

2,600,938

5 Sheets-Sheet 1



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June 17, 1952

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2,600,938

STEPPING SWITCH

Filed Sept. 20, 1949

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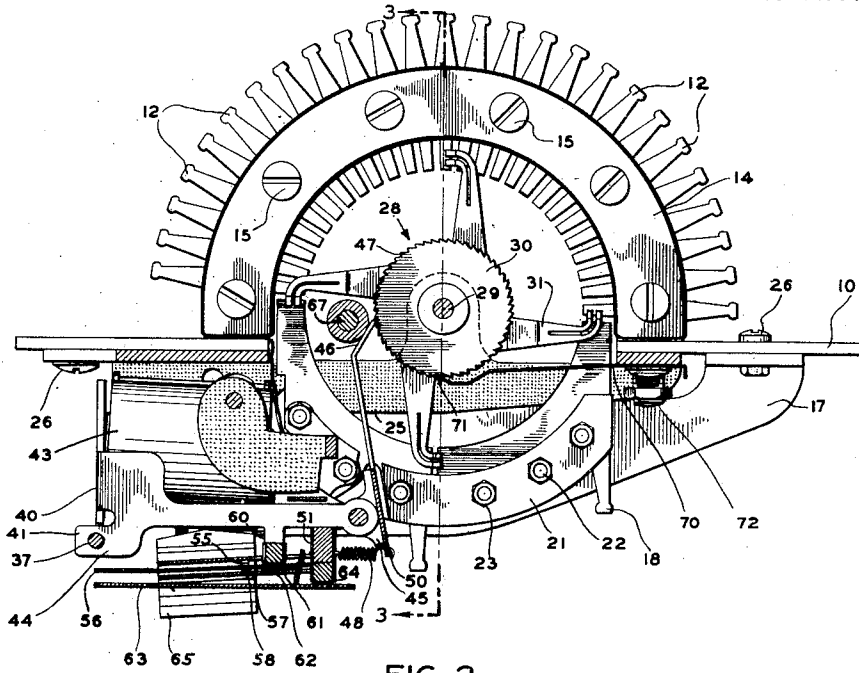


FIG. 2

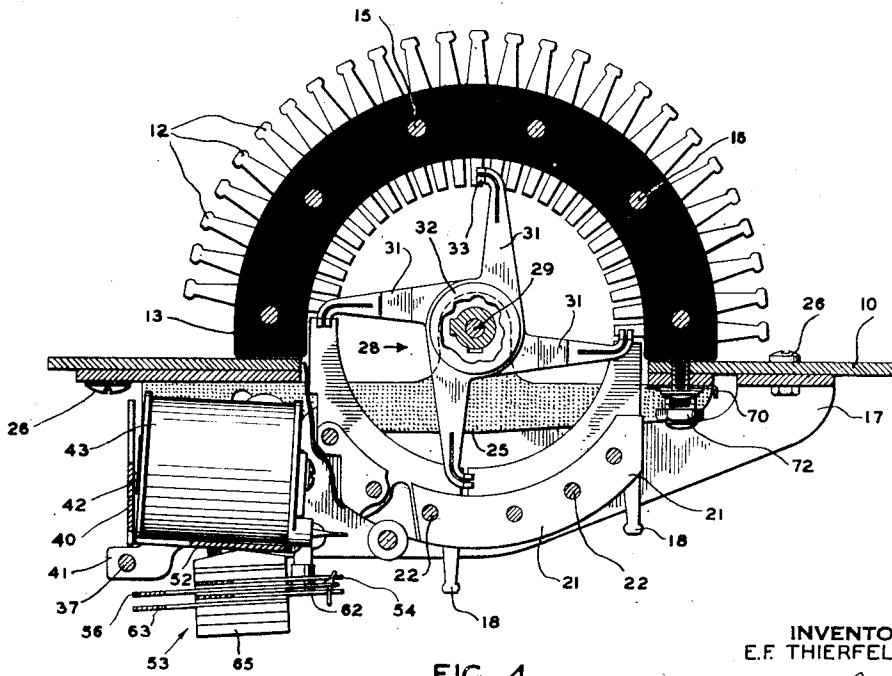


FIG. 4

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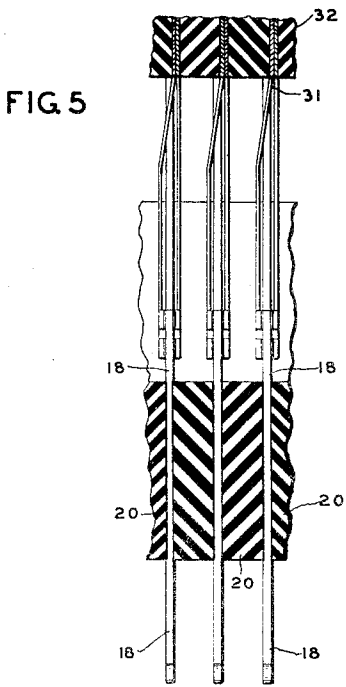
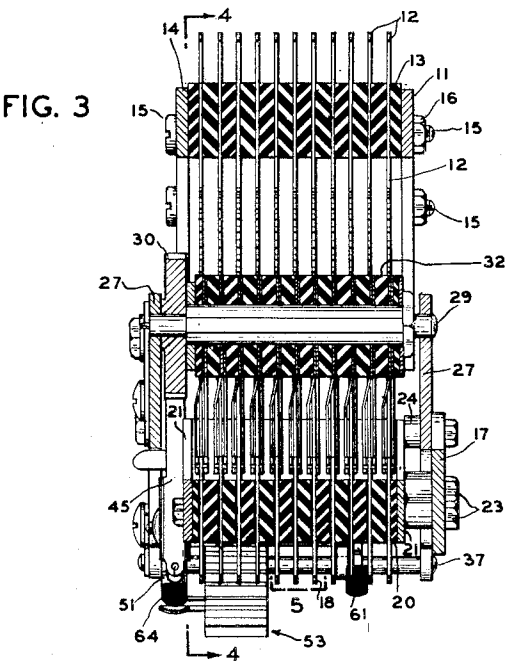
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STEPPING SWITCH

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FIG. 6

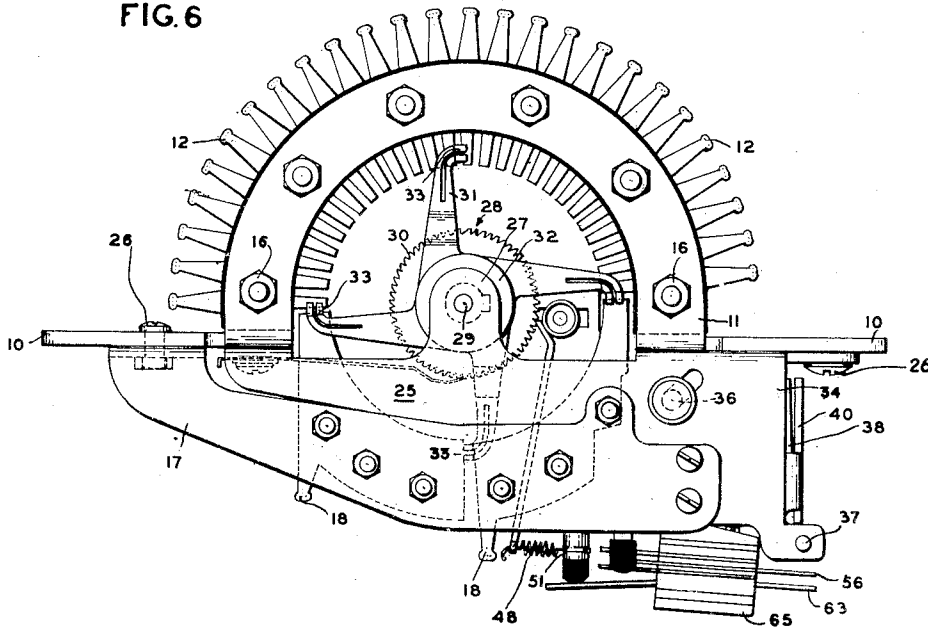
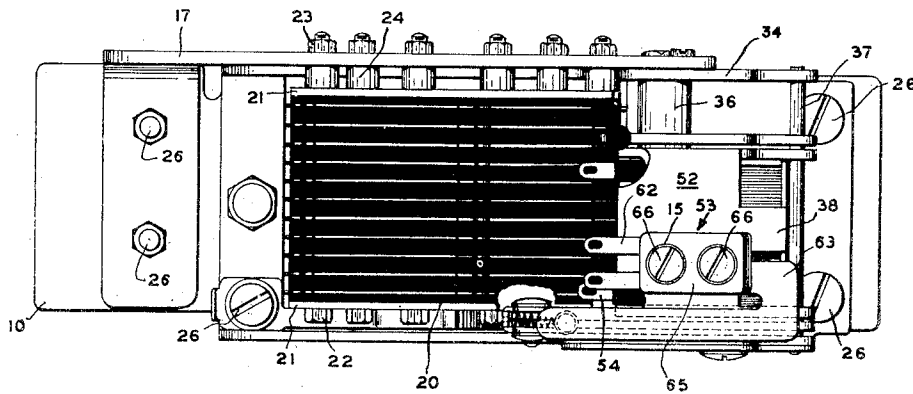


FIG. 7



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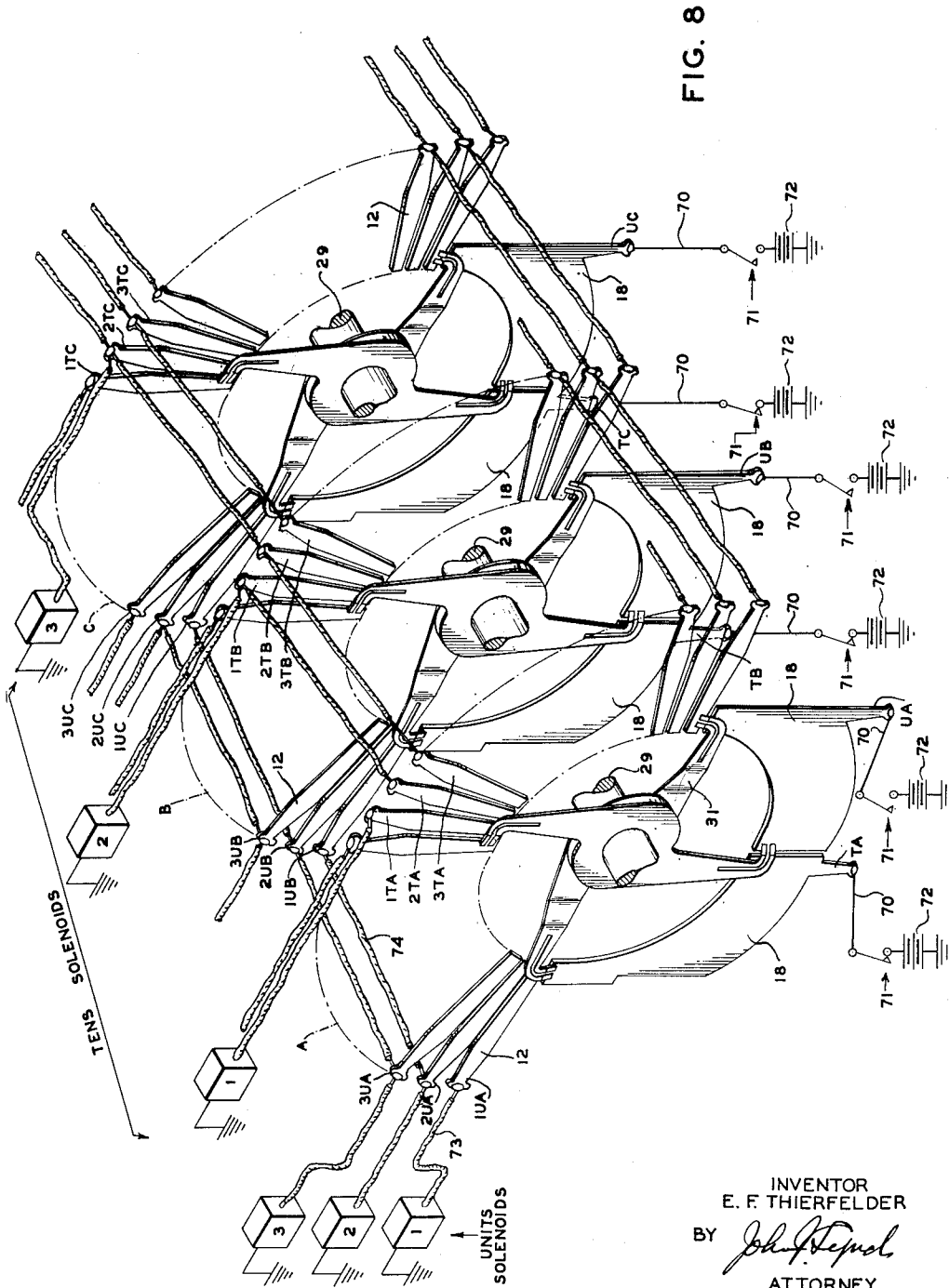
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STEPPING SWITCH

Filed Sept. 20, 1949

5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

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STEPPING SWITCH

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3 Claims. (Cl. 200—11)

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This invention relates to improvements in stepping switches and in particular to one in which series of contacts and contact plates can be connected in circuit alternately and successively.

The conventional stepping switch, as developed for automatic switching in the telephone art, is arranged in decks with each deck having a plurality of contacts arranged about an arc concentric with a shaft carrying double ended switch arms for each deck. Contact is made with the insulated switch arm by means of a brush, one for each deck, extending from the arc of contacts to make sliding contact with the enlarged center portion of each switch arm. Such a construction limits to one the number of circuits that can be completed through the branches represented by the contacts of one level.

The present invention removes this limitation by eliminating the brushes and utilizing the previously unused second end of the switch arm to make contact with a series of arcuate plates representing the several circuits to be successively connected to the branches represented by the contacts. One double ended switch arm is used for each arcuate plate for each circuit to be switched on each level, so that each level can control as many circuits as can be conveniently fitted into the space available.

For instance, in a calculator utilizing the partial products and multiplication table principle for multiplication it is desirable to have a multiplication table for each order of the factor having the greatest number of digits i. e. 6 in a 6×6 multiplier. Each multiplier must be capable of indicating both the units and tens digits of the various possible partial products. Stepping switches of the conventional type have been used for this purpose. The contact positions have been used to represent the digits of the multiplier and the decks to represent the digits of the multiplicand. The contact at the selected position in the selected deck then represents either the unit or the tens digit of the partial product, thus requiring two of the conventional stepping switches to represent a single partial product.

With a stepping switch constructed according to the present invention, a single switch represents both the units and tens of the partial product of each order of the factors, thus halving the number of switches needed and reducing the bulk, weight and cost of the multiplier by providing two switch arms and two arcuate contact plates on each level.

The principal object of the present invention, 55

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therefore, is to provide an improved stepping switch adapted to select circuits from several groups of circuits at each level.

A more specific object is to provide a novel stepping switch having more decks of contacts within the same lateral space.

Another object is to provide a novel improved stepping switch adapted to perform the functions of several conventional stepping switches within the space occupied by one switch of the conventional type.

Another object of the invention is to provide a novel improved stepping switch adapted to control circuits in the performance of the several functions of a calculator, such as addition, subtraction, and multiplication.

Another object is to provide a novel improved stepping switch for use as a multiplication table in a calculator in which a single switch can be used for determining both the tens and units of the partial products of one order of the desired factors simultaneously.

Other objects and structural details will be apparent from the following description when read in connection with the accompanying drawings wherein:

Fig. 1 is a view in perspective of a stepping switch constructed in accordance with my invention;

Fig. 2 is a view in elevation taken at the driving side of the switch, some of the parts being shown in section;

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 2 showing the relation of the arms, contacts and commutators;

Fig. 4 is a vertical section taken on the line 4—4 of Fig. 3;

Fig. 5 is an enlargement of that portion of Fig. 4 indicated by the dotted bracket 5;

Fig. 6 is a view in elevation taken at the side opposite from that illustrated in Fig. 2;

Fig. 7 is a bottom plan view with reference to Fig. 6; and

Fig. 8 is schematic representation of a circuit in which for example, the switch may be used.

Referring to the drawings in detail, and in particular to Figs. 1 and 4 there is provided a frame 10 formed with a semi-circular portion 11 upon which are supported twenty-six strip contacts 12 which are made of copper or other conductive material and are arranged in eleven arcs separated from each other by arcuate insulators 13 and held in place by an arcuate plate 14 that binds the contact assembly together through bolts 15 and nuts 16.

Attached to the frame 10 is a bracket 17 adapted to support sets of arcuate commutator contact plates 18 made of copper or other conductive material arranged in eleven decks, one pair to a deck and each pair separated from the other by arcuate insulators 20. The whole is bound together between arcuate plates 21 and attached to the bracket 17 by means of bolts 22 and nuts 23 and separated from the bracket 17 by spacers 24 so that each deck of commutator contacts 18 is coplanar with a deck of contacts 12.

A bracket 25 is attached to the frame 10 by screws 26. Ears 27 are formed integral with the bracket 25 on opposite sides thereof for supporting the wiper assembly 28 (Fig. 2) journaled in said ears, mounted on an axle 29 and upon which is fixed a ratchet wheel 30 and eleven double armed wipers 31 mounted in pairs at right angles to each other and separated from each other by insulator discs 32. Each wiper 31 is arranged to have one of its tips 33 sweep across a deck of contacts 12 while the other tip sweeps two commutator segments 18 one after the other, so that a conductive path is successively provided between each commutator segment and the thirteen contacts diagonally opposite it. As seen in Fig. 4, the near wiper in clockwise movement will sweep the first quadrant of contacts with its upwardly extending arm while the depending arm will sweep the contact plate 18 in the third quadrant. During the same action, the adjacent wiper will sweep the contacts and the plate of the second and fourth quadrants respectively.

Arm portions 34 integral with the bracket 25 support a heavy rod 36 and a light rod 37 (Fig. 7). On these rods are mounted a U-shaped coil yoke 38, an armature 40 and an armature backstop 41. The coil yoke 38 supports a core 42 on its central portion. The core supports a magnet coil 43. The U-shaped armature 40 is supported, with its central portion in front of the outer end of the core 42, on its arms 44 that are pivotably mounted on the light rod 37.

The side arm 44 of the armature 40 that is on the same side of the switch as the ratchet 30 has a lever 45 pivotably mounted at its inner end. The long end of this lever ends in a pawl 46 that is adapted to engage the teeth 47 of the ratchet wheel 30. The lever 45 is urged clockwise as seen in Fig. 2 by a spring 48 attached to its short end at 50 and to a lug 51 formed integral with the side arm 44 of the armature 40.

Mounted on one side of the outer portion 52 of the coil yoke 38 (Figs. 2 and 4) is a contact and spring pileup unit 53 comprising four U-shaped plates of resilient metal, one plate 54 carrying a contact 55 on the outer side of one of its arms and having facilities for making electrical connections on its other arm. The adjacent or next lower piece 56 carries two contacts 57 and 58 on either side of the arm immediately over the piece 54. This arm extends beyond the lower piece 54 and is adapted to exert pressure on a lug 60, formed in the lower edge of the side arm 44 of the armature 40, and having a cap 61 of insulating material. The next lower piece 62 bears a contact on the under side of the arm directly over the last mentioned piece 56. The outermost piece 63 is the largest of all and is arranged to exert spring pressure on the side arm 44 of the armature 40 fitted with a lever 45 through a cap 64 of insulating material fitted on the lug 51. The plates 54, 56, 62 and 63 on the spring pile up unit 53 are separated by insulators 65 and fastened together and to the coil yoke 38 by screws 66.

A screw 67 mounted in a slot 68 on the ear 27 of the ratchet side of the bracket 25 maintains the pawl 46 in proper position to engage the teeth 47 of the ratchet wheel 30. A plate 70 of spring material is formed with a pawl 71 at one end and is attached to the under side of the bracket 25 by screws 72 to prevent the ratchet 30 from slipping when the pawl 46 is not engaged.

When the relay coil 43 is energized it attracts the armature 40 to its core 42 lowering the arm 44 which carries with it the lever 45 against the pressure of the spring leaf 63 so that the pawl 46 is disengaged from the teeth 47 of the ratchet 30. The spring 48 urges the pawl 46 into engagement with a lower tooth 47 on the ratchet 30. When the coil 43 is deenergized the spring leaf 63 urges the arm 44 upwardly carrying with it the lever 45 still having its pawl 46 in engagement with a tooth 47 of the ratchet wheel 30 to move the latter one tooth space clockwise as seen in Fig. 2. The space between the teeth equals the space between the contacts 12. The ratchet wheel 30 carries with it the switch arms 31 so that their tips 33 travel onto the next contact on each quadrant of each level of contacts to break one current path and set up another.

The invention has been shown embodied in a modified stepping switch of the spring operated type. The invention could also be embodied in stepping switches of the magnet driven type having a release magnet to permit reversal and return to the starting position by the use of a different driving structure and the modification of the shape of the wiper tips to permit operation in both directions.

The above described switch may be used as an adding device by connecting the contacts 12 and the commutators 18 by wires in the manner shown schematically in Fig. 8. In this view three decks and three pairs of arms have been shown in an exploded perspective view without the supporting or driving structures to bring out the electrical connections. Only a few contacts 12 on each deck have been shown by way of illustration. It is to be understood that in most applications there would be more decks and more contacts on each deck.

It will be seen that the decks have been indicated by the letters A, B and C. The commutator contacts 18 have been designated T or U representing units or tens digits of partial products. The commutator for the units digits of the first deck is designated UA and that for the tens digits of the second deck TB etc. These commutator contacts are each connected by a wire 70 through a normally open switch contact 71 to a source of electrical energy such as a battery 72. The other side of this battery is connected to ground. Each contact 18 is designated by the digit it represents 1, 2 etc., either T or U depending upon whether it represents a digit of the units or tens and a letter A, B or C depending upon what deck it is in. The first contact in the ten's group of the C deck is thus represented by '1TC'. It will be seen that contact 3UA is connected to contacts 2UB and 1UC. Similarly other contacts are connected to the contact of the equivalent group in the next deck representing the next lowest number. The group of contacts not so connected is then connected to a solenoid arranged to print the highest number represented by the contacts so connected. The effect is to provide an adding device. The first position in deck C will print a "3" as will the second position in deck B and the third

position in deck A. As each successive deck is energized by the closing of the switch between its commutator contact and the battery a given position will represent successively higher values. The first amount to be added determines the position of the switch arms and the second amount determines which switch arm is energized and so which numeral printing solenoid is energized to print the total.

The switch may also be connected up for use as a multiplication table and partial products type of multiplier. In such an arrangement one section represents the units digits of the partial product and the other section represents the tens digits. The multiplicand is represented by the position of the switch arms. Each deck represents a possible multiplier. As an example, in multiplying six times six, the multiplicand is represented by positioning the switch arms to the sixth position. The multiplier is represented by completing the circuit to the sixth deck. This completes a circuit to the sixth contact on the sixth deck of each section. The units digit of which is "6" and the tens digit "3." Thus, to print the product, the sixth contact of the sixth deck of the units section must be connected to the "6" units solenoid; and the sixth contact of the sixth deck of the tens section must be connected to the "3" tens solenoid. Similarly for four times four the fourth contact of the fourth deck of the units section must be connected to the "6" solenoid and the fourth contact of the fourth deck of the tens section must be connected to the "1" solenoid. Those contacts in the units section, representing partial products having the same digit in the units order, are connected together and to the solenoid representing that digit and this also applies for the tens section. A connection of this sort is not shown but can be easily worked out in any convenient manner.

The circuit by which the switch arms are positioned may be any of several well known design and as these arrangements are not a part of the present invention, it is not believed necessary to show such a circuit.

While I have described what I consider to be highly desirable embodiments of my invention, it is obvious that many changes in form could be made without departing from the spirit of my invention, and I, therefore, do not limit myself to the exact form herein shown and described, nor to anything less than the whole of my invention as hereinbefore set forth, and as hereinafter claimed.

What I claim is:

1. In an electrical circuit stepping switch, a plurality of tiers of insulated contacts, each tier including radially extending contact strips arranged in spaced relation with each other in arcs constituting quadrants of a circle, contact plates of quadrant shape disposed in spaced relation to each other and to the strips and com-

pleting a circle with said strips, the strips and the plates of each tier being substantially coplanar, a shaft, a pair of wipers for each tier mounted on said shaft and each pair of wipers presenting arcuately spaced tip ends for simultaneous sweeping engagement with the contact strips and the contact plates, and means for rotating said shaft to impart a sweeping movement to said wipers to successively provide a conductive path between each contact plate and the contact strips of a quadrant.

2. In an electrical current stepping switch, a plurality of tiers of insulated contacts, each tier including radially extending contact strips arranged in spaced relation with each other about a semicircle, contact plates of quadrant shape disposed in spaced relation to each other and to the strips and completing with said strips a circle, the strips and the plates of each tier being substantially coplanar, a shaft, a pair of wipers for each tier mounted on said shaft, the wipers of each pair being arranged at right angles to each other and each wiper of the pair presenting diametrically opposite tip ends for simultaneous sweeping engagement with the contact strips and the contact plates, and means for rotating said shaft to impart a sweeping movement to said wipers to successively provide a conductive path between each contact plate and the contact strips in a quadrant diametrically opposite said plate.

3. An electrical stepping switch as set forth in claim 1 in which said shaft rotating means includes a ratchet gear secured to the shaft, the teeth of the ratchet being spaced to coincide with the spacing of said contact strips and means for intermittently rotating the ratchet gear one tooth at a time.

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