roller and plate assembly 1362, the spacer 1333, and the disc 1335.

The shaft 1331 is supported in a suitable bearing 1340 securely mounted in a frame of the machine and a second bearing 1344 riveted on an angle bracket 1343. A cam 1345 is keyed to the end of shaft 1331 and a bevel gear 1341 is fixed

on the same shaft to mesh with a second bevel gear 1342 securely mounted on the lower end of vertical shaft 334, also supported in the adjustable angle bracket 1343 secured to the base plate of the machine.

The aforesaid shaft 334 is supported at its upper end by bracket 358 secured to the back frame plate of the machine, and also has fixed thereto a hub and plate assembly 356 on which are mounted rollers 357, adapted to engage between the teeth of rack 355 mounted on the shiftable carriage 2350 (Figure 16), and thus, upon rotation of the assembly 356 by shaft 334, serves to drive the carriage laterally to the right or to the left.

The carriage may be released for free traverse by rocking rack 355 (Figure 16) about shaft 341 upwardly out of engagement with rollers 357. This rack may be rocked about its shaft 341 by means of arm 335 which extends through the cover of the carriage and carries a handle 336. Said arm is normally pulled against a stop 338 by spring 337 so that upon depression of said lever the spring is tensioned, and the rack 355 is rocked in a clockwise direction out of engagement with roller 357.

In this manner the carriage can be freed and moved to any desired lateral position, but if the operator should stop the carriage out of an operating position the teeth of the rack will not be aligned with the roller 357 and when the handle 336 is released the rack 355 will rest on top of the rollers 357, where it will remain until the shaft 334 is rotated in an attempt to shift the carriage. When this takes place, however, one of the rollers 357 during the first shift cycle will become aligned with a tooth space, thereby allowing the rack to be forced downwardly into engagement with one of the rollers by spring 337, and during the ensuing shift cycles will be traversed thereby to a selected position in the regular way.

Carriage shift controlling mechanism

Means are provided to alternatively rock either dog 4302 or 1304 (Figure 14) into engagement with clutch ratchet 1303 or 1305, respectively, to effect a rightward or leftward carriage shift. Said means comprises a lever 1480 fixed on shaft 2485 and having at its upper end, two facing lugs 1486, and a lever 2481, also provided with two identical facing lugs 1486. The lever 2481, however, is freely rockable on shaft 2485 adjacent lever 1480, and a spring 1490 is compressed between the four coincidental lugs 1486, thereby forming a yieldable connection between levers 1480 and 2481, by means of which lever 1480, integral with shaft 2485, can transmit its motion to lever 2481 only through spring 1490. If lever 2481 is restrained when shaft 2485 and lever 1480 are rocked, the spring 1490 will merely be further compressed and no damage to the parts will result from such restraint.

The lower end of lever 2481 is attached to the left end of link 2483 so that the rocking of lever 2481 imparts longitudinal movement to link 2483, said link being provided with a notch 2474 on the right end thereof to embrace a lateral extension 2471 formed on the lower end of lever 4375, whereby longitudinal movement of link 2483 will effect rocking movement of lever 4375 about its supporting shaft 4376. The upper end of lever 4375 is attached to a link 4374 so that the rocking of lever 4375 imparts longitudinal movement to link 4374 which has at its rear end an aperture in which are two facing lugs 1510. Adjacent the rear end thereof, is another link 1511 with an identical aperture, also with two facing lugs 1510. Links 4374 and 1511 are yieldably connected by compression spring 1512 located over the four lugs 1510.

Link 1511 is pivotally connected at its forward end to the shift clutch control dog 1301 by stud 1513, so that longitudinal movement of link 4374 will cause the clutch control dog to rock about shaft 1299. As previously described under the sub-heading "Carriage shifting mechanism," control dog 1301 constitutes the controlling means for the shift clutch 4300, and the direction of the rocking of control dog 1301 determines the direction of the shift by its engagement with ratchet wheel 1303 or 1305.

Two levers are fixed to shaft 2485 from which control of said shaft is derived, one being a tabulator operating lever 1250 (Figure 14), the function of which will be described hereinafter in connection with the "Tabulator initiating mechanism" and lever 2482 (Figure 14A), which is actuated by the shift keys 2405 and 2406 to directly effect shifting of the carriage in either direction.

As shown in Figure 14A, these keys are mounted on the usual vertically sliding stems, which are connected by links 1407 and 2408, pivotally connected at pin 2409. Spring 2410 tensioned between one of said links and the machine frame, normally retains both keys in raised position, but upon depression of one of the keys the pin 2409 is moved either to the right or to the left, according to the key depressed, being guided in such movements by a fixed member 2417 which also serves to prevent simultaneous depression of the keys. The pin 2409 is embraced by the bifurcated upper end of lever 2482, mentioned above as one of the two levers fixed to shaft 2485. Therefore, it will be seen that upon depression of the shift key 2405 the pin 2409 is moved to the right, rocking lever 2482 and shaft 2485 clockwise to engage dog 4302 with ratchet wheel 1303 and effect a rightward carriage shift, while upon depression of shift key 2406 the pin 2409 is moved to the left, rocking the lever 2482 and shaft 2485 counter-clockwise to engage dog 1304 with ratchet 1305 and effect a carriage shift to the left, in a manner described hereinbefore.

Means are provided whereby the dogs 4302 and 1304 are held in engagement with their respective ratchet wheels during approximately the first three quarters of the shift cycle, to insure the completion of any initiated shift no matter how quickly the key is released. On a leftward extension of the clutch control dog 1301 (Figure 14) is a formed ear 1354 engaging the projection 1353 of the latch 1350, said latch being pivotally mounted at 1351 and urged into engagement with said ear by spring 1352. When control dog 1301 is moved, either clockwise or counter-clockwise, the ear 1354 is held by latch 1350 which rocks about shaft 1351 under the tension of spring 1352 and seats its projection 1353 either above or below ear 1354, thus latching the clutch control dog 1301 against return movement.

Provision is made for additionally tensioning spring 1352 at the beginning of the shift cycle, and for this purpose centralizer 1364 is utilized, the upper end of spring 1352 being attached to the extreme left end thereof. When the shift clutch 4300 first begins to rotate, rollers 1363, mounted on disc 1362, revolve about shaft 1331 and in their movement, one of said rollers cams the centralizer 1364 upwardly, thereby exerting

more and more tension on spring 1352 until the shaft 1331 has made one-quarter of a rotation.

Provision is made for moving latch 1350 (Figure 14) to release ear 1354 at about three-quarter cycle position. It will be seen that the cam 1334, utilized for this purpose, includes two opposite rises over which a nose 1357 of latch 1350 rides. Upon counter-clockwise rotation of the cam from the position shown in Figure 14, the nose 1357 rides over one of these at the end of about three-quarters of its cycle. To secure the same cyclic time of operation of latch 1350 for the reverse rotation of shaft 1331, the cam 1334, which is free on shaft 1331, is driven by the disc 1335 keyed to said shaft and having two shoulders 1360 on opposite sides thereof so that upon clockwise rotation of disc 1335 from the position shown in Figure 14, pin 1361 on the cam 1334 is engaged by the shoulder 1360 on the opposite side, only after the disc has rotated about three-eighths of a rotation (which is three-quarters of its cycle), and the rocking of latch 1350 and disengagement of ear 1354 occurs at the correct cyclic time.

When the latch 1350 is thus released, the clutch control dog 1301 is automatically centralized to remove the effective dog 4302 or 1304 from engagement with its ratchet. For this purpose, a centralizer 1403 is pivotally mounted in the machine frame at 1404, and provided with a lug 1403*a* extending laterally into engagement with lever 4375 above the pivot 4376, and an adjustable lug 2417 having an offset 2416 engaging the lever 4375 below said pivot. The centralizer is pressed against the lever 4375 by a spring 1400 tensioned between a lateral extension 1402 and a stud 1401 in the machine frame. Thus, the centralizer 1403 tends to maintain the lever 4375 in a neutral position in which the clutch dog 1301 will be ineffective, and will return it to said neutral position automatically upon release of latch 1350, provided the operating keys 2405 and 2406 are released.

Although the drive to the carriage through the shift clutch is thus terminated at approximately three-quarter cycle position, the shift drive train will be rotated through the remainder of its cycle, consisting of one-quarter rotation of shaft 1331, by the centralizer 1364, pressed by spring 1352 against rollers 1363 on disc 1362 secured to said shaft. In addition to completing the shift cycle, the centralizer 1364 and rollers 1363 also serve to restrain any movements beyond the end of the cycle so that the carriage will always come to rest in an operating position.

Tabulator setting mechanism

The machine shown in Figure 1 is one in which the carriage may be moved to eight different operating positions and it therefore has eight tabulator selection keys 200, but could have more or less, depending upon the capacity of the machine, and it is to be understood that the mechanism controlled by each of the tabulator selection keys is duplicated in all orders of the machine, but that only one order will be described in detail.

The tabulator selection keys 200 have two primary functions; first, to position the tabulator controlling mechanism for a shift in the correct direction; and, second, to initiate a shift.

The means provided to condition the tabulating selection mechanism are operable by any one of the tabulator selection keys 200 consisting of two functionally integral portions which are preferably made separate for convenience in manufacture and assembly. The upper portion of each key 200 (Figure 2) consists of a stem 201 which is slidably mounted preferably in the same key frame 101 provided to support the numeral keys 100. The bottom of each stem 201 is positioned to operate against the top of a lower portion of the respective key 200 which consists of a stem 202, which is slidably mounted in the tabulator key frame 208, securely held in a lateral position in the machine by two brackets 203 attached to the front frame plate of the machine.

Each key 200 is normally held in a raised position by compression spring 204 compressed between the frame 208 and an ear 212 of stem 202. On the lower end of each stem 202 is a notch adapted to embrace the lateral extension 211 of a lever 215, rockably mounted on shaft 236, so that downward movement of the stem 202 will impart counter-clockwise movement to lever 215 about shaft 236. A roller 216 is riveted on the rearwardly extending arm of lever 215 and is adapted to impinge one or the other of the divergent sides 281 of an aligned one of a series of tabulator control levers 280 and cam it to the position shown in Figure 2. The mechanism shown in this figure is that of an order in which the key 200 has been depressed and all parts are in the position they assume when the carriage has come to rest in its tabulated position.

Means are provided to latch the stem 202 in a partially depressed position so that the key 200 of which it is a part will remain depressed until the latch means is released by the depression of another one of the series of tabulator selection keys 200. Lugs 209 (Figure 3), on the lower end of the stems 202, are provided with a curved surface at the bottom, adapted to cam the lock bar 213 to the right, against a compression spring (not shown) during the downward movement of a stem 202 until its lug 209 passes beneath the lock bar 213, and thus allows said lock bar to spring back to a position overlying the top of the lug 209, thereby holding the stem in a partially depressed position, until another key 200 is depressed and its corresponding lug 209 again cams the lock bar to the right, thus allowing the key first depressed to be raised by spring 204 (Figure 2), and the second key to remain down due to latching of its stem 202 in the same manner as the first.

Pendulum type interlocks 205 (Figure 3) are provided to prevent the simultaneous depression of two or more keys, and are attached to the tabulator key frame 208 by the shoulder studs 206 so that said interlocks are free to rock about their respective studs. The stems 202 are provided with arms 212 (Figure 2) to operate against the shoulders 207 of the interlocks 205. As shown in Figure 3, a stem 202 has been depressed and the ear 212 of said stem in passing downwardly between the two adjacent interlocks 205 has forced the interlock to the right thereof to rock counter-clockwise about the stud 206, and similarly has forced the interlock to the left thereof in a clockwise direction. In these movements of the interlocks, the opposite shoulder 207 abuts the adjacent shoulder of the next interlock 205, and so on, until all interlocks to the left of the depressed stem 202 have been rocked clockwise and all interlocks to the right of said stem have been rocked counter-clockwise to positions where their shoulders 207 lie in the path of the ears 212 of all raised stems 202, thereby limiting the depression of a second key to only that amount which will allow the lug 209 to cam the lock bar 213 far enough to release the depressed stem, but serv-

ing to prevent a complete depression of the second key if the first is being manually held down.

Tabulator controlling mechanism

An indication of the desired position of the carriage having been set into the tabulator control mechanism by the depression of one of the keys **200**, it is also necessary to set into said mechanism an indication of the present position of the carriage, and for this latter purpose a tabulator controller **270** (Figures 2 and 10), movable in time with the lateral shifting movement of the carriage, is provided. Tabulator controller **270** is riveted, or otherwise secured, to two rearwardly extending arms **271** of the bail **279**. Said bail is mounted on, and is free to move rockably and transversely on the worm shaft **275**, and between the flanges of the bail **279**, from which arms **271** are extended, is a bushing **273** and a nut **272** which engages the groove of the worm shaft **275**. On one end of the nut **272** (Figure 10) is a flange **269**, having a bifurcation **274** formed on one side thereof, adapted to embrace an angle plate **210** (Figure 2), secured to key frame **208**, thereby preventing rotation of the nut **272** with the shaft **275** and causing rotation of said shaft to effect transverse movement of the nut **272**, the bail **279**, and the controller **270**.

Means are provided whereby movement of the carriage will drive the worm shaft **275** (Figures 10 and 16) at such a rate as will impart a lateral movement to the controller **270** proportionate to the movement of the carriage, but in the opposite direction; this opposite directional drive being necessary only because the number one tabulator selection key **200** is preferably situated at the extreme right side of the keyboard while the number one position of the carriage is at the extreme left. For this purpose a driving rack **333** (Figures 15 and 16) is attached to the carriage **2350** and has downwardly protruding teeth adapted to engage a spur gear **332** fixed to the upper end of a shaft **330**. Two brackets **331** and **327**, secured to the machine frame, support the upper and lower ends of shaft **330**, respectively, bracket **331** having a bearing fixed thereto, while the bracket **327** supports an adjustable thrust bearing **329**, in which the lower end of the shaft **330** is journaled while a nut **328** permits adjustment of said thrust bearing to insure the correct clearance between a bevel gear **326** secured to the lower end of shaft **330** and a second bevel gear **325** fixed to the left end of worm shaft **275**. This construction affords a positive drive from the carriage **2350** to the worm shaft **275** and the correct timing thereof, and in viewing Figure 15 it will be seen that leftward movement of rack **333** imparts counter-clockwise rotation to gear **332**, shaft **330**, and bevel gear **326** (Figure 16), which in turn rotates bevel gear **325** in mesh therewith and its integral shaft **275** in a clockwise direction to ultimately produce a rightward movement of controller **270** (Figure 10).

The controller **270** (Figure 10) is so mounted as to permit it to rock a sufficient amount about its shaft **275** to freely follow the movement of control levers **280** as they are rocked about shaft **285** from one to another of their various displaced positions. Two projections **268** (Figure 2) are provided on the flange **269** of the nut **272** to serve as limit stops for the bail **279** connecting arms **271**. The distance between the projections **268**, however, is enough greater than the width of the bail to allow the required movement of the controller **270** and bushing **273** with respect to the nut **272** and member **269**.

Shaft **285** (Figure 2) is provided with a wide keyway into which keys **282** of members **280** extend; said keys being sufficiently narrower than their keyway to permit limited rocking movement of each of the levers **280** with respect to shaft **285**.

The controller **270** extends laterally a sufficient distance to insure that it will always engage in the recesses **276** of at least three adjacent members **280**, and has three steps of different elevation, **277**, **276***a*, and **278** (Figure 12), by virtue of which it positively positions the control levers **280** engaged thereby at as great a stagger with relation to each other as the keyway of shaft **285** will permit (see Figures 11B, 11C, and 11D). Each lever **280** has a laterally formed ear **283** overlying a nose **284** on the next lever to the right in such a manner that when a lever is positioned clockwise as shown in Figure 11D, all those to the right of it are positioned equally far clockwise, and when a lever is positioned counter-clockwise as shown in Figure 11B, all to the left of it are positioned equally far counter-clockwise. Thus controller **270** serves to positively locate all levers **280** with respect to the keyway in shaft **285**, the lever **280** engaged by the middle of controller **270** having its key located centrally of the keyway, all those to the right thereof against the lower side of the keyway and all those to the left against the upper side.

When a tabulator selection key **200** is depressed, a roller **216** (Figure 2) is moved upwardly to rock its respective lever **280** into a definite angular position, thereby rocking shaft **285** into a position determined by the angular relation existing between the lever **280** and the keyway in shaft **285**, which in turn is determined by which side of the controller **270** the key is depressed.

As shown in Figure 10, controller **270** extends laterally a sufficient distance to engage in the recesses **276** of the three adjacent control levers **280** B, C, and D, and is formed with the previously described three offset portions **276***a*, **277**, and **278**, so that the three levers **280** B, C, and D so engaged by it will be rocked to three different angular positions with respect to shaft **285**. In the present example, the lever **280**C (Figures 11C and 12) aligned with the intermediate step **276***a*, of controller **270**, has its key **282** intermediate the keyway of shaft **285**, and the lever **280**B (Figure 11B) aligned with the lower step **277** has its key located against the bottom of said keyway, and the lever **280**D (Figure 11D) in line with the upper step **278** has its key **272** located against the upper surface of the keyway in said shaft.

Figures 11A to 11E, inclusive, show control levers **280** positioned as they would be with the tabulator control key in line with lever **280**C (Figure 11C) depressed.

If the tabulator key in control of lever **280**A positioned as shown in Figure 11A, hereinafter called order A, is now depressed, the roller **216** of order C will be retracted from lever **280**C by the key of order C being freed to rise under pressure of spring **204** as described hereinbefore, and the roller **216** of order A will press against the divergent side of **281** of control lever **280**A to rotate said control lever clockwise about shaft **285**.

Now in viewing lever **280**A in Figure 10, which is from the left instead of the right as is the case of Figures 11A and 2, this setting movement of lever **280**A forces its lateral extension **283** and

arm 284 of lever 280B downwardly, which carries the controller 270 upward, thus rocking lever 280C and 280D counter-clockwise. Lever 280D (Figure 11D) represents the position of said lever before the setting occurred; therefore this upward movement of controller 270 just referred to, forces lever 280D further clockwise and the key 282 of said lever, being in the position shown in Figure 11D, rocks shaft 285 with it an equal amount.

If a tabulator key on the other side of controller 270 is depressed, for instance the one which controls order D (Figure 11D), the roller 216 of that order will be moved upwardly by said tabulator key, thereby rocking lever 280D counter-clockwise and forcing controller 270 downwardly, and in turn rocking levers 280C and 280D counter-clockwise. Since the key 282 of lever 280B (Figure 11B) is against the upper surface of the keyway of shaft 285, this counter-clockwise movement rocks said shaft an equal amount in a counter-clockwise direction, instead of clockwise as was the case in the previous example. Therefore, it is evident from the foregoing that the depression of a tabulator key on one side of the controller 270 rocks shaft 285 in one direction, but the depression of a tabulator key on the other side of said controller rocks shaft 285 in the opposite direction.

Fixed on the end of shaft 285 (Figure 8) by means of a key of the same width as the keyway of the shaft, is a right end control lever 290 connected by a link 291 with a T member 292 pivotally mounted at 293 on a main starting lever 240, the operation of which will be described hereinafter. As shaft 285 is rocked in one direction or the other, as just described, the T member 292 will be rocked about its pivot 293 to carry one of its upper arms 294 and 295 over one of the ears 251 and 252 of shift operating lever 1250 which, as hereinafter described, effects operation of the carriage shifting mechanism in one direction or the other, according to the direction in which T member 292 is rocked.

Tabulator initiating mechanism

The direction in which the carriage must be shifted in order to reach the desired position having been automatically determined, means are provided for initiating operation of the shifting mechanism to move the carriage to the desired position.

As previously described, the depression of a tabulator key 200 to the position shown in Figure 2 only conditions the tabulator controlling mechanism for a shift to a selected position. Means are provided, however, whereby a further depression of a key 200 will, if desired, actually initiate tabulation.

It will be noted that the roller 216 (Figure 2) of the lever 215 is at the entrance of the slot 289 of lever 280, having already positioned said control lever; therefore, when the lever 215 is rocked further counter-clockwise, upon further depression of key 200, the roller 216 merely rises upwardly into the slot without imparting further movement to the control lever 280, but during the said movement of lever 215 its shoulder 217 contacts the flange 231 of the bail 235 pivotally mounted on shaft 236 and provided with a link 237 (Figures 4 and 9) pivotally attached to the rearwardly extending arm thereof by the shoulder stud 233. A notch 238 (Figure 9) is formed on the forward edge of link 237 to receive one end of a torsion spring 234, while the other end of said spring is held in a hole in the rear flange of the bail 235 so as to urge the link 237 clockwise about stud 233. On the rear side of said link is a shoulder 239 adapted to operate against the lower edge of lateral extension 261 (Figure 4) of a starting interponent 1260 which is rockably mounted on a fixed stud 262, and urged to rock in a counter-clockwise direction by a spring 263 tensioned between the aperture 264 of the lever 1260 and a stationary stud (not shown), such movement being limited by the bushing 287 of shaft 285. The upper edge of the lateral extension 261 abuts the shoulder 266 (Figure 9) of the lower toggle link 265, also pivotally mounted on stud 262, the upper end of which link is pivotally attached to the upper toggle link 268 by stud 267, said upper toggle link having an elongated hole 286 at its upper end engaging a stud 242 on starting lever 240.

Said starting lever is pivotally mounted on a stud 243 attached to a frame of the machine, and to the top of its upwardly extending arm 244 is connected a tension spring 245, the lower end of which is securely fastened to the framing of the machine. This toggle link construction affords means for maintaining the starting lever 240 in its raised position (shown in Figure 9) against the tension of spring 245. It will be seen that the toggle is in a position just past center, with a pressure being exerted from spring 245 to lever 240, to upper toggle link 268, thence to lower toggle link 265 which tends to rock counter-clockwise about stud 262 under this pressure, but is limited by the bushing 287 on the shaft 285.

When the tabulator bail 235 (Figure 4) is thus rocked counter-clockwise about the shaft 236, the link 237 is raised upwardly, and being held against the lateral extension 261 of the interponent 1260 by spring 234, rides along the surface of the lateral extension 261 until its shoulder 239 abuts the lower edge of said extension, whereupon it rocks the interponent 1260 clockwise about the stud 262. A similar clockwise movement is imparted to lower toggle link 265 (Figure 9) by the contact of the upper edge of the lateral extension 261 against the shoulder 266 of the toggle link 265 until the toggle link joint at 267 is forced past center, at which time the starting lever 240 is freed to be rocked downwardly about stud 234 by spring 245, carrying with it the T member 292, which has been positioned over ear 252 or 251, as previously described, to contact one or the other of the ears of the operating lever 1250, and rotate the operating arm clockwise or counter-clockwise, thus actuating mechanism to engage the shift clutch 4300 as described in the section entitled "Carriage shift controlling mechanism."

A master tabulator key 220 (Figures 1 and 9) is also provided for initiating operation of the tabulator mechanism. This key is provided with two stems 221 guided for vertical movement on shaft 222 (Figure 9) extending through slots 223 in said stems, and pivotally connected at 227 to upward extensions of a bail 226 pivoted on shaft 230 and provided with a downward extension 228 adapted to contact a lateral extension 232 of bail 235 to rock the latter when key 220 is depressed. The key is normally maintained in raised position by spring 229 tensioned between the pivot stud 227 and a stud 225 on the machine frame, but upon depression will rock bail 235 to initiate operation of the tabulator mechanism as above described.

It is possible to initiate a tabulated shift by means of this master tabulator key **220** even though no tabulator key **200** stands depressed, since the keys **200** comprise what is known in the art as a "flexible keyboard" and any depressed key **200** may be caused to rise by depressing any other key **200** just sufficiently to move latch bar **213** enough to release the latched down stem **202** and then letting up the second key before it has been depressed far enough to cause its stem **202** to be latched down by bar **213**.

Means are provided whereby the right end control lever **290** (Figure 8) will be automatically positioned for a tabulated carriage shift to the left whenever the master tabulator key is thus depressed without a carriage position having been selected by depressing a tabulator selection key **200**. A spring **288** (Figure 8) is tensioned between an upper projection **299** of end control lever **290** and a stud (not shown) riveted to a frame of the machine, so that if no tabulator key **200** is depressed so that its stem **202** is latched down, the shaft **285** will be rotated to its extreme counter-clockwise position, carrying T member **292** to the left where its arm **294** overlies ear **251** of operating arm **1250**. Thereafter upon subsequent depression of the master tabulator key **220**, a shift to the left will result.

Tabulator arresting mechanism

Means are provided to stop a tabulated shift when the carriage reaches its tabulated position. Referring to Figure 10, assume a shift has been initiated from order C to order A in the manner previously described, in which the lever **280A** and shaft **285** will have been rocked counter-clockwise (viewing Figure 10 from the left): the control lever **280A** being positively held by its roller **216** (Figure 2) and the shaft **285** being held in position by the difference in the three elevations of the steps of the controller **270**, differentially positions the three levers **280** in contact therewith.

As the carriage and controller **270** traverse toward the controlling order (now order A) and the intermediate step **276***a* of the controller moves into the bifurcation **276** of control lever **280A**, the controller **270** will be forced downwardly by the difference in the elevation of the steps **277** and **276***a*, and will rock all control levers **280** to the right and left of lever **280A** clockwise, as viewed in Figure 10. The shaft **285** thus will be freed by the levers **280** to the right of lever **280A** and positively rocked clockwise by the control levers **280** to the left of lever **280A**. This rocking of shaft **285** back to neutral functions to arrest the tabulated shift in a manner to be described hereinafter.

In order to permit this movement of shaft **285** to arrest the shifting mechanism, however, it is necessary to first restore and recock the starting lever **240** and means are therefore provided to recock this starting lever (Figure 9) by power derived from the shift clutch during the first cycle of its operation. On the downwardly extending arm **241** of the starting lever is riveted a roller **246** positioned to engage in the hook-shaped forward end of lever **300** so that when starting lever **240** moves downwardly the lever **300** is rocked counter-clockwise about shaft **301**, and, in turn, rocks the cam follower **1347** clockwise about shaft **431** until roller **1346**, riveted to the rear of said cam follower, contacts the low surface of the cam **1345** which is secured to the shift jack shaft **1331** (Figure 13) and is rotated whenever the shift clutch operates. At approximately the same time the roller **1346** contacts cam **1345**, said cam begins to rotate and rocks the cam follower **1346** counter-clockwise and lever **300** clockwise, thereby forcing starting lever **240** to its raised position as shown in Figure 9. The height of the cam **1345** is preferably of such magnitude that the starting lever **240** will be substantially overcocked, and the elongated hole **286** is provided for such overcocking and to allow the toggle links **288** and **265** to be returned to the position shown in Figure 9 by the torsion spring **259**. The cam **1345** makes one-half revolution for each shift cycle; therefore, the starting lever **240** is recocked at half cycle or one-quarter revolution of shaft **1331**, following which the starting lever **240** is permitted to lower the stud **242** until it seats in the bottom of the elongated hole **286**, and the remainder of the cycle idly rotates cam **1345** until its low point again underlies the roller **1346**.

If a tabulation is called for which will require six shift cycles before the tabulated position is reached, and the lever **240** is recocked during the first cycle, as just described, thus raising the T member **292** (Figure 8) with it and releasing the operating lever **1250**, the latter would, if allowed to return to its neutral position, stop the shift mechanism when only one of the six required cycles had been completed.

For this reason means have been provided to latch the operating lever **1250** in its operative position until only a partial cycle of operation is necessary to reach the tabulated position, at which time the latch will be disengaged to free the lever **1250** and stop the shift. For this purpose, operating arm latch **305** (Figure 8) is rockably mounted on stud **262** and has an upwardly extending arm **306** on which is formed a lateral extension **307** adapted to engage a projection **253** of the operating arm **1250**, while on the other extension of latch **305** is a slightly flattened nose **309** which underlies the roller **296** of lever **290**. A torsion spring **310** is provided to urge the latch **305** in a clockwise direction about stud **262** by the pressure of one of its ends against the ear **311** and the other end against the stud **316** on lever **315** (Figure 5). As described in detail hereinbefore, the end control lever **290** (Figure 8) is rocked as soon as the tabulating controls are conditioned for a shift, and remains in that position until the tabulated position has nearly been reached; therefore, when said end control lever is rocked either clockwise or counter-clockwise from its central position, the roller **296** is removed from the nose **309** of the latch **305**, thereby releasing the latch **305** to rock clockwise under the urge of spring **310** until its lateral extension **307** abuts the projection **253** of the operating arm **1250**, and upon subsequent rocking of the operating arm **1250** by T member **292** the projection **253** is removed from behind the lateral extension **307**, allowing said extension to move to a position where it underlies or overlies the projection **253**, thereby latching the lever **1250** against return movement after the T member **292** is raised.

When the tabulated position has nearly been reached, however, the end control lever **290** returns to the position shown in Figure 8, causing its roller **296** to ride up the side of nose **309** and rock latch lever **305** counter-clockwise to remove lateral extension **307** from underneath or above the projection **253** and allow operating arm **1250** to return to its neutral position under the urge

of spring 1400 (Figure 14), thus terminating the shift, as previously described.

The means effective to stop the carriage shifting operation, initiated by the master tabulator key 220 without having first selected a position with a tabulator selection key 200, comprises a stud 313 (Figure 12) riveted to the center frame 314 of the machine so as to lie in the path of controller 270. It will be recalled that the controller 270 travels in the opposite direction to that of the carriage, so that for this automatic carriage shift to the left, the controller moves rightwardly. It will also be recalled that the controller 270 will have been moved downwardly about its shaft 275, resulting from the rotation of shaft 285 and the rocking of control lever 280, and the only possible way to arrest a tabulated shift is to rotate shaft 285 back to neutral. For this purpose the stud 313 is in the form of a cone, the upper side of which serves to cam the controller 270 upwardly when it approaches its extreme right end position, thus rocking control levers 280 and the shaft 285 to their neutral positions and stopping the shift driving mechanism.

Means are provided to stop a rightward carriage shift initiated by the depression of the tabulator selection key 200, followed by some manual misoperation such as immediately depressing another tabulator selection key just enough to release the first key, but not enough to latch the second key down, and then allowing said second key also to rise. With no selection key 200 depressed, no control lever 280 will be positively held to stop a shift, and the driving mechanism might continue to run and attempt to shift the carriage beyond the right end position; therefore, a stud 313*a*, similar to the stud 313 (Figure 12) is riveted in the left side frame, located in the path of the controller 270 so that just before the carriage reaches its extreme right end position the controller will be cammed downwardly and rock the control lever 280, the shaft 285, and stop the shift driving mechanism.

As shown in Figure 1, juxtaposed the master tabulator key 220 is a clear key 122, the depression of which releases all numeral keys 100 locked in a depressed position, and simultaneously returns to zero all keyboard check dials 147, and a "Middle dial" clear key 2373 which controls one clear clutch to return to zero all product dials 418, and an "Upper dial" clear key 2910 provided to control another clear clutch to return to zero all counter dials 1874.

The numeral keys 100 (Figure 18), secured to their respective key stems 103, are slidably mounted in their key frames 101 and normally held in a raised position by springs 102, but when one of said keys is depressed its lower edge is adapted to impinge upon one of the divergent sides 130 of the selection bar 1120 and move it a proportional amount depending upon which key is depressed and lock said bar in a fixed position as the key stem enters the notch 131; and, as described in detail in the Harold T. Avery Patent Number 2,271,240, issued January twenty-seventh, 1942, the movement of the selection bar 1120 rotates the check dial 147 a proportional amount, thereby registering the figure in said check dial corresponding to the figure delineated on the numeral key depressed.

On the lower end of key stem 103 is a lug 116 with a curved surface at the bottom thereof, adapted to cam a lock bar 117 to the rear against the spring 118 until the lug 116 passes beneath said lock bar and allows it to spring forward to a position where it overlies the lug 116, thereby locking the key 100 in a depressed position against the tension of the spring 102 until the lock bar is again moved a sufficient amount to allow clearance for the lug 116.

Means are provided whereby the depression of a single clear key will slide the lock bars in all orders of the machine simultaneously, and free all keys 100 locked in a depressed position. On shaft 126 (Figure 17), mounted transversely of the machine, is rockably mounted a clear bail 125 which has an upwardly extending arm 127 underlying a roller 124 mounted on the stem of the keyboard clear key 122, said stem being slidably mounted in the usual way and maintained in a raised position by spring 123 tensioned between a lug on the lower end of the key stem and a stud riveted to the frame of the machine. When it is desired to clear the keyboard, the key 122 (Figures 1 and 17) is depressed and in its downward movement its roller 124 impinges the side of arm 127 and rocks bail 125 clockwise about shaft 126 until its pad 129 (Figure 18) contacts the slidable lock bars 117 and forces them to the rear, thereby releasing all depressed keys 100 in the manner previously described.

When a depressed key 100 rises out of the notch 131 of its respective selection bar 1120, as just described, said selection bar is free to move on its suspending links 128 and 129 (129 not shown) in response to a spring provided for the purpose, to its forward position, thus, by its connection to the check dial 147, restoring that dial to zero as shown completely in said Avery patent.

The product and counter dials are cleared by power derived from the motor, instead of manually as in the case of the check dial clearance just described. Keys 2373 and 2910 (Figure 1) are provided to control said motor power and the clutches driven thereby to accomplish this clearance operation.

The "Middle dial" clear key 2373 (Figure 19) by which the clutch 2360 is controlled, is secured to the upper end of key stem 2375 which is slidably mounted on a stationary shaft 2374, and rockably mounted at its lower end on bail 2346 by means of stud 371, said bail being pivotally mounted on shaft 344, and a spring 2372 tensioned between the stationary shaft 2374 and one end of stud 371, thereby maintaining the key 2373 and the bail 2346 in the position shown in Figure 19. On the downwardly extending arm of bail 2346 is a shoulder stud 2349 adapted to operate in the L-shaped aperture 2348 of link 2347, said link being provided with a nose 345 adapted to ride upon stud 343 secured to the framing of the machine when it is moved by bail 2346. The rear end of link 2347 is connected to bell crank 2376, pivotally mounted on stud 2377, and having a shoulder stud 2378 secured to its upper end adapted to be embraced by the bifurcated forward end of clutch operating lever 379, said operating lever being made integral with clutch dog 381 which is normally held in position to lock clear clutch 2360 against rotation by spring 2382.

Thus clear clutch 2360 is not effective to transmit power from the motor until dog 381 is moved rearwardly to cause clutch engagement. The construction of this type of clutch is well known and is similar to that shown in Figure 11 of Friden Patent Number 1,643,710 to which reference may be had for details thereof. A cam 363 keyed to a sleeve integral with the driven side of clutch 2360 is adapted to impart a clockwise rocking

movement to cam follower 364, pivoted at 2365, and held against the cam by spring 2366, and to thus move the rigid U-section link 367 connected to the upper end thereof. The left end of link 367 is pivotally connected to a lever 368 fixed to a sleeve 369, splined to slidable carriage support shaft 359 which shaft is journaled in and laterally shiftable with the carriage. This shaft, is, therefore, rocked by operation of the clutch 2360 no matter what the position of the carriage may be at the time.

From the foregoing it is evident that upon depression of key 2373, clutch dog 381 is rocked counter-clockwise to release clutch 2360 and upon engagement of said clutch cam 363 is rotated, the effect of which is to impart clockwise rocking movement to cam follower 364 and counter-clockwise movement to shaft 359 to return to zero all product dials, in a manner completely disclosed in the above noted Avery Patent Number 2,271,240.

Means are provided to prevent continuous rotation of the clear clutch if the operator should hold the clear key 2373 depressed. When link 2347 is moved forwardly as just described, its nose 345 rides up on stud 343, thereby camming link 2347 upwardly to a position where the L-shaped aperture of said link may move rearwardly over stud 2349, under the urge of spring 2382 until the clutch dog 381 contacts the housing of clutch 2360 on which it rides until said clutch completes its cycle. At this time the dog 381 drops into a recess on said clutch housing, thereby disengaging the clutch until key 2373 is again depressed. When the operator releases the clear key, its stem 2375 and bail 2346 will be restored by spring 2372, said restoration thus moving the stud 2349 rearwardly until the link 2347 can drop down to the position shown in Figure 19.

The clearance of the counter dials is accomplished in precisely the same manner as just described. The connection between the "Upper dial" clear key 2910 and its respective clear clutch 2911, identical to clutch 2360, is substantially the same as controlled by key 2373. The engagement of clutch 2911 rotates cam 1915, the effect of which imparts counter-clockwise rocking movement to cam follower 2916 about shaft 2365, clockwise rocking of lever 1917 and shaft 354 to return to zero all counter dials, as described in detail in the above noted Avery Patent Number 2,271,240.

Interlocks

When the master tabulator key 220 is depressed simultaneously with either the clear key 2373 or clear key 2910, or both, typical in the operation of the present invention, it is necessary to provide means for disabling the shift controlling mechanism until the clearance operations are completed. Said means comprises, in the clear control trains, arms 400 and 400A (Figure 19) extending downwardly from bell cranks 2376, either of which is adapted to restrain the shift controlling mechanism. The shift control train includes the centralizer 1403, the lower end of which has pivotally connected thereby by stud 2411, the left end of a link 1412 on the other end of which is an elongated hole 1414 engaging with a stud 401 secured to bail 402. This construction affords a lost-motion connection between bail 402 and lever 1403, when operated in one way, but a positive and effective connection when operated reversely, as will be presently described. Bail 402 is pivotally mounted on shaft 403 and the forwardly extending arm thereof is attached to the lower end of link 404, the upper end of which is pivotally connected to an arm of interlock 393. Said interlock is pinned to shaft 386, and is provided on the upper end thereof with a lateral extension 399 adapted to cooperate with arm 400 of bell crank 2376.

In the typical operation cited above, in which the master tabulator key and either or both of the clear keys are simultaneously depressed, the arm 400 (Figure 19) is lowered behind extension 399 at the beginning of the downward movement of key 2373 or 2910, to hold interlock 393 against clockwise movement, before either the shifting or clearing operations are initiated. As the keys are depressed further, the dog 381 releases clutch 2360 to function at approximately the same time as the tabulated shift is tripped for initiation, which, as will be recalled from the previous description, drops T member 292 (Figure 9) onto one of the ears, 251 or 252, of operating arm 1250 under the tension of spring 245, thus tending to rock arm 1250 (Figure 14) and lever 4375, during which rocking, centralizer 1403 must be forced to the left, carrying with it link 1412 (Figure 19). The stud 401, being at the right end of elongated hole 1414 is thus forced toward the left to impart clockwise rocking of bail 402, upward movement to link 404, and clockwise rocking to interlock 393. But the arm 400, having been lowered behind lateral extension 399, prevents this rocking of interlock 393 and restrains the movement of the shift train just described, back as far as the levers 1480 and 2481 (Figure 14) which compress spring 1490 and function to delay the shift operation until the clear clutch has completed its cycle. At this time the dog 381 (Figure 19) riding on the housing of the clutch 2360, drops into a recess therein, and raises arms 400 and/or 400A to the position shown in Figure 19. The interlock 393 will thus be free to rock clockwise and allow the shifting operation to start. The function of noses 397 and 383, acting through ear 2384 to levers 385 and 388 to close the electric motor switch, is disclosed completely in the above noted Avery Patent Number 2,271,240.

The performance of calculations on the calculating machine incorporating the tabulator above described, ordinarily involves an automatic shift of the carriage, or requires a traverse of the carriage by some means; and the tabulator was conceived for the primary purpose of returning the carriage to a given position after certain calculations and ensuing carriage shifting operations. Therefore, it is imperative to provide means for preventing operation of latch 305 (Figure 8) except when the tabulator controls are effective, in order to prevent certain misfunctions. From the foregoing description of the tabulator setting mechanism, it will be recalled that when the carriage is moved a slight amount out of its tabulated position, the shaft 285 and end control lever 290 is rocked to such an extent that roller 296 is removed from nose 309, thus releasing latch 305 into operation. This all occurs at the beginning of the first shift cycle which we may assume was initiated by an automatic shift in multiplication or division, or by the depression of a shift key 2405 or 2406; but whichever it may be, the shaft 2485 and tabulator operating arm 1250 will have been rocked to a position where the lateral extension 307 of latch 305 would be free to drop in under or over the nose 253 to prevent return movement of operating arm 1250 unless latch 305

were disabled. The shift controls would be locked in operation and the shift might continue indefinitely since the latch **305** can be disengaged by the tabulating controls only.

Means have been provided, therefore, to disable latch **305** except during a shift initiated by the tabulator controls, thereby making this misfunction impossible. Restraining lever **315** (Figure 5) is freely mounted on shaft **285** and is held in a position with its shoulder **317** normally against the roller **297** mounted on stud **293** (Figure 8) riveted to lever **240**, by the pressure of torsion spring **310** against the stud **316**. An ear **318** is formed on the restraining lever **315**, which operates in conjunction with the lateral extension **307** of latch **305**, and the parts are shown in Figure 5 in the positions occupied when the tabulator starting lever **240** is in its raised or cocked position with the ear **318** restraining the clockwise movement of latch **305**. If a shift is initiated by the starting lever **240**, roller **297** travels downwardly with starting lever **240** and rocks member **315** clockwise about shaft **285** to remove ear **318** from behind lateral extension **307**, thereby releasing latch **305** to latch operating arm **1250**. During the first shift cycle, when starting lever **240** and roller **297** are raised, lever **315** is also released to be raised by spring **310** until its ear **318** contacts the underneath surface **303** of lever **305**, which has been rocked clockwise to engage operating arm **1250**. When the tabulated position is reached the latch **305** will be rocked counter-clockwise in the manner described hereinbefore, thereby allowing the member **315** to rise to the restraining position shown in Figure 5.

If a directional shift key **2405** or **2406** is depressed, however, the starting lever **240** will not function, and latch **305** will be restrained, making it possible for lever **1250** to rock shaft **2485** and return to its centralized position upon release of the shift key.

Figure 7 illustrates the form of the lateral extension **307** which makes it possible for ear **318** (Figures 5 and 7) of lever **315** to engage lateral extension **307** of latch **305** and still allow projection **253** of operating arm **1250** to move up and down and also engage extension **307**.

Means are provided to disable the tabulator starting mechanism when the carriage occupies the position corresponding to a depressed tabulator key. On the lower section of control lever **290** (Figure 6) is riveted a stud **298** adapted to engage in the slot **321** of tabulator disabling lever **320**, said disabling lever being freely rockable on stud **262**, and provided with a nose **322** adapted to engage one end of a stud **231** riveted to bail link **237**. When the carriage occupies the position corresponding to a depressed tabulator key, the shaft **285** and control lever **290** are in their neutral position and hold the disabling lever **320** in the position shown in Figure 6 where its nose **322** lies in the path of stud **231**, so that upon depression of either the master tabulator key **220** or a tabulator selection key **200** to rock the tabulator bail **235** counter-clockwise and initiate a shift, the bail link **237** is rocked counter-clockwise about stud **233** as the stud **231** rides over the end of nose **322**, thereby preventing the contact of shoulder **239** (Figure 4) of link **237** with the lower surface of the ear **261** of the interponent **1260**, movement of which trips the toggle and releases the starting lever **240**. If the carriage is out of the position corresponding to a depressed tabulator key, however, the shaft **285** and end control lever **290**, as previously described, will have been rocked clockwise or counter-clockwise, thereby rocking disabling lever **320** and moving nose **322** thereon out of the path of stud **231**, thus allowing bail link **237** (Figure 4) to function normally and initiate a tabulated shift.

Means are also provided to allow the toggle and tabulator starting lever **240** to return to and be locked in their initial positions, even though the operator may hold a tabulator key depressed after one-half of the first shift cycle has been completed. The starting lever **240** (Figure 9) has on its downwardly extending arm **241** a leftward projection **247** adapted to rock link **237** counter-clockwise by engaging the stud **231**, so that if the operator holds any of the keys **200** or the key **220** depressed, holding the link **237** in its upward position, projection **247** will force link **237** out of engagement with interponent **1260** and allow said interponent to return to its extreme counter-clockwise position before the starting lever **240** is recocked, thereby preventing repeated tripping of the starting lever **240** during each shift cycle.

Typical methods of use in calculation

Specific examples of the operations capable of being effected by the various tabulator keys and other control keys of the machine, will most clearly illustrate the advantages of the present invention in connection with a machine of the general type disclosed in the above noted Avery Patent Number 2,271,240.

In addition to the clear keys **122**, **2373**, and **2910** (Figure 1), the shift keys **2405** and **2406**, and the automatic tabulating shift described hereinbefore, the above mentioned machine comprises a zero multiply key **2001** and a series of multiplier keys **2002** for performing the multiplication of a number set up in the numeral keys **100**, a single depression of any one of which will effect a carriage shift one order to the left or to the right, depending upon which shift directional control key **1201** or **1202** has been previously set.

If, for example, in office routine calculations, an operator makes a series of computations of the same type, such as multiplication, in which the multipliers comprise from two to five digits, the operator may latch down the number four tabulator selection key which is to the high of the mean between the two and five digit multipliers just mentioned. If the size of the multipliers is usually the same, however, with only an occasional deviation therefrom, he will, of course, depress the tabulator selection key corresponding to the number of digits in the most frequently occurring multiplier. Assume, however, that he selects and depresses the number four tabulator selection key to effect return of the carriage to number four position after each calculation by the depression of the master tabulator key **220**, simultaneously with the clear keys. If the multiplier of the next example is a three-digit number, for instance **725**, the operator will consecutively depress the 0–7–2–5 multiplier keys **2001** and **2002**, the zero serving to shift the carriage one order to the left before the multiplication operation functions. If the multiplier in the next problem is a two-digit number, for instance **68**, the operator will depress 0–0–6–8 on the multiplier keys, thereby shifting the carriage two orders to the left before effecting the multiplication by six and eight. If the next problem, however, has a five-digit multiplier, the operator will make a short depression of the right

hand directional shift key 2405 and immediately begin the multiplication.

If in another series of calculations the multiplier varies widely and inconsistently, so that no position can be readily selected, the proper one of the series of tabulator selection keys can be completely depressed after each computation, and the carriage shift will be initiated and automatically terminated in the selected position.

For the convenience of operators who have become accustomed to starting all calculations with the carriage in one or the other of the extreme end positions, means have been provided whereby the present machine may be conditioned to return the carriage to either end position. The depression of the master tabulator key without any selection having been made by the depression of a tabulator selection key, will operate just the same as when the number one tabulator selection key is depressed and will always shift the carriage to the number one position; while, if the other extreme position is desired, the latching down of the stem 202 of the number eight tabulator selection key will always return the carriage to the other end position upon subsequent depression of the master tabulator key.

The entire arrangement possesses a flexibility that readily adapts it to use on any problems that may arise. For instance, if after using a number of multipliers ranging from two to five digits each, as above described, a number of multipliers are encountered ranging from five to seven digits, the number six tabulator selection key may be depressed for the first one in this group, and then the master tabulator key used for the remainder of the group in the general manner above described. Also, instead of making a series of extensions in the order listed, an operator could at his option, first extend all calculations involving three-digit multipliers, then all those involving four-digit multipliers, et cetera, depressing the proper tabulator selection key for the first calculation in each group and the master tabulator key for the remainder of the group.

With the arrangement disclosed, the operator can utilize the master tabulator key in any of these many ways to which it is adapted, and at the same time effect the clearance of any desired combination of dials, without any preconditioning operation being required in order to secure any of the many various results.

For instance, by depressing the master tabulator key and all three clear keys simultaneously, all dials will be restored to zero and the desired positioning of the carriage secured, all by a single manual stroke of the operator. However, by merely varying the combination of keys simultaneously depressed, any one of a large number of different results may be secured by a similar single manual stroke.

For instance, if it is desired to utilize the counter dials to accumulate multipliers, the operator simultaneously depresses the master tabulator key 220, keyboard clear key 122, and the middle dial clear key 2373, at the beginning of each calculation; while to accumulate products, he simultaneously depresses the master tabulator key 220, keyboard clear key 122, and upper dial clear key 2910; and to retain a constant multiplicand, he simultaneously depresses the master tabulator key 220, the middle dial clear key 2373, and the upper dial clear key 2910. Any of the above combinations executed without the depression of the master tabulator key 220, will clear the selected dials and leave the carriage fixed as may, for instance, be desired for making an addition.

Sequence of mechanical operations

A summary of the functions of the mechanisms resulting from one of the foregoing examples will aid in understanding the invention as a whole; therefore, let us use the first example cited above, in which the number four tabulator selection key has been depressed to shift the carriage to the number four position, and in this case Figure 2 will represent the fourth or controlling order of the machine in which the tabulator selection key 200 has remained partially latched down by lock bar 213 after the shift initiated thereby, and the notch in the lower end of key stem 202 has forced lever 215 counter-clockwise so as to press its roller 216 against the divergent sides 281 of control lever 280 to rotate it to its intermediate position as shown. With the controller 270 in the position corresponding to the depressed key, its intermediate step 276A (Figure 12) is at rest in the controlling order with the shaft 285 in neutral. Before the ensuing multiplication the shift direction control key 1201 (Figure 1) is depressed to control the automatic shift mechanism for a shift to the left, so that as an incident to the subsequent multiplication operation resulting from the manipulation of the multiplier keys 2002, an automatic shift, one order to the left occurs after the multiplication by each digit, until the computation is completed and the carriage reaches the number one position. During the automatic shifting operation just mentioned, the controller 270 (Figure 10) moves an equal amount, but to the right, and the control lever 280 (Figure 2) of the fourth order being held by roller 216, controller 270 (Figure 10) is cammed upwardly and transmits its rocking movement to all control levers 280 to the right of the controlling order. Shaft 285 is thus rocked clockwise, thereby rocking end control lever 290 (Figure 8) which through link 291 rocks the T member 292 to the right, so that its arm 295 overlies the ear 262 of the operating arm 1250. With the calculation completed and the tabulating mechanism thus automatically set, the dials of the machine are cleared by the simultaneous depression of the three clear keys 122, 2373, and 2910 (Figure 1) and the master tabulator key 220 to initiate a tabulated return shift to the number four position. The downward movement of the master tabulator key 220 (Figure 9) and its key stem 221 rocks bail 226 and its integral arm 228 clockwise, thereby contacting lateral extension 232 to rock operating bail 235 counterclockwise, carrying the bail link 237 upwardly so that its shoulder 239 contacts the lower surface of lateral extension 261, the upper side of which is in a position against the shoulder 266 so that upon clockwise rotation of the interponent 1260, the toggle joint 267 is moved to the right until it passes center to release operating arm 240 which rocks downwardly carrying with it the T member 292 and rocking operating arm 1250 clockwise.

This results in a similar rocking of shaft 2485 (Figure 14), thus moving arm 2481 and link 2483 to the left, the lever 4375 clockwise, the link 4374 to the right, control dog 1301 clockwise, and the dog 4302 into engagement with ratchet 1303 to initiate carriage shifting to the right.

During the first shift cycle the cam 1345 (Figure 9) is rotated, thus camming roller 1346 upwardly and forcing cam follower 1347 counter-

clockwise, lever 300 clockwise, and starting lever 240 upwardly to a position shown in Figure 9, with the toggle links 288 and 265 and interponent 1260 in the position shown to lock the starting lever 240 in its raised position. This recocking occurs during the first shift cycle, while three more cycles are necessary to bring the carriage to the number four position. The T member 292 was thus raised from engagement with the operating arm 1250 (Figure 8), but said operating arm is held by latch 305, moved into engagement therewith at the beginning of the shift, which retains lever 1250 in its operating position until the tabulated position has been reached.

The controller 270 (Figure 10) moves leftwardly towards the controlling order during this tabulated shift until it is forced downwardly by the control lever 280 of the controlling order, thereby rocking all the control levers except the number four counter-clockwise and forcing shaft 285 back to its neutral position shown in Figure 8. The end control lever 290 and its roller 296 thereupon engage the nose 309 and rock lever 305 counterclockwise to release the operating arm 1250, thus stopping the shift.

The second form of the present invention is shown as embodied in the commercially known "Marchant" calculating machine as shown in the aforementioned Avery Patent Number 2,271,240, and this form will next be described in detail.

Division key control of clear clutch

As described in the aforementioned Avery Patent 2,271,240, there are two clear clutches and two sets of controls therefor; one clutch being provided to clear the product dials and the other to likewise clear the counter dials. It being an object of this invention to control the latter by the division key, as well as a clear key, means are provided to connect said division key with the controls for said clear clutch.

The division key 970 (Figure 21), which is depressed to initiate an automatic division operation as described in the aforesaid Avery Patent 2,271,240, is mounted on a key stem 971, held in position by two links 972 and 973 to allow up and down movement of said key stem. A link 965 is pivotally attached at one end thereof to a downwardly extending arm of the link 973, and at its other end to a lever 1026, fixed to a shaft 1256. This shaft runs laterally of the machine and on the rightward end thereof is fixed a second lever 1804 (Figure 22) so that upon depression of the division key 970 shaft 1256 and lever 1804 are rocked in a clockwise direction.

A stud 105 is secured to a depending arm of lever 1804 and is adapted to engage the left edge (Figure 22) of an aperture 349 and move link 348 to the left. A second aperture 350 in the form of an L is provided on the right end of link 348 embracing a stud 120 attached to the downwardly extending arm of a bell crank 376, said bell crank having at its upper end a stud 378 which is embraced by the bifurcated forward end of clear clutch bail 1913. A clutch dog 1911 is formed on bail 1913 and functions to release the clear clutch 1900 so that it will operate when the link 348 rocks bell crank 376 clockwise about stud 377, and clutch bail 1913 counterclockwise about shaft 600.

A cam follower 1916 is freely rockable on shaft 365 and is urged against the cam 1905 by spring 366, so that as the clutch 1900 functions and rotates cam 1905, it imparts counter-clockwise rocking to cam follower 1916 and clockwise rocking to lever 1918 attached to the upper end thereof, to clear all counter dials in a manner completely described in the aforesaid Avery Patent 2,271,240.

One cycle clear

Means are provided whereby the clear clutch 1900 is automatically limited to one cycle of operation. Beneath the link 348 (Figure 22) is a stud 106 rigidly attached to the machine frame and so located thereon as to lie in the path of curved surface 107 of link 348. As said link is moved forwardly to cause engagement of the clear clutch, it is cammed upwardly by stud 106 until stud 120 is free to pass rearwardly in the horizontal part of the L-shaped aperture 350 and free the clutch controlling mechanism so that the clutch will be disengaged at the end of its cycle. The stroke of lever 1804 is greater than would be required to release clutch 1900 so that during said stroke the clutch dog 1911 is first moved to release the clutch, and the further movement thereof breaks the effective connection between link 348 and bell crank 376, described above, at which time stud 120 moves only that distance rearwardly in the horizontal part of the L-shaped aperture, allowed by the movement of the dog 1911 from the high point of its stroke to where it rests on the housing of clutch 1900. At the end of the first revolution of the clutch, however, clutch dog 1911 re-seats in the recess of the clutch housing and disengages the clutch; this re-seating being possible because the stud 120 is free to move to the right in aperture 350.

Additional means are provided to insure single cycle operations of the clear clutch, even though the lever 348 is moved only far enough to engage the clear clutch but not enough to be cammed upon stud 106 to the height necessary for the stud 120 to pass to the rear portion of aperture 350, thereby avoiding the necessity of depending on additional key movement to effect the trip off. This mechanism includes a guide 110 pivoted to link 348 at 111, and limited in the amount of its movement by two lugs 112 and 113. Also included, is a roller 1914 mounted on clutch release dog 1911 in the plane of the counter clear cam 1905 in such a manner that at each rotation of the clear clutch the high of the cam engages roller 1914 and rocks dog 1911 a predetermined distance from the periphery of the clutch. This movement results in a downward rocking of levers 1913 and 376 in excess of the movement transmitted from key 1910 and, therefore, results in link 348 being moved further forward than the position into which it need be manually moved to engage the clutch. This forward movement cams link 348 up higher on stud 106 and well above the height necessary for stud 120 to enter the horizontal leg of the aperture 350, but since the camming is produced by the forward pressure of stud 120 on the front face of aperture 350 and the link 348 will tend to maintain such pressure during the return of stud 120, no tendency will exist for stud 120 to move rearwardly into the horizontal leg of aperture 350 until the pressure between lever 376 and link 348 is appreciably reduced.

It is for this reason that guide 110 is provided, and the arrangement is such that when link 348 is cammed to the left and upwardly, as a result of cam 1905 engaging roller 1914, guide 110 is first rocked in a counter-clockwise direction on its pivot 111 by means of stud 106. Then

as the leftward and upward movement continues, the tip 108 drops into place above the stud 106, so that when the parts return, link 348 does not fall back into its initial position along the same path on which it moved upward, due to the tip 108 of the guide engaging the top of stud 106; instead, it moves horizontally to the right for a certain distance at a level higher than that necessary to permit stud 120 to pass into the horizontal leg of aperture 350. Guide 110 constrains the rear end of link 348 to thus move to the right for a horizontal distance greater than that required for the link to return to the position into which it was brought by the depression of the key; therefore, stud 120 will be free to move on rearwardly into the horizontal leg of aperture 350, thus dropping the clutch release dog 1911 into position to stop the clutch at the end of the cycle.

The mechanism just described is operated in the same manner when actuated by the key 1910 as when actuated by lever 1804. The upper dial clear key 1910 is secured to the top of key stem 375 (Figure 22), slidably mounted in the machine in such a way as to be limited in its stroke by the stationary stud 374, and normally maintained in a raised position by spring 373, tensioned between studs 374 and 372, the latter one serving also as a pivotal connection between the lower end of said key stem and a bail 346, pivotally mounted on shaft 347. A downwardly extending arm of bail 346 is connected to the forward end of link 348 to effect leftward movement of said link to release clutch 1900 when key 1910 is depressed.

Control of automatic division

In the machine disclosed in the aforesaid Avery Patent 2,271,240 an automatic division operation is initiated by depressing key 970. Roller 974 on the stem 971 of said key normally lies in contact with the right edge of the upper portion of the division operating arm 975 which is pivotally mounted at 976 and urged clockwise by a strong spring 977. Roller 974 thus prevents clockwise movement of arm 975 until it is moved to substantially the position in which it is shown in Figure 23, prior to which the key 970 will have been depressed far enough to initiate operation of the clear clutch as has been described.

When roller 974 has moved to the position in which it is shown in Figure 23, arm 975 will be rocked clockwise by spring 977 and roller 979 carried on arm 975 will depress a bar 503 pivotally mounted for parallel movement upon a link 544 pivoted to the machine frame at 544a and a plate 505 pivoted to the machine frame at 507; said bar being normally maintained in raised position by a spring 510 tensioned between the lower end of link 544 and the frame.

Depression of bar 503 carries downwardly a link 514 pivotally mounted on plate 505 at 513 and provided with a notched lower end which is maintained in engagement with an ear 515 of clutch dog 394 by a spring 516 tensioned between link 514 and bar 503. Clutch dog 394, rockably mounted on shaft 501, is normally maintained in engagement with a notch of clutch 430 to lock the same, by a spring 522 tensioned between the dog and the frame, but spring 977 is sufficiently strong to overcome spring 522 and rock the dog 394 counter-clockwise upon depression of the division key 970.

The driving engagement of clutch 430 effected by such movement of dog 394 carries on the automatic division operation as described in detail in the aforesaid Avery Patent 2,271,240. According to the present invention, however, means are provided for delaying the rocking of clutch dog 394 until the clearance operation has been completed.

The clear clutch controlling bell crank 376 (Figure 22) moves clockwise when the division key is first depressed, thereby lowering the arm 400 thereof behind a lateral extension 399 of an interlock 393 to prevent clockwise movement of said interlock and the shaft 386 to which it is fixed. A second lever 396 (Figure 23) is also fixed on shaft 386 and has an ear 409 adapted to overlie the setting clutch control dog 394.

The parts are shown in Figure 23 in the position they assume when division key has been depressed and the clear clutch is in approximately its mid-cycle position, thereby locking the dog 394 against operation.

When the roller 974 is removed from restraining relation with the division operating arm 975, said arm is moved clockwise by spring 977, its roller 979 forcing the bar 503, triangular plate 505, and link 514 downwardly until the play is taken up between the upper shoulder of the notch of link 514 and the ear 515. The clutch control dog 394 and the levers 396 and 393 being restrained by arm 400, however, limit the movement of link 514 and operating arm 975 to only that amount allowed by the play between ear 515 and link 514. When the clear clutch completes its cycle, however, the members 1913 and 376 are raised together with the arm 400 to free interclock 393. At this time the spring 977 moves division operating lever 975 further clockwise, thereby imparting downward movement to link 514 and counter-clockwise movement to clutch control dog 394 to effect engagement of the setting clutch 430 and carry forward the division operation as described completely in the aforementioned Avery Patent 2,271,240.

Means are provided to insure the complete depression of the division key, in case the operator ceases to press upon said key when he hears the machine begin to clear the counter register. The division operating arm 975 is urged rearwardly by the strong spring 977, and the connecting linkages are so proportioned that when the division key is depressed far enough to initiate the operation of the clear clutch, said key is forced further down by the pressure of the rounded lower corner 975a of division operating arm 975, against the upper side of roller 974, to cause the complete tripping of the controls.

Clearance disabling mechanism

Means are provided whereby the above described clearance operation initiated by the division key may be eliminated, if desired, by the depression of a disabling key. A special key can be added to a machine requiring such an arrangement, but for convenience and economy, it is possible to utilize one of the carriage shift keys for this purpose, since the shift key linkage of the machine of the Avery Patent 2,271,240 is disconnected when the machine functions in division.

A complete disclosure on the carriage shifting mechanism may be found in the aforesaid Avery Patent 2,271,240, but will be briefly outlined herein. The two shift keys 1405 and 1406 (Figure 21) are connected to pin 1409 which moves to the right or to the left, depending upon which key is depressed. Said pin is embraced by the bi-

furcated upper end of lever 1482, which rocks shaft 1485, and lever 1481 fixed thereto, thereby imparting longitudinal movement to link 1483, rocking movement to lever 1375 pivoted at 1376, and so on to link 1374 and clutch control dog 1302 to control the shift clutch 1300.

As described hereinbefore, when the division key is depressed lever 1026 (Figure 21) is rocked clockwise with shaft 1256. Connected to lever 1026 is a link 1476, the other end of which is attached to the link 1483 so that as lever 1026 is rocked in this manner the rear end of link 1483 is forced down so that its notch 1474 becomes disengaged from ear 1471 formed on the lower end of lever 1375, thereby rendering the keys 1405 and 1406 ineffective to initiate operation of the shift clutch.

The lever 1482 (Figure 24) is provided with a downwardly extending arm on which is a lateral extension 1464 formed in such a manner as to underlie the link 348. The arrangement is such that when the shift key 1406 is depressed concurrently with the division key, to disengage the normal clearance operation, the pin 1409 moves to the left, thus imparting counter-clockwise movement to lever 1482, raising ear 1484 and the rear end of link 348 to a position in which the horizontal leg of aperture 350 is aligned with stud 120. When link 348 is subsequently moved to the left by stud 105 in the manner previously described, the horizontal part of aperture 350 merely passes over stud 120 without imparting any motion to the bell crank 376 and no clearance operation is instituted.

Interlock

If an operator of such a machine should attempt to perform the above described disabling operation, but instead of depressing the division key and shift key concurrently, he depresses the shift key first and after the shift is in operation he attempts to initiate a division operation, means are provided to make such depression ineffective until the shift cycle is completed, so no damage to the machine would result. Lever 1410 (Figure 21) is pivotally attached to the framing of the machine by stud 1411 and is provided with a lug 1408 formed laterally to contact lever 1375 above its pivot 1376 and an adjustable lug 1415 adapted to contact lever 1375 below its pivot, therefore if the lever 1375 is rocked clockwise or counter-clockwise to control a shift to the right or left, the lever 1410 is always moved leftwardly, carrying with it a link 1418 and forcing interlock 1416 to rock clockwise about stud 1417 to a position in which its upper surface 1419 underlies ear 1420 of the triangular plate 505. In viewing Figure 23, it will be recalled that if this triangular plate is restrained, the division mechanism will be locked against operation until the interlock 1416 (Figure 21) is removed from beneath ear 1420, which will occur when the shift clutch control dog 1302 and centralizer 1410 is returned to the position shown in Figure 21 by spring 1375a.

It will be apparent to those skilled in the art that both forms of the invention may be conjointly used in the same machine if desired and that the invention is not to be regarded as restricted to the specific forms illustrated except as required by the spirit of the appended claims.

I claim:

1. In a motor driven machine of the character described, a first cyclically operable clutch mechanism and control means for initiating and interrupting operation thereof; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device for said spring energized member, interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said restraining device, means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means, and means operable by a single manual stroke for operating the control means for initiating operation of said first clutch and releasing said spring energized member from said restraining device.

2. In a motor driven machine of the character described, a first cyclically operable clutch mechanism, control means for initiating operation thereof and means operable by the motor for interrupting operation of said clutch; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device for said spring energized member, interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said restraining device, means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means, and means operable by a single manual stroke for operating the control means for initiating operation of said first clutch and releasing said spring energized member from said restraining device.

3. In a motor driven machine of the character described, a first cyclically operable clutch mechanism and control means for initiating and interrupting operation thereof; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device for said spring energized member, interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said restraining device, means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means, a depressible key, a control connection between said key and the control means for said first clutch mechanism for initiating operation of said first clutch mechanism, and a second control connection selectively operable simultaneously with or independently of said first mentioned control connection for releasing said spring energized member from said restraining device.

4. In a motor driven machine of the character described, a first cyclically operable clutch mechanism, control means for initiating operation thereof and means operable by the motor for interrupting operation of said clutch; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device for said spring energized member, interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said restraining device, means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means, a depressible key, a control connection between said key and the control means for said first clutch mechanism for initiating operation

of said first clutch mechanism, and a second control connection selectively operable simultaneously with or independently of said first mentioned control connection for releasing said spring energized member from said restraining device.

5. In a motor driven machine of the character described, a first cyclically operable clutch mechanism and control means for initiating and interrupting operation thereof; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device for said spring energized member, interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said restraining device, means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means, means for concurrently operating the control means for initiating operation of said first clutch and releasing said spring energized member from said restraining device, and means settable to render the control means of said first clutch ineffective to initiate operation thereof.

6. In a motor driven machine of the character described, a first cyclically operable clutch mechanism, control means for initiating operation thereof and means operable by the motor for interrupting operation of said clutch; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device for said spring energized member, interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said device, means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means, means for concurrently operating the control means for initiating operation of said first clutch and releasing said spring energized member from said restraining device, and means settable to render the control means of said first clutch ineffective to initiate operation thereof.

7. In a motor driven machine of the character described, the combination with a first cyclically operable clutch mechanism and control means for initiating and interrupting operation thereof; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device therefor, and a key for releasing said member from said device; interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said device by said key; and means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means; of means actuated by said releasing key for operating the control means for initiating operation of said first clutch.

8. In a motor driven machine of the character described, the combination with a first cyclically operable clutch mechanism, control means for initiating operation thereof and means operable by the motor for interrupting operation of said clutch; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device therefor, and a key for releasing said member from said device; interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said device by said key; and means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means; of means actuated by said releasing key for operating the control means for initiating operation of said first clutch.

9. In a motor driven machine of the character described, the combination with a first cyclically operable clutch mechanism and control means for initiating and interrupting operation thereof; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device therefor, and a key for releasing said member from said device; interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said device by said key; and means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means; of means actuated by said releasing key for operating the control means for initiating operation of said first clutch, and means settable to render the control means of said first clutch ineffective to initiate operation thereof.

10. In a motor driven machine of the character described, the combination with a first cyclically operable clutch mechanism, control means for initiating operation thereof and means operable by the motor for interrupting operation of said clutch; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device therefor, and a key for releasing said member from said device; interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said device by said key; and means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means; of means actuated by said releasing key for operating the control means for initiating operation of said first clutch, and means settable to render the control means of said first clutch ineffective to initiate operation thereof.

11. In a motor driven machine of the character described, the combination with a first cyclically operable clutch mechanism and control means for initiating and interrupting operation thereof; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device therefor, and a key for releasing said member from said device; interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said device by said key; and means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means; of means controlled by said releasing key for initiating operation of said first clutch, and selectively adjustable means for disabling said last named means.

12. In a motor driven machine of the character described, the combination with a first cyclically operable clutch mechanism, control means for initating operation thereof and means operable by the motor for interrupting operation of said

clutch; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device therefor, and a key for releasing said member from said device; interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said device by said key; and means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means; of means controlled by said releasing key for initiating operation of said first clutch, and selectively adjustable means for disabling said last named means.

13. In a motor driven machine of the character described, a first cyclically operable clutch mechanism and control means for initiating and interrupting operation thereof; a second clutch mechanism and control means for initiating operation of said second clutch mechanism including a spring energized member, a restraining device for said spring energized member, interlock means controlled by said first clutch mechanism for restraining said spring energized member after release of said member from said restraining device, means controlled by said first clutch mechanism for releasing said spring energized member from said restraining means, a key operable to actuate the control means for said first clutch, a second key juxtaposed with said first mentioned key and operable to release said spring energized member from said restraining device; said keys having tops disposed contiguously for simultaneous depression by a single finger of the operator.

14. In a motor driven machine of the character described, having a first clutch, a second cyclically operable clutch, a first clutch control means for engaging said first clutch, and a second clutch control means movable from a clutch disengaging position to a clutch engaging position; the combination of spring means for supplying power to said first clutch control means to cause engagement of said first clutch, and a key for releasing said spring means, a second key juxtaposed with said first mentioned key for moving said second clutch control means to clutch engaging position; said keys having tops disposed contiguously for simultaneous depression by a single finger of the operator, means responsive to movement of said second clutch control means to clutch engaging position for restraining operation of said spring means when released by said first mentioned key, means operable under control of said second clutch upon conclusion of a cycle of operation thereof for moving said second clutch control means to clutch disengaging position, and means responsive to said second clutch control means upon movement thereof to clutch disengaging position to render said restraining means ineffective.

15. In a motor driven machine of the character described, a first power operable mechanism, a second power operable cyclic mechanism, devices for controlling initiation of the operation of said first mechanism, interlocking means controlled by said devices for preventing operation of said first mechanism simultaneously with operation of said second mechanism, a key for actuating said devices, means comprising a second key juxtaposed with said first mentioned key for initiating operation of said first mechanism; said keys having tops disposed contiguously for simultaneous depression by a single finger of the operator, means operable by said first mentioned key upon said simultaneous depression to control said interlocking means to delay operation of said first mechanism, and means controlled by said devices and rendered effective thereby at the end of a cycle of operation of said second mechanism to disable the interlocking means.

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