

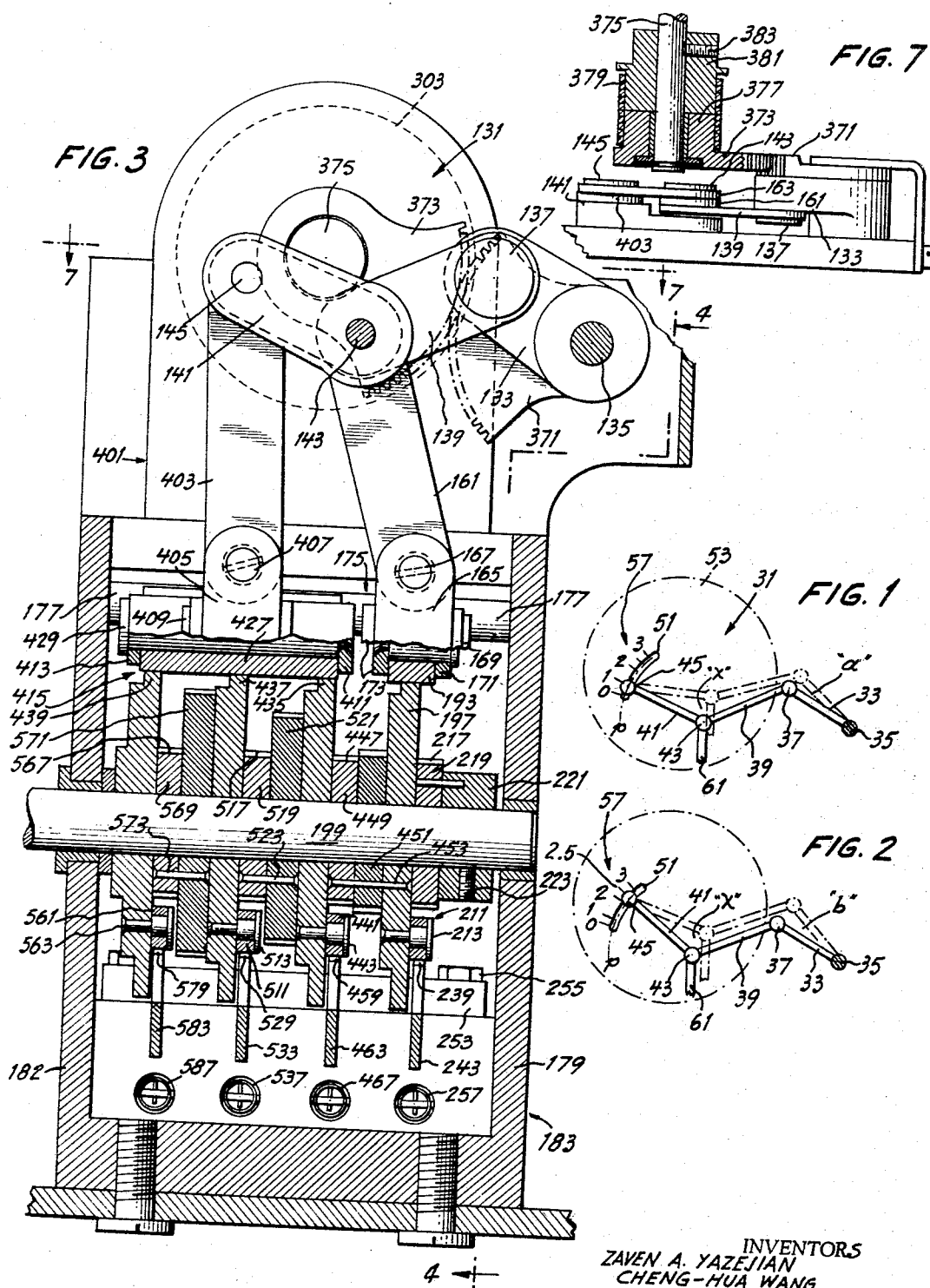
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Z. A. YAZEJIAN ETAL
INCREMENTAL FEED MECHANISM

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3 Sheets-Sheet 1



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3 Sheets-Sheet 3

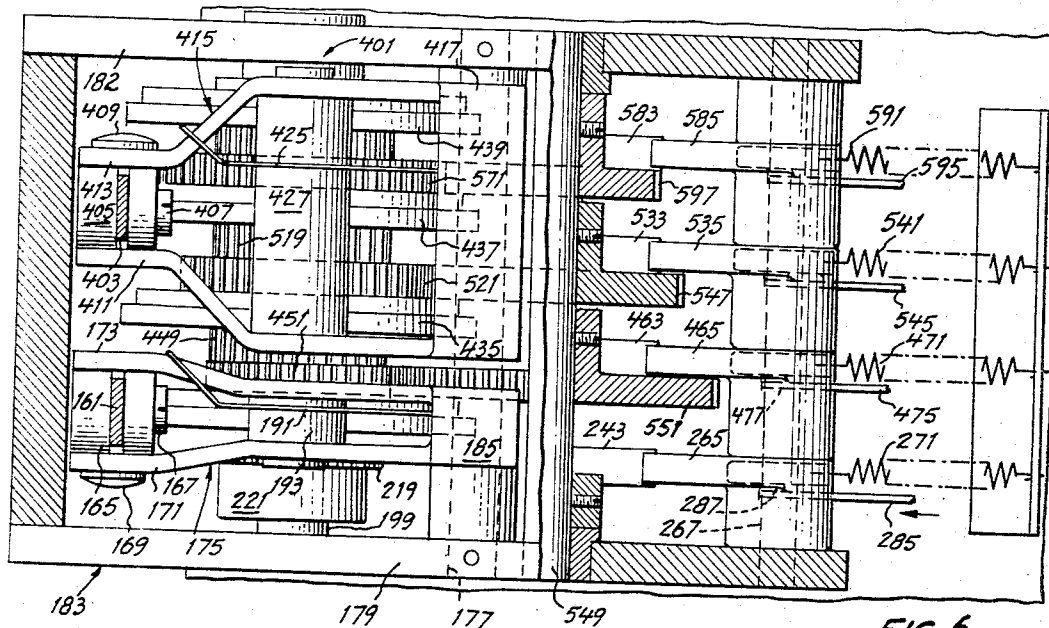


FIG. 6

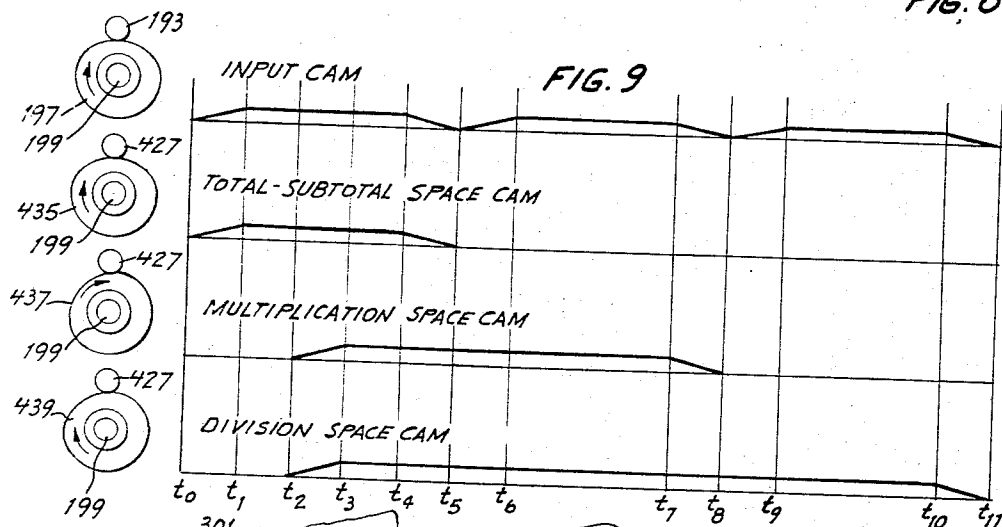


FIG. 9

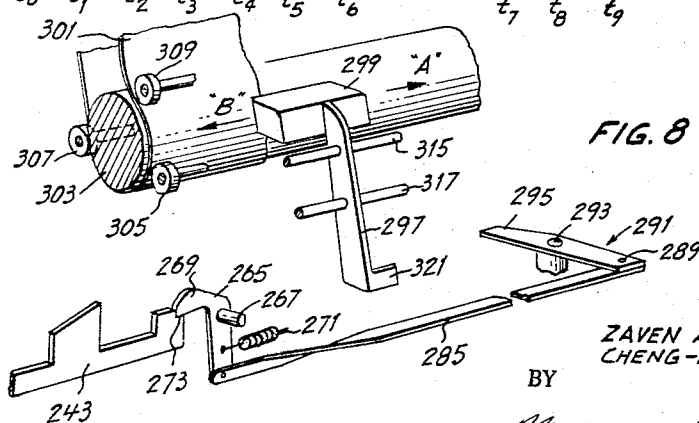


FIG. 8

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3,333,670

INCREMENTAL FEED MECHANISM

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This invention relates to feed mechanisms and more particularly to mechanisms for effecting the feed of an article in a step by step, incremental manner.

A great variety of articles are fed in a step by step, incremental manner during the utilization thereof. Raw materials such as bar and plate stock, are fed in such a step by step, incremental manner to position successive portions thereof for coaction with forming tools to be shaped thereby; stepping switches are fed in a step by step, incremental manner to sequentially make and break either one or more electrical circuits; and webs of material such as paper and the like are fed in a step by step, incremental manner to position successive portions thereof at a work-station wherein markings in the form of punches, printed characters or magnetic inscriptions are either placed thereon or read therefrom. The aforementioned are not intended to be exhaustive but merely to illustrate the range of applications for a step by step incremental feed mechanism and the variety of materials which are commonly fed in a step by step, incremental manner.

Step by step, incremental feeding is sometimes accomplished by a pawl and ratchet type of drive. However, such a drive inherently must correspond to the spacing of the ratchet teeth or multiples thereof and thus the utility of the drive mechanism is greatly limited. If a step by step, incremental feed is required that does not correspond to the spacing of the ratchet teeth then, the ratchet must be replaced by one with differently spaced teeth, if possible, or a whole drive mechanism must be replaced; thus involving either considerable expense; lost time, or both.

Many non-pawl and ratchet type feed mechanisms have been designed in an attempt to provide a step by step, incremental feed which does not suffer from the limitations found in the pawl and ratchet type feed mechanisms. These non-pawl and ratchet type feeds are almost invariably of the friction gripping type. In order to effect a differential spacing many of such friction gripping mechanisms either grip in a differential manner or release in a differential manner while others require a differential action of an input member. The mechanism required to effect such differential gripping, releasing, and action are in most instances complex in structure and operation, expensive in cost, and subject to great variation in the amount of motion imparted to the feed mechanism due to friction and inertia of the system. In addition the termination of such movement is usually effected by a positive type stop subjecting the system to impact and often upsetting not only the position to which the space control is set but also the magnitude of the feed motion imparted by the feed mechanism. Furthermore the great majority of such friction gripping feed mechanisms once set cannot be altered during operation thereof and are thus limited in the variety of uses to which same can be put.

It is therefore an object of this invention to provide an improved step by step, incremental feed mechanism.

Another object is to provide an improved step by step, incremental feed mechanism which is selectively settable

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to effect feeds of a plurality of different predetermined spacings.

Still another object is to provide an improved step by step, incremental feed mechanism which is selectively settable to effect feeds of a plural number of different predetermined spacings and which may be so set and/or have the setting thereof varied during a feed operation.

Yet another object is to provide an improved step by step, incremental feed mechanism which is selectively settable to effect feeds of a number of predetermined spacings in response to movement of an actuator through a uniform stroke of predetermined amount.

A still further object is to provide an improved, step by step, incremental feed mechanism of the friction gripping type which is selectively settable to effect feeds of a number of predetermined spacings in response to movement of an actuator through a uniform stroke of predetermined amount, which grips immediately upon the inception of such stroke, releases immediately at the end of such stroke, and which does not require engagement with a positive type stop to terminate operation thereof.

This invention involves step by step incremental feed mechanisms and contemplates providing same with a linkage train responsive to the uniform stroke of an input actuator and selectively settable, either before, during, or after operation of such input actuator, to a number of positions to effect movement of an output element through correspondingly different and varying degrees of magnitude. In carrying out the invention, according to a preferred embodiment, the linkage train is formed of three active links with one end of a first one of such links disposed on a fixed pivot and the other end of such first link pivotally connected to one end of a second link, and with one end of a third link disposed on a selectively positionable pivot and the other end of such third link pivotally connected to both such second link and to an input actuator. A system of cams rendered operative in response to the particular functions of the equipment not only controls the position of the selectively positionable pivot carrying the third link but also imparts a uniform stroke to the input actuator which in turn imparts a movement to an output element the magnitude of which depends upon the position of the selectively positionable pivot. Such movement of the output element operates a one way friction type clutch which through appropriate structure imparts a corresponding incremental feeding movement to the article to be fed.

Features and advantages of the invention will be seen from the above, from the following description of the preferred embodiment when considered in conjunction with the drawings, and from the claims.

In the drawings:

FIG. 1 is a schematic representation of a linkage train, embodying the present invention, showing the unactuated (solid line) and actuated (dot and dash line) positions thereof;

FIG. 2 is a view of the linkage train of FIG. 1 adjusted to one of the selectively settable positions thereof and showing the unactuated (solid line) and actuated (dot and dash line) positions thereof;

FIG. 3 is an elevational view, in partial section, of a feed mechanism incorporating a linkage train of the type shown in FIGS. 1 and 2;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 3; FIG. 5 is a view similar to that of FIG. 4 but showing elements thereof positionally displaced;

FIG. 6 is a sectional view taken on line 6—6 of FIG. 4;

FIG. 7 is a sectional view taken on line 7—7 of FIG. 3;

FIG. 8 is a perspective showing of mechanism for releasing the cams of FIGS. 3, 4 and 5; and

FIG. 9 is a time displacement diagram for the cams shown in FIGS. 3, 4 and 5.

For convenience the invention will be described as applied to the paper feed mechanism of a calculator, it being understood nevertheless that without departing from the scope of the invention that subject feed mechanism can be applied to the paper feed for any business machine, for feeding of webs other than paper in a business machine; for feeding of webs in non-business machines, and in any other type of equipment requiring an article to be fed in a step by step, incremental manner.

Basic Concept

With reference to FIG. 1, 31 generally designates a linkage train having a first active link 33 carried by a fixed pivot stud 35 and having its free end connected by a pivot pin 37 to a second active link 39. A third active link 41 has one end thereof connected by a pivot pin 43 to second active link 39 and the other end thereof carried by a positionable pivot stud 45 disposed for selective displacement along an arcuate path p . Thus it is seen that the links are interconnected serially end to end in a chain forming a zig-zag path peaking at the interconnections. Arcuate path p is here defined by a slot 51 formed in a fixed support 53, however, any other convenient manner of defining path p may be used. Positionable pivot stud 45 may be displaced either manually by providing an appropriate means thereon to grasp and move same by hand, automatically in response to rotation of a cam through suitable cam followers or to the operation of a servo mechanism appropriately connected thereto, or in response to any other suitable positioning mechanism. A scale 57 is inscribed in proximity to stud 45 as an indication of the position thereof along arcuate path p from a reference point 0.

An input actuator 61 also carried by pivot pin 43 is disposed for substantially vertical linear movement between an unactuated position (shown in full lines in FIG. 1) and an actuated position (shown in dot and dash lines in FIG. 1). The stroke distance x between said positions is substantially fixed thus providing input actuator 61 with a uniform stroke. Movement of input actuator 61 between said unactuated and actuated positions is accomplished by associating suitable drive means, such as a cam and follower, solenoid, gear train, etc., therewith.

With positionable pivot stud 45 secured in place, as at position 1 on scale 57 (FIG. 1), movement of input actuator 61 through stroke distance x results in a counterclockwise pivoting (FIG. 1) of third active link 41 about stud 45 and displacement of second active link 39 (as shown in FIG. 1) so as to effect a clockwise pivoting about fixed pivot stud 35 (FIG. 1) of first active link 33 and a movement thereof through an angular distance a . With positionable pivot stud 45 displaced to another position, such as position 2.5 on scale 57 (FIG. 2), the identical movement of input actuator 61 through stroke distance x results in a counterclockwise pivoting (FIG. 2) of third active link 41 about stud 45 and displacement of second active link 39 (as shown in FIG. 2) so as to effect a clockwise pivoting about fixed pivot stud 35 (FIG. 2) of first active link 33 and a movement thereof through an angular distance b which is greater in magnitude than angular distance a . Displacement of stud 45 to a position on scale 57 between positions 0 and 1 for a movement of input actuator 61 through stroke distance x will of course produce a movement of first active link 33 through an angular distance smaller in magnitude than that of angular displacement a .

It will thus be seen that both the position of position-

able pivot stud 45 and the throw x of input actuator 61 are independently controllable and that the total displacement of first active link 33 is a function of the two controlled motions. By merely changing the position of positionable pivot stud 45 the geometry of linkage train 31 is changed such that the uniform stroke movement x of input actuator 61 results in an angular displacement of first active link 33 of a different magnitude and, since there is a plural number of positions to which stud 45 may be set there is a corresponding plural number of angular distances through which first active link 33 will be displaced for any given stroke distance x . By merely changing the stroke distance x through which input actuator 61 is displaced a completely different set of angular displacements is obtained for first active link 33 for the aforementioned positions of positionable pivot stud 45. Furthermore, pivot stud 45 need not be stationary while input actuator 61 is in motion but instead may be in either continuous or intermittent motion while input actuator 61 is moving through stroke distance x ; as it would be if it were interconnected with and responsive to a servo-type system.

General application

FIGS. 3—8 show a paper feed mechanism of a calculator incorporating a linkage train 131 similar in construction and operation to linkage train 31. A first active link 133 (FIGS. 3, 4, and 7) carried by a fixed pivot stud 135 (FIG. 3) is interconnected by a pivot pin 137 (FIGS. 3 and 7) to a second active link 139. A third active link 141 has one end thereof connected by a pivot pin 143 to second active link 139 and the other end thereof carried by a positionable pivot stud 145. An input actuator 161 (FIGS. 3, 4, and 6) is freely carried on pivot pin 143 between second active link 139 and an auxiliary link 163 (FIG. 7) having one of its ends disposed on pivot pin 143 and the other of its ends disposed on pivot stud 145. A mounting block 165 (FIGS. 3, 4, and 6) secured to input actuator 161 by suitable means such as a pivot bolt 167 (FIGS. 3 and 4) journals input actuator 161 on a connecting rod 169 disposed between a pair of spaced arms 171 and 173 (FIGS. 3 and 6) of a rocker assembly 175 rockably carried by a rock shaft 177 disposed between a pair of side walls 179 and 182 of a casing 183. A flange 185 (FIGS. 4 and 6) interconnects spaced arms 171 and 173 of rocker assembly 175. A leaf spring 191 having one end thereof wrapped about rock shaft 177 and the other end hooked over arm 173 of rocker assembly 175 also engages a cam follower 193 (FIGS. 3, 4, and 6) rotatably carried by a follower shaft 195 disposed between spaced arms 171 and 173 of rocker assembly 175 to bias the outer surface of cam follower 193 into engagement with the cam surface of an input cam 197 rotatably disposed on an input shaft 199. Suitable means are provided for imparting rotative to input shaft 199.

An input drive pawl 211 (FIGS. 3 and 4) pivotally carried by input drive pin 213 secured to input cam 197, is formed with a tooth 215 (FIG. 4) adapted to coast with teeth 217 formed on an input drive ratchet 219 pinned to a drive hub 221 (FIGS. 3 and 6) which is in turn secured by suitable means such as a set screw 223 (FIG. 3) to drive shaft 199 for conjoint rotation therewith. A spring 225 (FIG. 4) having one of its ends secured to an abutment 227 carried by input cam 197 and the other of its ends secured to input pawl 211 urges input pawl 211 in the clockwise direction (FIG. 4) about pawl pin 213 to normally engage a heel 229 formed on input pawl 211 with a stop surface 239 (FIG. 4) formed on a stop section 241 of an input control slide 243 (FIGS. 3 and 4).

Input control slide 243 is disposed for right and left (FIG. 4) sliding movement with respect to casing 183 with the front portion of slide 243 guided in such movement by a channel (not shown) formed in a ledge 245 (FIG. 4) of casing 183 and with the rear portion there-

of guided in such movement by a channel (not shown) formed in a ledge 247 disposed on the bottom wall of casing 183. A plate 249 and bolts 251 secure the front portion of input control slide 243 from movement out of the channel formed in ledge 245 while a plate 253 and bolts 255 secure the rear portion of input control slide 243 from movement out of the channel formed in ledge 247. A spring 257 (FIGS. 3 and 4) secured at one of its ends to input control slide 243 and at the other of its ends to casing 183 urges control slide 243 to the right (FIG. 4) but is normally prevented from moving control slide 243 in such direction by a bell crank 265 (FIGS. 4 and 6) rockably mounted on a bell crank shaft 267 disposed between side walls 179 and 181 of casing 183 and having a nose 269 (FIG. 4) urged by a spring 271 (FIGS. 4 and 6) to seat in a notch 273 (FIG. 4) formed in the rear portion of input control slide 243.

A release rod 285 (FIGS. 4 and 6) is connected by a pin 287 to bell crank 265 and by a pin 289 (FIG. 8) to a release arm 291 pivotally disposed as at 293 within casing 183 and having an end 295 thereof protruding into the path of travel of a support bracket 297 upon which is mounted a print head 299.

Print head 299 includes appropriate conventional structure (not shown) for marking numerical information on a record sheet 301 (FIGS. 4 and 8) in the form of a web of paper disposed about a platen 303 and urged thereagainst by a pair of feed rollers 305 (FIG. 8) and 307 and a guide roller 309 (FIGS. 4 and 8). Feed rollers 305 and 307 and guide roller 309 are of common construction mounted to resiliently engage platen 303 and to coact therewith to grip record sheet 301 therebetween and in response to rotation of platen 303 to feed record sheet 301 a predetermined amount to present a new area of record sheet 301 to print head 299 to receive markings therefrom, to provide spaces between the lines of markings so placed upon record sheet 301, or to feed record sheet 301 for any other purpose required by the calculator.

Conventional feed and escapement mechanism (not shown) are provided for moving support bracket 297, and pivot head 299 carried thereby, in the direction of arrow A (FIG. 8) to pass print head 299 across successive portions of record sheet 301 and thus permit print head 299 to place sequential markings thereon. When print head 299 reaches the rightmost extremity of its movement appropriate return structure (not shown) moves same in the direction of arrow B (FIG. 8) and returns same to the leftmost extremity of its intended movement. A pair of rods 315 and 317 (FIGS. 4 and 8) guide support bracket 297 and print head 299 during the feed and return movements thereof.

As support bracket 297 and print head 299 approach the extremity of their movement in the direction of arrow A (FIG. 8) a projection 321 formed on support bracket 297 contacts end 295 of release arm 291 and pivots same clockwise (FIG. 8) about pivot 293. Release rod 285, in response to such clockwise pivoting of release arm 291 moves to the left (FIGS. 4 and 8) pivoting bell crank 265 in the clockwise direction about bell crank shaft 267 and against the bias of spring 271. As nose 269 of pivoting bell crank 265 moves away from notch 273 of control slide 243 spring 257 thereof effects a movement of control slide 243 to the right (FIG. 4) moving same from its unactuated position to an actuated position (FIG. 5) and withdrawing stop surface 239 away from heel portion 229 of input drive pawl 211 to thus permit spring 225 to move tooth 215 of input drive pawl 211 into the path of rotation of teeth 217 of rotating input drive ratchet 219. Tooth 215 of input drive pawl 211 is thereafter engaged by a tooth 217 of input drive ratchet 219 and the rotation of input drive shaft 199 is transmitted through input drive pawl 211 and input drive pin 213 to input cam 197 to rotate same in the clockwise direction (FIG. 4). As input cam 197 rotates abutment 227 carried

thereby is moved into engagement with a return projection 325 (FIG. 5) formed on control slide 243 to coact therewith and move control slide 243 to the left (FIG. 5) against the bias of spring 257 and until nose 269 of bell crank 265 seats in notch 273 of control slide 243 to again latch control slide 243 in its unactuated position (FIG. 4). Drive of input cam 197 by input shaft 199 continues until heel portion 229 of input pawl 211 moves into engagement with stop surface 239 of control slide 243 to coact therewith to pivot input drive pawl 211 in the counterclockwise direction (FIG. 4) about input drive pin 213 against the bias of spring 225 and disengage tooth 215 of input drive pawl 211 from its position of engagement with a tooth 217 of input drive ratchet 219. Clockwise rotation (FIG. 4) of input cam 197 is thereafter terminated by engagement of a stop pin 327 carried by input cam 197 with stop surface 239 of input control slide 243. A detent 341 (FIGS. 4 and 5) disposed on a pivot 343 and urged by a spring 345 in the clockwise direction thereabout coacts with a seat 347 formed in input cam 197 to effectively locate input cam 197 in a home position as shown in FIG. 4.

Immediately upon the inception of rotation of input cam 197 (t_0 —FIG. 9) there is an increase in the radius thereof resulting in a coaction with the cam follower 193 to effect a clockwise pivoting (FIG. 4) of rocker assembly 175 to lift (FIG. 4) input actuator 161, pivoting third active link 141 in the counterclockwise direction (FIG. 3) about positionable pivot stud 145 and translating second active link 139 in such a manner as to impart to first active link 133 a clockwise pivoting motion (FIG. 3) about fixed pivot stud 135. Lifting of input actuator 161 and therefore clockwise pivoting of first active link 133 continues until the radius of input cam 197 becomes constant (t_1 —FIG. 9) from which time there is a period of dwell (t_1 — t_4 , FIG. 9) followed by a decrease in the radius of input cam 197 (t_4 —FIG. 9) during which links 133, 139, and 141 and input actuator 161 all return to their unactuated (FIG. 3) positions due to the action of leaf spring 191 and other suitably disposed springs, and rotation of input cam 197 is terminated as hereinbefore described (t_5 —FIG. 9).

Clockwise rotation (FIG. 3) of first active link 133 is transmitted by a gear sector 371 (FIGS. 3 and 7) formed therewith to a gear sector 373, rockably disposed on a platen shaft 375, to rock gear sector 373 in the counterclockwise direction with respect to platen shaft 375 (FIG. 3). A hub 377 (FIG. 7) formed on gear sector 373, during counterclockwise rotation thereof coacts with a clutch spring 379 (FIGS. 4 and 7) wound thereabout to produce a wrapping action in the coils of clutch spring 379 and thereby clutch same to hub 377. Thereafter counterclockwise rotation (FIG. 3) of hub 377 effects a corresponding drive of clutch spring 379; of a hub 381 (FIG. 7) disposed on platen shaft 375 in juxtaposition to hub 377 and about which the coils of clutch spring 379 are tightly wound; of platen shaft 375 secured to hub 381 by suitable means such as a set screw 383; and of platen 303 to rotate same through a predetermined degree of rotation. Feed rollers 305 and 307 and guide roller 309 (FIG. 9) due to their resilient engagement with rotating platen 303 are driven thereby and record sheet 301 when disposed therebetween and gripped thereby is fed a predetermined unitary amount usually sufficient to provide proper spacing between successive adjacent lines of characters.

Counterclockwise rotation of first active link 133 to return it to the position corresponding to the position of its counterpart link 133 in FIG. 1 (accomplished as hereinbefore described), effects a counterclockwise rotation of gear sector 371 and a corresponding clockwise rotation of gear sector 373 and hub 377 formed thereon. The clockwise rotation of hub 377 is not however transmitted through spring 379 to hub 381 and platen shaft 375 because, due to the manner in which the coils of clutch

spring 379 are wound, clockwise rotation of hub 377 produces an action in clutch spring 379 which unwraps the coils thereof from hub 377 and thus declutches same. The drag of feed rollers 305 and 307 and guide rollers 309 upon platen 303 and record shaft 301 is sufficient to maintain same in their advanced position during the retrograde movements of the aforementioned elements.

To change the magnitude of said predetermined unitary amount of feed, without displacing positionable pivot stud 145, one need only vary the uniform stroke distance x as by providing a different cam contour on input cam 197.

Variable spacing

As hereinbefore described for each uniform stroke distance x of input actuator 161 there are a plurality of angular distances through which first active link 133 can be displaced; one for each of the plural number of positions to which positionable pivot stud 145 can be placed. A large number of line spacings are not usually required in marking the detail tape (record sheet 301) of a calculator. Observations of the details and results of successive problems marked on record sheet 301 is, however facilitated by providing extra spaces between the markings for each problem and between the component parts of the results for any particular problem if such results include more than one part (such as in division where there is a Quotient and quite often a Remainder). Such extra spaces are herein effected through the use of a space control mechanism indicated generally by the designation 401 (FIG. 3, 4, and 6).

A spacing actuator 403 (FIGS. 3 and 6) is disposed with one end thereof pivotally carried on pivot stud 145 between third active link 141 and auxiliary link 163 (FIG. 7), and the other end thereof journaled in a mounting block 405 (FIGS. 3 and 6) and secured therein by suitable means such as a pivot bolt 407. A rod 409 serves to journal mounting block 405 between a pair of spaced arm 411 and 413 of a space rocker assembly 415, itself rockably disposed on rock shaft 177. A flange 417 (FIG. 6) interconnects spaced arms 411 and 413 of space rocker assembly 415. A leaf spring 425 having one of its ends wrapped about rock shaft 177 (in the manner similar to that of leaf spring 191) and the other of its ends hooked over arm 413 of space rocker assembly 415 also engages a space cam follower 427 (FIGS. 3 and 6), rotatably carrier by a follower shaft 429 (FIG. 3) disposed between spaced arms 411 and 413 of space rocker assembly 415, to urge the outer surface of space cam follower 427 into engagement with the respective cam surfaces of a plurality of space control cams 435, 437, and 439 respectively which for convenience of explanation of the system shall be hereinafter referred to as total-subtotal space cam 435, multiplication space cam 437 and division space cam 439.

Total-subtotal spacing

The cam contour of total-subtotal space cam 435 is identical to the contour of input cam 197. A drive pawl 441 (FIG. 3) pivotally carried by a drive pin 443 secured to total-subtotal space cam 435 is, in a manner similar to that of input drive pawl 211 of input cam 197 (FIG. 4), biased in the clockwise direction about drive pin 443 by a spring (not shown) to urge a tooth (not shown) formed on drive pawl 441 towards the path of rotation of teeth 447 (FIGS. 3 and 6) formed on a drive ratchet 449 freely carried by input drive shaft 199 but fixedly secured to input cam 197, along with a pinion gear 451, (FIG. 3) by a pin 453. A stop surface 459 formed on a total-subtotal control slide 463 (FIGS. 3 and 6) is normally maintained by a bell crank 465 (FIGS. 5 and 6) against the bias of a spring 467 (FIGS. 3 and 5) and in such a position as to prevent the tooth of drive pawl 441 from moving into the path of rotation of teeth 447 of ratchet 449 (as is done for input drive pawl 211 by stop surface 239 of input control slide 243, FIG. 4). Bell crank 465 is pivotally carried by bell crank shaft 267 (FIGS. 5 and

6) and is urged in the counterclockwise direction thereabout (FIG. 5) by a spring 471 (FIGS. 5 and 6) to normally seat a nose formed in bell crank 465 in a notch formed in total-subtotal control slide 463 and thus prevent spring 467 from moving control slide 463 from its unactuated position (FIG. 5) to an actuated position (similar to that shown for control slide 243 in FIG. 5).

A release rod 475 (FIGS. 5 and 6) pivotally connected to bell crank 465 by a pivot pin 477 (FIG. 6) is interconnected by conventional means (not shown) to the total and subtotal keys of the calculator (or to linkages interconnected therewith) such that actuation of either said total key or said subtotal key effects a shifting of release rod 475 to the left (FIGS. 5 and 6) and a clockwise pivoting (FIG. 5) of bell crank 465 about bell crank shaft 267 thus permitting spring 467 to move control slide 463 to the right (FIGS. 4 and 6) releasing drive pawl 441 for clockwise rotation (FIG. 5) by its spring (not shown) to move the tooth formed thereon into the path of rotation of teeth 447 of drive ratchet 449 and thus establish total-subtotal space cam 435 in a "set" condition. However, as hereinbefore described, drive ratchet 449 is not interconnected directly to input drive shaft 199 but is instead connected by a pin 453 to input control cam 197 and therefore only rotates when input cam 197 is rotated through input drive pawl 211 and input ratchet 219 connected to input drive shaft 199.

Depression of either the Total key or Subtotal key by the machine operator in addition to establishing total-subtotal space cam 435 in a "set" condition also releases other mechanisms of the calculator which in a conventional manner effect a print-out of the amount stored in the calculator.

As print head 299 reaches the end of its printing operation release arm 291 (FIG. 8) is operated, as hereinbefore described, to actuate release rod 285 and bell crank 265 and release input control slide 243 for movement by spring 257 (to the right—FIG. 4) away from heel 229 of drive pawl 211. Spring 225 then rocks tooth 215 of input drive pawl 211 into the path of rotation of teeth 217 of input drive ratchet 219 and the drive from input drive shaft 199 is transmitted thereby to input cam 197 and by input cam 197 to pin 453, ratchet 449, drive pawl 441 and total-subtotal space cam 463 producing concurrent and conjoint rotations thereof.

Immediately upon the inception of rotation of input cam 197 and total-subtotal space cam 435 (t_0 —FIG. 9) there is an increase in the radii thereof thus imparting simultaneous lifting action to both input actuator 161 and spacing actuator 403. As previously described the lifting action imparted to input actuator 161 results in a clockwise rotation (FIG. 3) of first active link 133 and gear sector 371 about fixed pivot stud 135 and a counterclockwise rotation (FIG. 3) of gear sector 373, hub 377, clutch spring 379 and hub 381 to rotate platen shaft 375 and platen 303 and thereby feed record sheet 301. The lifting action imparted to space actuator 403, on the other hand, displaces pivot stud 145 so as to alter the geometric relationship originally existing between first active link 133, second active link 139 and third active link 141 (in a manner similar to the alteration of the linkage 31 of FIG. 1 to obtain the arrangement shown in FIG. 2). Lifting of input actuator 161 and spacing actuator 403 continues until the radii of cams 197 and 435 respectively become constant (t_1 —FIG. 9). Due to the relocation of pivot stud 145 first active link 133, gear sector 371, gear sector 373, clutch spring 379, and platen shaft 303, are all rotated through an amount which is greater in magnitude than that through which they were rotated with pivot stud 145 located as shown in FIG. 3. Record sheet 301 is therefore fed an amount greater than said predetermined unitary distance and a space is thus provided thereon following the line of markings representing the Total or Subtotal and preceding the next line of markings. Paper feed is terminated as the radii of cams

197 and 435 become constant (t_1 —FIG. 9) and as the cam radii decrease (t_4 —FIG. 9) input actuator 161 and space actuator 403 and their attendant structures return to their unactuated positions (FIG. 3). Rotation of cams 197 and 435 is terminated by engagement of their respective stop pins (327 for cam 161 FIG. 3) with their respective stop surfaces (239 for cam 161 and 459 for cam 435).

Total-Subtotal cam 435 is provided with an abutment (not shown) similar to abutment 227 (FIG. 4) of input cam 197 and disposed thereon for coaction with a return projection 479 (FIG. 5) formed on total-subtotal control slide 463 to return slide 463 from its actuated position (similar to the position shown for slide 243 in FIG. 5) to its unactuated position (FIG. 5). A detent similar to detent 341 (FIG. 4) is also provided for total-subtotal cam 435 to coact with a seat appropriately formed therein (such as seat 347) to locate total-subtotal cam 435 in its home position.

Multiplication spacing

A drive pawl 511 (FIG. 3) pivotally carried by a drive pin 513 secured to multiplication space cam 437, in a manner similar to that of input drive pawl 211 of input cam 197 (FIG. 4), biased in the clockwise direction about drive pin 513 by a spring (not shown) to urge a tooth (not shown) formed on drive pawl 511 towards the path of rotation of teeth 517 (FIGS. 3 and 6) formed on a drive ratchet 519 freely carried by input drive shaft 199 but fixedly secured to a pinion gear 521 by a pin 523. A stop surface 529 formed on a multiplication control slide 533 (FIGS. 3 and 6) is normally maintained by a bell crank 535 (FIG. 6) against the bias of a spring 537 (FIG. 3) and in such a position as to prevent the tooth of drive pawl 511 from moving into the path of rotation of teeth 517 of drive ratchet 519 (as is done for input drive pawl 211 by stop surface 239 of input control slide 243 FIG. 4). Bell crank 535 is pivotally carried by bell crank shaft 267 (FIGS. 5 and 6) and is urged in the clockwise direction thereabout (FIG. 5) by a spring 541 (FIG. 6) to normally seat a nose formed in bell crank 535 in a notch formed in multiplications control slide 533 and thus prevent spring 537 from moving slide 533 from its unactuated position (similar to that shown for input control slide 243 FIG. 4) to an actuated position (similar to that shown for input control slide 243 in FIG. 5). A release rod 545 (FIGS. 5 and 6) pivotally connected to bell crank 535 as by a pivot pin (not shown) is interconnected by conventional means (not shown) to the multiplication key of the calculator (or to linkages associated therewith) such that actuation of the multiplication key effects a shifting of release rod 545 to the left (FIG. 6) and a clockwise pivoting (FIG. 5) of bell crank 535 about bell crank shaft 267 thus permitting spring 537 to move control slide 533 to the right (FIG. 6) releasing drive pawl 511 for clockwise rotation (FIG. 5) by its spring (not shown) to move the tooth formed thereon into the path of rotation of teeth 517 of drive ratchet 519 and to thus establish multiplication space cam 437 in a "set" condition. However, as hereinbefore described, drive ratchet 519 is not interconnected directly to input drive shaft 199 but is instead connected by a pin 523 to a pinion 521, which is in turn in mesh with a pinion 547 (FIG. 6) keyed to a pinion shaft 549 (FIGS. 4 and 6) disposed between walls 179 and 181 of casing 183. A pinion 551 also keyed to pinion shaft 549 is disposed thereon in a position enmeshed with pinion 451 of input cam 197 and therefore only when input cam 197 is rotated through input drive pawl 211 and input drive ratchet 219 are pinion shaft 549, pinion 547 and pinion 521 rotated. The gear ratio is such as to provide a 2:1 ratio of drive between input cam 197 and multiplications space cam 437.

Depression of the multiplication key by the operator in addition to establishing multiplications space cam 437 in a "set" condition also releases other mechanisms of the

calculator which in a conventional manner first store and print the multiplier. As print head 299 reaches the end of its printing operation for the multiplier, release arm 291 (FIG. 8) is operated, as hereinbefore described, to actuate release rod 285 and bell crank 265 and release input control slide 243 for movement by spring 257 (to the right—FIG. 4) away from heel 229 of input drive pawl 211. Spring 225 then rocks tooth 215 of input drive pawl 211 into the path of rotation of teeth 217 of input drive ratchet 219 and the drive from input drive shaft 199 is transmitted thereby to input control cam 197 and by input control cam 197 to pin 453, input pinion 451, pinion 551, pinion shaft 549, multiplication pinion 547, pinion 521, multiplication ratchet 579, drive pawl 511, and multiplication space cam 437 producing concurrent and conjoint rotation thereof but at a 2:1 ratio of input cam to multiplication cam.

Immediately upon the inception of rotation of input cam 197 (t_0 —FIG. 9) there is an increase in the radius thereof and a coaction between same and input cam follower 193 imparting a lifting action to input actuator 161 which continues during the period t_0 — t_1 (FIG. 9). The contour of multiplication space cam 437, however, is such as to provide a radius of constant dimension, or a dwell, during such time period (t_0 — t_1 , FIG. 9) and therefore no lifting action is imparted to spacing actuator 403 and positionable pivot stud 145 remains in its FIG. 3 position. As such the elements cooperate as hereinbefore explained to rock first active link 133 and gear sector 371 in the clockwise direction (FIG. 3) and gear sector 373, spring clutch 379, platen shaft 375, and platen 303 in the counterclockwise direction to feed record sheet 301 said predetermined unitary distance. Rotation of input cam 197 continues through a period of dwell (starting at t_1 —FIG. 9) during which period the radius of multiplication space cam 437 increases (starting at t_2 —FIG. 9) and again becomes constant (at t_3 —FIG. 9); the cam surface thereof coacting with space follower 427 to lift space actuator 403 and relocate positionable pivot stud 145. Input actuator 161, and associated elements, thereafter (t_4 — t_5 , FIG. 9) return to their unactuated positions (FIG. 3) and rotation of input cam 197 is terminated with multiplication space cam still in a "set" position but rotated through 180 degrees.

Conventional internal structure of the calculator then provides an automatic print-out of the product and print head 299 again moves across record sheet 301 in the direction of arrow A and again operates release arm 291 to release input control slide 243 and permit another complete rotation of input cam 197. During such rotation input actuator 161 is again lifted (t_5 — t_6 , FIG. 9) and platen 303 rotated (as hereinbefore described) but since positionable pivot stud 145 is maintained at a relocated position the uniform stroke of input actuator 161 results in rotation of first active link 133 through a greater angle than with stud 145 in its FIG. 3 position, and consequently a greater amount of rotation is imparted to platen 303 to feed record sheet 301 an amount greater than said predetermined unitary distance thus providing a space between the product as marked on record sheet 301 and ensuing lines of markings. Multiplication space cam 437 and input cam 197 continue their conjoint rotation; the elements associated therewith returning to their unactuated positions during the period (t_7 — t_8 , FIG. 9). Positionable pivot stud 145 is thus returned to its FIG. 3 position.

Multiplication space cam 437 is provided with an abutment (not shown) similar to abutment 227 (FIG. 4) of input cam 197 and disposed thereon for coaction with a return projection (not shown) formed on multiplication control slide 533 to return slide 533 from its actuated position (similar to the position shown for slide 243 in FIG. 5) to its unactuated position (similar to the position shown for slide 243 in FIG. 4). A detent similar to detent 341 (FIG. 4) is also provided for multiplication space

cam 437 to coast with a seat appropriately formed thereon (such as seat 247 of cam 197) to locate multiplication space cam 437 in a home position.

Division spacing

A drive pawl 561 (FIG. 3) pivotally carried by a drive pin 563 secured to division space cam 439, in a manner similar to that of input drive pawl 211 of input cam 197 (FIG. 4), is biased in the clockwise direction about drive pin 563 by a spring (not shown) to urge a tooth (not shown) formed on drive pawl 561 towards the path of rotation of teeth 567 (FIGS. 3 and 6) formed on a drive ratchet 569 freely carried by input drive shaft 199 but fixedly secured to a pinion gear 571 by a pin 573. A stop surface 579 formed on a division control slide 583 (FIGS. 3 and 6) is normally maintained by a bell crank 585 (FIG. 6) against the bias of a spring 587 (FIG. 3) and in such a position as to prevent the tooth of drive pawl 561 from moving into the path of rotation of teeth 567 of drive ratchet 569 (as is done for input drive pawl 211 by stop surface 239 of input control slide 243 FIG. 4). Bell crank 585 is pivotally carried by bell crank shaft 267 (FIGS. 5 and 6) and is urged in the clockwise direction thereabout (FIG. 5) by a spring 591 (FIG. 6) to normally maintain a nose formed on bell crank 585 in a notch formed in multiplication control slide 583 and thus prevent spring 587 from moving slide 583 from an unactuated position (similar to that shown for control slide 243 in FIG. 4) to an actuated position (similar to that shown for control slide 243 in FIG. 5). A release rod 595 (FIGS. 5 and 6) pivotally connected to bell crank 585 as by a pivot pin (not shown) is interconnected by conventional means (not shown) to the Division Key of the calculator (or to linkages associated therewith) such that actuation of the Division Key effects a shifting of release rod 595 to the left (FIG. 6) and a clockwise pivoting (FIG. 5) of bell crank 585 about bell crank shaft 267 thus permitting spring 587 to move division control slide 583 to the right (FIG. 6) releasing drive pawl 561 for clockwise rotation (FIG. 5) by its spring (not shown) to move the tooth formed thereon into the path of rotation of teeth 517 of drive ratchet 519 and to thus establish division space cam 439 in a "set" condition. However, as hereinbefore described, ratchet 569 is not interconnected directly to input drive shaft 199 but is instead connected by a pin 573 to a pinion 571 which is in turn in mesh with a pinion 597 (FIG. 6) keyed to pinion shaft 549 (FIGS. 4 and 6) upon which pinion 551 is disposed in mesh with pinion 451 of input cam 197 and therefore only when input cam 197 is rotated through input drive pawl 211 and input ratchet 219 are pinion shaft 549, pinion 597 and pinion 571 rotated. The gear ratio between pinions 451, 521, 597 and 571 are such as to provide a 3:1 ratio of drive between input cam 197 and division cam 439.

Depression of the Division Key by the operator in addition to establishing division space cam 439 in a "set" condition also releases the mechanisms of the calculator which in a conventional manner first stores and prints the divisor. As print head 299 reaches the end of its printing operation for the divisor, release arm 291 (FIG. 8) is operated, as hereinbefore described, to actuate release rod 285 and bell crank 265 and release input control slide 243 for movement by spring (to the right—FIG. 4) away from heel 229 of input drive pawl 211. Spring 225 then rocks tooth 215 of input drive pawl 211 into the path of rotation of teeth 217 of input drive ratchet 219 and the drive from input drive shaft 199 is transmitted thereby to input control cam 197 and by input control cam 197 to pin 453, input pinion 451, pinion 551, pinion shaft 549, division pinion 597, pinion 571, division ratchet 569, drive pawl 561 and division space cam 439 producing concurrent and conjoint rotation thereof but at a 3:1 ratio of input cam to division cam. Immediately upon the inception of rotation of input cam 197 (t_0 —FIG. 9) there is an

increase in the radius thereof and a coaction between same and input cam follower 193 imparting a lifting action to input actuator 161 which continues during the period (t_0 — t_1 , FIG. 9). The contour of division space cam 439, however is such as to provide a radius of constant dimension, or a dwell, during such time period (t_0 — t_1 , FIG. 9) and therefore no lifting action is imparted to spacing actuator 403 and positionable pivot stud 145 remains in its FIG. 3 position. As such the elements co-operate as hereinbefore explained to rock first active link 133 and gear section 371 in the clockwise direction (FIG. 3) and gear sector 373, clutch spring 379, platen shaft 375, and platen 303 in the counterclockwise direction to feed record sheet 301 said predetermined unitary distance.

Rotation of input cam 197 continues through a period of dwell (t_1 — t_4 , FIG. 9) during which period the radius of division space cam 439 increases (starting at t_2 —FIG. 9) and again becomes constant (t_3 —FIG. 9) the cam surface thereof coacting with space follower 427 to lift spacing actuator 403 and relocate positionable pivot stud 145. Input actuator 161 and its associated elements thereafter (t_4 — t_5 , FIG. 9) return to their unactuated positions (FIG. 3) and rotation of input cam 197 is terminated with division space cam still in a "set" condition but rotated through 120 degrees.

Conventional internal structure of the calculator then provides an automatic print-out of the "remainder" and print head 299 again moves across record sheet 301 in the direction of arrow A and again operates release arm 291 to release input control slide 243 and permit another complete rotation of input cam 197. During such rotation input actuator 161 is again lifted (t_5 — t_6 , FIG. 9) and platen 303 rotated as hereinbefore described, but since pivot stud 145 is maintained at a relocated position the uniform stroke of input actuator 161 results in a rotation of first active link 133 through a greater angle and consequently produces a greater amount of rotation of platen 303 to feed record sheet 301 more than said predetermined unitary distance thus providing a space between the "remainder" as marked on record sheet 301 and the ensuing lines of markings. Input actuator 161 and its associated elements thereafter (t_7 — t_8 , FIG. 9) return to their unactuated positions (FIG. 3) and rotation of input cam 197 is terminated with division space cam still in a "set" condition but rotated through 240 degrees.

Again the conventional internal structure of the calculator provided an automatic print-out but this time of the "quotient" thus print head 299 again moves across record sheet 301 in the direction of arrow A and again input control cam 197 is cycled to operate input actuator 161 (t_8 — t_9 , FIG. 9). Since spacing actuator 403 is still in its relocated condition and positionable pivot stud 145 accordingly displaced record sheet 301 is again fed a distance greater than said predetermined unitary distance and a space is provided on record sheet 301 between the markings representing the "quotient" and the next line of markings. Division space cam 439 and input cam 197 continues their conjoint rotation; the elements associated therewith returning to their unactuated positions during the period (t_{10} — t_{11} , FIG. 9). Positionable pivot stud 145 is thus returned to its FIG. 3 position.

Division space cam 439 is provided with an abutment (not shown) similar to abutment 227 (FIG. 4) of input cam 197 and disposed thereon for coaction with a return projection (not shown) formed on division control slide 583 to return slide 583 from its actuated position (similar to that shown for slide 243 in FIG. 5) to its unactuated position (similar to that shown for slide 243 in FIG. 4). A detent similar to detent 341 (FIG. 4) is also provided for division space cam 439 to coast with a seat appropriately formed thereon (such as seat 247 of cam 197) to locate division space cam 439 in its home position.

From the above description it will thus be seen that a novel and improved feed mechanism has been provided

for effecting a step by step, incremental movement of an article; which feed mechanism, although of relatively simple construction and operation when compared to other feed mechanisms, is capable of effecting feeds of a large number of different incremental spacings, and is selectively settable either manually or in response to an automatic control, prior to actuation thereof, during actuation thereof, or in a continuous manner, to vary the magnitude of any such incremental space.

What we claim is:

1. A device of the class described: comprising
 - (a) linkage means including a plurality of at least three link members pivotally interconnected serially end to end in a chain with one end of the chain pivotally mounted on fixed structure and with the other end of said chain positioned from said one end a distance less than the fully extended length of said chain whereby the geometric relationship of said links with each other forms a zig-zag path peaking at the interconnections;
 - (b) input means disposed for coaction with said linkage means to actuate same and pivot said link members with respect to each other;
 - (c) output means at said one end of said chain disposed for coaction with said linkage means to be operated thereby in response to actuation thereof, the magnitude of the output of said output means depending upon the geometric relationship between said plurality of link members of said linkage means; and
 - (d) positionable means at the other end of said chain of links selectively settable to a plurality of positions whereby the distance between the ends of said chain of links may be varied and coacting with said linkage means to alter the geometric relationship between said plurality of link members by changing the distance between the ends of said chain of links thereby to vary the magnitude of the output of said output means.
2. A device of the class described: comprising
 - (a) linkage means including first, second and third link members pivotally interconnected serially end to end in a chain with one end of the chain pivotally secured to fixed structure and with the free end of the third link member positioned from the said one end of the chain a distance less than the fully extended length of said chain whereby the geometric relationship of said links with each other forms a zig-zag path peaking at the interconnections;
 - (b) input means connected to said link chain at the interconnection of the second and third links and disposed for movement through a predetermined stroke distance for coaction with said linkage means during such movement to actuate said linkage means and pivot said link members with respect to each other;
 - (c) output means at the said one end of said chain of links to be operated thereby in response to actuation thereof, the magnitude of the output of said output means for any given predetermined stroke movement of said input means depending upon the geometric relationship between said link members of said linkage means;
 - (d) positionable means at the other end of the chain of links selectively settable to a plurality of positions whereby the distance between the ends of said chain of links may be varied thereby coacting with said linkage means to alter the geometric relationship between said link members to vary the magnitude of the output of said output means for any given predetermined stroke movement of said input means; and
 - (e) means coacting with said input means to modify the output of said output means by changing the

position of said positionable means during actuation of said input means.

3. A device of the class described: comprising
 - (a) a fixed pivot;
 - (b) a first active link having one of its ends pivotally carried by said fixed pivot;
 - (c) a second active link having one of its ends pivotally interconnected to the other end of said first active link;
 - (d) a third active link having one of its ends pivotally connected to the other end of said second active link;
 - (e) a positionable pivot disposed for movement in a path angularly related to said fixed pivot and pivotally carrying the other end of said third active link whereby the distance between the said other end of said third link and said fixed pivot may be varied by movement of said positionable pivot along said path of movement;
 - (f) selectively settable means for effecting movement of said positionable pivot and for positioning said positionable pivot in any one of a plurality of positions;
 - (g) actuating means coacting with said second and third active links to pivot same with respect to each other and to thereby pivot said first active link with respect to said fixed pivot; and
 - (h) drive means coacting with said first active link during pivotal movement thereof to be driven thereby the magnitude of such drive depending upon the geometric relationship between said first active link, said second active link, and said third active link, the extent of actuation of said actuating means, and the position of said positionable pivot.
4. The device of claim 3: wherein
 - (a) the angularly related path of said positionable pivot is arcuate with respect to said fixed pivot; and
 - (b) said selectively settable means moves said positionable pivot along said path to change said geometric relationship between said first, second and third active links to thereby vary the magnitude of the drive imparted to said drive means.
5. The device of claim 3: wherein
 - (a) said actuating means is movable in a substantially linear path and through a uniform stroke distance each time it is actuated; and
 - (b) said selectively settable means comprises cam means selectively operable to change the position of said positionable pivot either before, after, or during operation of said actuating means and in either a continuous or discontinuous manner.
6. An incremental drive: comprising
 - (a) a driven member;
 - (b) a drive member;
 - (c) means interconnecting said driven member to said drive member so as to transmit any movement imparted to said drive member to said driven member;
 - (d) a fixed pivot carrying said drive member;
 - (e) a drive arm connected to said drive member for conjoint movement therewith;
 - (f) a connecting arm pivotally connected to said drive arm;
 - (g) a positionable arm pivotally connected to said connecting arm and disposed for movement with respect to said fixed pivot;
 - (h) a positioning arm coacting with said positionable arm to selectively position same with respect to said fixed pivot;
 - (i) an actuating arm coacting with said positionable arm and said connecting arm to pivot same with respect to each other and with respect to said fixed pivot and to thereby pivot said drive arm and said drive member with respect to said fixed pivot through

- an amount depending upon the movements of both said positioning arm and said actuating arm;
- (j) said interconnecting means transmitting the movement of said drive member to said driven member;
 - (k) said drive member including an input cam disposed for coaction with said actuating arm and adapted to move said actuating arm in a predetermined manner from an unactuated position to an actuated position and to permit return of said actuating arm to said unactuated position;
 - (l) input drive means selectively connectable with said input cam to operate same thereby to move said actuating arm;
 - (m) said input drive means including cam means disposed for coaction with said positioning arm and adapted to move said positioning arm in a predetermined manner from its unactuated to its actuated position and to return said positioning arm to said unactuated position; and
 - (n) positioning drive means selectively connectable with said positioning cam to operate same thereby to move said positioning arm.
7. The drive of claim 6: including
- (a) a gear train interconnecting said positioning drive means to said input drive means at a ratio requiring plural complete operations of said input cam for a single complete operation of said positioning cam; and
 - (b) means coacting with said input drive means to initiate a cycle of operation thereof until said positioning cam has been operated through a single operation.
8. The drive of claim 7: including
- (a) a plurality of positioning cams;
 - (b) a positioning drive means for each of said plurality of positioning cams;
 - (c) a plurality of gear trains each gear train interconnecting a positioning drive means and its associated positioning cam to said input drive means at a different drive ratio; and
 - (d) selection means for interconnecting predetermined ones of said positioning drive means to said input drive means through its associated gear train.
9. An article feed mechanism: comprising
- (a) rotative drive means;
 - (b) input cam means;
 - (c) clutch means for interconnecting said input cam means to said rotative drive means;
 - (d) clutch control means selectively operable to energize said clutch means and interconnect said input cam to said rotative drive means to be driven thereby, and automatically operable to deenergize said clutch means to disconnect said input cam means from said rotative drive means after said input cam means has been driven thereby through a complete cycle of operation;
 - (e) input actuator means disposed for coaction with said input cam means to be moved thereby from an unactuated position to an actuated position;
 - (f) return means for moving said input actuator means from said actuated position to said unactuated position;
 - (g) linkage means interconnected with said input actuator means and operated thereby through a predetermined increment of movement during movement of said input actuator means from said unactuated position to said actuated position;
 - (h) one way friction clutch means interconnected to said linkage means to be operated thereby through a predetermined increment of movement in response to operation of said linkage means;
 - (i) article feed means coacting with said one way friction clutch means to advance an article through a

- predetermined increment of movement for each operation of said one way friction clutch means;
- (j) said article feed means including positioning means interconnected to said linkage means and selectively operable to alter the geometric relationship therebetween and thereby to vary the magnitude of said predetermined increment of movement of said linkage means, said one-way friction clutch means, and said article feed means; and
 - (k) said positioning means including a plurality of different positioning cam means;
 - (l) interconnecting means for connecting a selected one of said positioning cam means to said input cam means to be driven thereby conjointly with the operation thereof, each such positioning cam means coacting with said linkage means to provide a movement thereof of a different magnitude; and
 - (m) means responsive to operation of particular functions of the article feed mechanism to select particular ones of said positioning cam means.
10. In a calculator or like business machine having printing means for marking the results of calculations performed therewithin upon a record sheet and including a printing platen and a plurality of rollers disposed for coaction one with the other to grip the record sheet and pass same in proximity to the printing means the invention comprising:
- (a) a platen drive shaft carrying the printing platen;
 - (b) a drive hub secured to said platen drive shaft for conjoint rotation therewith;
 - (c) a driving hub rotatively disposed on said platen drive shaft in juxtaposition to said drive hub;
 - (d) a drive spring coiled about said driving hub and said drive hub so as to transmit rotation of said driving hub to said drive hub in a direction to feed the record sheet in a predetermined direction past the printing means;
 - (e) a driving gear sector formed on said driving hub;
 - (f) a fixed pivot stud;
 - (g) an actuating gear sector pivotally carried by said fixed pivot stud in meshing engagement with said driving gear sector;
 - (h) a first active link secured to said actuating gear sector for conjoint movement therewith about said fixed pivot stud;
 - (i) a first pivot pin carried by said first active link;
 - (j) a second active link having one end thereof pivotally carried by said first pivot pin;
 - (k) a second pivot pin disposed at the other end of said second active link;
 - (l) a third active link having one end thereof pivotally carried by said second pivot pin;
 - (m) a positionable pivot stud pivotally carrying the other end of said third active link, the position of said positionable pivot stud establishing a geometric relationship between said first active link, said second active link and said third active link;
 - (n) an input actuator pivotally interconnected to said second pivot pin; and
 - (o) an actuator drive disposed for coaction with said input actuator to move same from an unactuated position through a uniform stroke distance in a substantially linear manner to an actuated position and to return same to said unactuated position;
 - (p) the movement of said input actuator pivoting said third active link about said positionable pivot stud and translating said second active link with respect thereto so as to pivot said first active link about said fixed pivot stud through an incremental distance depending upon the magnitude of movement of said input actuator and the geometric relationship established between said first active link, said second active link and said third active link by the position of said positionable pivot stud;
 - (q) said actuator gear sector, driving gear sector, driv-

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ing hub, drive spring, drive hub, and platen shaft, platen and plurality of rollers transmitting the movement of said third active link to the record sheet to feed same in a step by step incremental manner through a predetermined unitary amount.

11. The calculator of claim 10 wherein said actuator drive includes:

- (a) a constantly rotating drive shaft;
- (b) a drive hub fixedly secured to said drive shaft;
- (c) an input drive ratchet fixedly secured to said drive hub and having a plurality of ratchet teeth formed thereon;
- (d) an input cam rotatably carried by said drive shaft;
- (e) an input drive pawl pivotally mounted on said input cam for movement between a position engaging a tooth of said input drive ratchet and a position removed from the teeth of said input drive ratchet;
- (f) an input drive pawl spring urging said input drive pawl towards its position of engagement with said input drive ratchet teeth;
- (g) an input control slide disposed for movement between an unactuated position and an actuated position, said input control slide in the unactuated position thereof coacting with said input drive pawl to maintain same removed from the teeth of said input drive ratchet;
- (h) an input control slide spring urging said input control slide to its actuated position;
- (i) an input control slide bell crank coacting with said input control slide to maintain same in its unactuated position against the bias of said input control slide spring;
- (j) release means coacting with said input control slide bell crank and the printing means to release said input control slide in response to said printing means completing a printing operation;
- (k) an abutment disposed on said input control cam for coaction with a projection formed on said input control slide to return said input control slide to its unactuated position at a predetermined time during the rotation of said input control cam;
- (l) an input drive cam stop surface formed on said input control slide for coaction with said input drive pawl to pivot same against the bias of said input drive pawl spring and out of engagement with said ratchet teeth of said input drive ratchet;
- (m) an input drive cam stop pin disposed on said input drive cam for coaction with said input drive cam stop surface to arrest rotation of said input drive cam after one complete revolution thereof; and
- (n) input drive cam locating detent means coacting with said input drive cam to locate and detent same in a home position.

12. The calculation of claim 11: including

- (a) a positioning actuator pivotally interconnected to said positionable pivot stud;
- (b) a positioning actuator drive disposed for coaction with said positioning actuator to move same and said positionable pivot stud with respect to said fixed pivot stud to thereby alter said geometric relationship between said first active link, said second active link, and said third active link, to thus modify the magnitude of movement of said first active link and the elements associated therewith to vary said step by step incremental feed of said record strip and either increase the magnitude thereof with respect to said predetermined unitary amount or decrease the magnitude thereof with respect to said predetermined unitary amount.

13. The calculator of claim 12 wherein said positionable actuator drive: includes

- (a) an input cam gear fixedly secured to said input drive cam for conjoint rotation therewith;
- (b) a pinion gear fixedly secured to a pinion gear shaft

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and disposed thereon in a position of meshing engagement with said input cam gear;

- (c) a plurality of other pinion gears fixedly secured to said pinion gear shaft;
- (d) a plurality of positioning cam gears rotatively disposed on said drive shaft in positions enmeshed with an associated one of said other pinion gears, the gear ratio for each pair of positioning cam gears and other pinion gears being different;
- (e) a plurality of positioning drive ratchets each one of which is fixedly secured to one of said positioning cam gears and each one of which has a plurality of ratchet teeth formed therein;
- (f) a plurality of positioning cams rotatably carried by said drive shaft and each associated with one of said positioning drive ratchets;
- (g) a positioning drive pawl pivotally mounted on each of said positioning cams for movement between a position engaging a tooth of its associated drive ratchet and a position removed from the teeth of its associated drive ratchet;
- (h) a positioning drive pawl spring associated with each positioning drive pawl urging its respective positioning drive pawl towards its position of engagement with its associated positioning drive ratchet;
- (i) a positioning control slide for each positioning cam disposed for movement between an unactuated position and an actuated position, each said positioning control slide in the unactuated position thereof coacting with an associated positioning drive pawl to maintain same removed from the teeth of its associated positioning drive ratchet;
- (j) a positioning control slide spring for each positioning control slide urging same towards its actuated position;
- (k) a positioning control slide bell crank associated with each positioning control slide to maintain same in its unactuated position against the bias of its respective positioning control slide spring;
- (l) release means for each positioning control slide bell crank, each such release means being responsive to a different mathematical function of the calculator to release its respective positioning control slide and thereby permit the associated positioning drive pawl to be moved by its respective positioning drive pawl spring into engagement with its associated positioning drive ratchet whereby any rotation of said input control cam will be transmitted by said input cam gear, said pinion gear, and an associated one of said other pinion gears and positioning cam gears to a predetermined one of said positioning cams to impart a predetermined degree of rotation thereto;
- (m) an abutment disposed on each of said positioning cams for coaction with a projection formed on its associated positioning control slide to return same to its unactuated position at a predetermined time during the rotation of said input control cam;
- (n) a positioning control cam stop surface formed on each of said positioning control slide for coaction with its associated positioning drive pawl to pivot same against the bias of its respective positioning drive pawl spring and out of engagement with the teeth of its respective positioning drive ratchet;
- (o) a positioning drive cam stop in disposed on each positioning drive cam for coaction with its associated positioning drive cam stop surface to arrest rotation of its respective positioning drive cam after one complete revolution thereof; and
- (p) a positioning drive cam locating means for each positioning drive cam to locate same in a home position.

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