

ly from one cathode to another and has reached the cathode corresponding to the actuated multiplier key to cut off the transmission of impulses to the said associated counting device, and means operable, upon the multicathode electronic tube having ensured the transmission to the counting devices of the various orders associated with the actuated keys of the plurality of keys of a number of impulses equivalent to the product of the multiplicand by one digit of the multiplier, to transfer the numeral registered in each counting device into the counting device of the next adjacent higher order.

10. A calculating machine which comprises in combination a plurality of keys, a plurality of counting devices, a plurality of electrodes associated with said counting devices, means resulting from the actuation of a key of said plurality of keys for selecting a predetermined number of the electrodes of the said plurality of electrodes, the selected number being related to the value of the actuated key, means for transmitting from the said preselected electrodes to the counting device associated with the actuated key of said plurality of keys a number of electrical impulses related to the selected number of electrodes to effect a change, related to the value of the actuated key, in the registration of the said counting device, and two secondary sources of impulses successively connected to the counting devices of a pair of adjacent counting devices and operable to register in the counting device of the higher order the value initially registered in the lower order of the said pair of counting devices.

11. An office calculating machine which comprises in combination a plurality of orders of keys, a corresponding plurality of counting devices, a plurality of primary electrodes associated with the said orders of keys and said counting devices, means resulting from the actuation of a key of an order of keys for selecting a predetermined number of the electrodes of the said primary electrodes, the selected number of electrodes being related to the value of the actuated key, means for applying a potential to the selected primary electrodes, means operable as a result of the actuation of a key of said order of keys for effecting the sequential transmission from said electrodes to the associated counting device of a number of electrical impulses equal to the selected number of electrodes to effect a change, related to the value of the actuated key, in the registration of the said counting device, and two sources of auxiliary impulses connected successively to the counting devices of the respective orders of counting devices, one of said sources being operable to register in each counting device a predetermined numeral the registration of which causes an impulse to ensure that the second auxiliary source feeds a number of impulses into the counting device of the higher order which corresponds to the numeral initially registered in the lower order of the said pair of adjacent counting devices.

12. A calculating machine comprising a plurality of pulse-operated counting devices, a plurality of orders of keys each order being uniquely associated with one of said counting devices, means for generating and distributing electrical pulses so connected with said keys that during a cycle of operation of the machine the number registered by each counting device is changed by the application of pulses from said pulse-generating and distributing means by an amount equal to the value of any actuated key in the order of keys associated with that counting device, a series of multiplier keys, means responsive to the actuation of a multiplier key for shifting the contents of each counting device into the counting device of the next higher order, and means operative after the completion of the shift for initiating a number of cycles of operation of the machine equal to the value of the actuated multiplier key.

13. A calculating machine comprising a plurality of pulse-operated counting devices, carry means effective

between adjacent ones of said counting devices, a plurality of electrodes, a plurality of orders of keys coupled to said electrodes, each order being uniquely associated with one of said counting devices, means responsive to the actuation of any of said keys for establishing an electrical connection substantially simultaneously to a number of the electrodes equal to the value of the actuated key in its order, means for scanning all the electrodes, means for coupling the orders of keys successively to their respective associated counting devices once during each cycle of operation of the machine to cause a number of pulses equal to the value of any actuated key to be fed from the connected electrodes to the counting device associated with the order of that key, a series of multiplier keys, means responsive to the actuation of a multiplier key for shifting the contents of each counting device into the counting device of the next higher order and means operative after the completion of the shift for initiating a number of cycles of operation of the machine equal to the value of the actuated multiplier key.

14. A calculating machine comprising a plurality of pulse-operated counting devices, a plurality of electrodes, a plurality of orders of keys, each order being uniquely associated with one of said counting devices, and each key being operative when actuated to establish an electrical connection substantially simultaneously to each of a number of said electrodes equal to the value of that key in its order, means for successively scanning all the electrodes, means for deriving from the scanned electrodes a number of pulses equal to the number of connected electrodes, means operative during a cycle of operation of the machine for applying to each of the counting devices a number of pulses equal to the value of any actuated key in the order of keys associated with that counting device, a series of multiplier keys, means responsive to the actuation of a multiplier key for shifting the contents of each counting device into the counting device of the next higher order, and repeating means controlled by the series of multiplier keys and operative after the completion of the shift operation to initiate a number of cycles of operation of the machine equal to the value of the actuated multiplier key.

15. A calculating machine comprising a plurality of pulse-operated decimal counting devices, carry means operative between adjacent ones of said counting devices, a plurality of orders of keys each of which orders is uniquely associated with one of said counting devices, means for causing, during a cycle of operation of the machine, the application to each counting device of a number of pulses equal to the value of any actuated key in the order of keys associated with that counting device, a series of ten multiplier keys, means responsive to the actuation of any one of said multiplier keys for generating groups of ten impulses, means for applying one of said groups of pulses to each counting device in succession until that counting device produces a carry whereafter the remainder of said group of pulses is applied to the counting device of the next higher order, and means operative after groups of pulses have been applied to all the counting devices for initiating a number of cycles of operation of the machine equal to the value of the actuated multiplier key.

16. A calculating machine comprising a plurality of multicathode electronic counting tubes, carry means operative between adjacent ones of said counting tubes, a plurality of orders of keys each order being associated with one of said counting tubes, means for generating and distributing electrical pulses so connected with said keys that during a cycle of operation of the machine a number of pulses equal to the value of any actuated key in any order is applied to the counting tube associated with that order, a multicathode electronic control tube, a series of multiplier keys each associated with a cathode of said control tube, means responsive to the actuation of any one of said multiplier keys for shifting the

number registered by each counting tube to the counting tube of the next higher order, means operative after the completion of the shift for transferring the glow in said control tube to the next succeeding cathode and for initiating one cycle of operation of the machine, and means for repeating said glow transfer and said cycle initiation until the glow reaches the cathode associated with the actuated multiplier key.

17. A calculating machine comprising a plurality of pulse-operated counting devices, carry means effective between adjacent ones of said counting devices, an electronic pulse generator having a plurality of pulse outputs, a plurality of orders of keys coupled to said pulse generator each order being uniquely associated with one of said counting devices and each key being operative, when actuated, to establish an electrical connection to the pulse output corresponding to the value of that key in its order, a timing device synchronised by the pulse generator, and means controlled by the timing device for coupling the orders of keys successively to their associated counting devices to cause a number of pulses equal to the value of any actuated key to be fed from the connected pulse output to the counting device associated with the order of that key.

18. A calculating machine as claimed in claim 17 including means controlled by said timing device for disabling said pulse generator when all the orders of keys have been coupled to their associated counting devices.

19. A calculating machine comprising a plurality of pulse-operated counting devices, carry means effective between adjacent ones of said counting devices, a pulse generator having a plurality of outputs, a plurality of orders of keys coupled to said pulse generator, each order being uniquely associated with one of said counting devices, means responsive to the actuation of any of said keys for establishing an electrical connection to the pulse output corresponding to the value of the actuated key in its order, an electronic timing device, and means responsive to the actuation of any of said keys for initiating a cycle of operation of said timing device during which the orders of keys are successively coupled under the control of said timing device to their respective associated counting devices to cause a number of pulses equal to the value of any actuated key to be fed from the connected pulse generator output to the counting device associated with the order of that key.

20. A calculating machine comprising a plurality of pulse-operated counting devices, carry means effective between adjacent ones of said counting devices, a multicathode electronic stepping tube having a plurality of cathodes, a plurality of orders of keys, each order being uniquely associated with one of said counting devices, means responsive to the actuation of any of said keys for establishing an electrical connection substantially simultaneously to a number of the cathodes equal to the value of the actuated key in its order, means for causing a glow to step cyclically around all the cathodes of said stepping tube, a timing device, and means including said timing device for completing said electrical connection to each of said counting devices via the keys of the order associated with such counting device during a separate cycle of operation of said stepping tube.

21. A calculating machine comprising a plurality of pulse-operated counting devices, a multicathode electronic stepping tube having a plurality of cathodes, a plurality of orders of keys coupled to said cathodes each order being uniquely associated with one of said counting devices, means responsive to the actuation of any of said keys for establishing an electrical connection substantially simultaneously to a number of the cathodes equal to the value of the actuated key in its order, means for driving said stepping tube, and gating means adapted during each of a succession of cycles of said stepping tube to connect a distinct one of said counting devices with

said stepping tube via the keys of the order with which such counting device is associated.

22. A calculating machine comprising a plurality of pulse-operated counting devices, a plurality of orders of keys each order being uniquely associated with one of said counting devices, a pulse generator having a plurality of pulse outputs, means responsive to the actuation of any key in said orders of keys for establishing an electrical connection to the pulse output corresponding to the value of the actuated key in its order, means for coupling the orders of keys successively to their respective associated counting devices, a series of multiplier keys, means responsive to the actuation of a multiplier key for effecting multiplication by ten by shifting the contents of each counting device into the counting device of the next higher order, and means responsive to the completion of the shift operation for initiating a number of cycles of operation of said coupling means equal to the value of the actuated multiplier key during each of which cycles the number registered by each counting device is increased by the application of pulses from the pulse generator by an amount equal to the value of any actuated key in the order of keys associated with that counting device.

23. A calculating machine comprising a plurality of pulse-operated counting devices, carry means effective between adjacent ones of said counting devices, an electronic stepping tube having a plurality of cathodes, a plurality of orders of keys coupled to said cathodes, each order being uniquely associated with one of said counting devices, a timing device synchronised by said stepping tube, means responsive to the actuation of any of said keys for establishing an electrical connection substantially simultaneously to a number of the cathodes equal to the value of the actuated key in its order, means for driving the stepping tube, means controlled by the timing device for coupling the orders of keys successively to their respective associated counting devices once during each cycle of operation of the timing device to cause a number of pulses equal to the value of any actuated key to be fed from the connected cathodes to the counting device associated with the order of that key, a series of multiplier keys, means for effecting multiplication by ten by shifting the contents of each counting device into the counting device of the next higher order, and means for initiating a number of cycles of operation of the timing device equal to the value of the actuated multiplier key.

24. A calculating machine comprising a plurality of pulse-operated decimal counting devices, carry means operative between adjacent ones of said counting devices, a plurality of orders of keys each of which orders is uniquely associated with one of said counting devices, a pulse generator having a plurality of outputs, means responsive to the actuation of a key in any of said orders of keys for causing, during a normal cycle of operation of the machine, the application to each counting device of a number of pulses from said pulse generator equal to the value of any actuated key in the order of keys associated with that counting device, a series of ten multiplier keys, means responsive to the actuation of any one of said multiplier keys for initiating an abnormal cycle of operation of the machine, means operative during said abnormal cycle for applying a group of nine pulses to each counting device in succession until that counting device registers nine whereafter the remainder of said group of nine pulses is applied to the counting device of the next higher order, means operative during said abnormal cycle for applying one additional pulse to the counting device of the lowest order, and means operative after the said groups of pulses have been applied to all the counting devices for initiating a number of normal cycles of operation of the machine equal to the value of the actuated multiplier key.

25. A calculating machine comprising a plurality of

multicathode electronic counting tubes, carry means operative between adjacent ones of said counting tubes, a plurality of orders of keys each order being associated with one of said counting tubes, a pulse generator having a plurality of outputs each of which is associated with a key having a particular value in each order, means responsive to the actuation of any of said keys for causing the pulse generator output associated with the value of the actuated key to be connected once during a cycle of operation of the machine to the counting tube associated with the order of the actuated key to cause a number of pulses equal to the value of the actuated key to be applied to said counting tube, a multicathode electronic control tube, a series of multiplier keys each associated with a cathode of said control tube, means responsive to the actuation of any one of said multiplier keys for shifting the number registered by each counting tube to the counting tube of the next higher order, means operative after the completion of the shift for transferring the glow in said control tube to the next succeeding cathode and for initiating one cycle of operation of the machine, and means for repeating said glow transfer and said cycle initiation until the glow reaches the cathode associated with the actuated multiplier key.

26. A calculating machine comprising a plurality of pulse-operated counting devices, a plurality of orders of keys each order being uniquely associated with one of said counting devices, a pulse generator having a plurality of pulse outputs, means responsive to the actuation of any key in said orders of keys for establishing an electrical connection to the pulse output corresponding to the value of the actuated key in its order, means for coupling the orders of keys successively to their respective associated counting devices, a series of multiplier keys, means responsive to the actuation of a multiplier key for initiating a number of cycles of operation of said coupling means equal to the value of the actuated multiplier key during each of which cycles the number registered by each counting device is increased by the application of pulses from the pulse generator by an amount equal to the value of any actuated key in the order of keys associated with that counting device, and means for shifting the contents of each counting device resulting from the first of two successive actuations of multiplier keys into the counting device of the next higher order.

27. A calculating machine comprising a plurality of pulse-operated counting devices, carry means effective between adjacent ones of said counting devices, a plurality of orders of keys each order being uniquely associated with one of said counting devices, a pulse generator having a plurality of pulse outputs each associated with the complement of the value of one of the keys in each order, means responsive to the actuation of a key in any of said orders of keys for establishing an electrical connection to the pulse output associated with the complement of the value of that key, means operative during a cycle of operation of the machine for causing the number registered by each counting device to be increased by the application of pulses from said pulse generator by an amount equal to the complement of the value of any actuated key in the order of keys associated with that counting device, first and second electronic stepping tubes, means for complementing and shifting the number registered by the counting device associated with the highest order of keys into the first electronic stepping tube, means for complementing and shifting the number registered by each other counting device into the counting device associated with the next higher order of keys, means for complementing and shifting the number registered by the second electronic stepping tube into the counting device associated with the lowest order of keys, means for initiating a number of cycles of operation of the machine equal to the number required to cause the first electronic stepping tube to register a predetermined number, and means for increasing the number regis-

tered by the second electronic stepping tube by unity each time a cycle of operation of the machine takes place.

28. A calculating machine comprising a series of first counting devices, a second counting device, and a third counting device, carry means effective between adjacent ones of said first counting devices and between the highest of said first counting devices and said second counting device, a plurality of orders of keys each order being uniquely associated with a respective one of said first counting devices, control means for selecting primary or secondary cycles of operation of the machine, means operative during a primary cycle of operation of the machine for causing the number registered by each counting device to be increased by an amount equal to the complement of the value of any actuated key in the order of keys associated with that counting device, means operative during a secondary cycle of operation of the machine for complementing and shifting the number registered by said highest first counting device into said second counting device, for complementing and shifting the number registered by each of said first counting devices except said highest first counting device into the next higher counting device, and for complementing and shifting the number registered by said third counting device into the lowest of said first counting devices, means for causing said control means to select a secondary cycle when said second counting device registers a predetermined number and a primary cycle when said second counting device fails to register said predetermined number, and means for causing said third counting device to register the number of primary cycles performed by the machine.

29. A calculating machine comprising a plurality of pulse-operated counting devices, a plurality of orders of manually actuatable keys each order of keys being uniquely associated with one of said counting devices, means operative during a cycle of operation of the machine for applying a number of pulses related to the value of any actuated key to the counting device associated with the order of that key, switching means for setting the machine to perform a plurality of different arithmetical operations including addition and multiplication, a plurality of multiplier keys, locking means operative upon operation of said switching means to set the machine for multiplication to prevent any actuated key in any of said orders from returning to its unactuated position when released until the machine has gone through a number of said cycles equal to the value of an actuated multiplier key, and means controlled by said switching means for disabling said locking means when the machine is set to perform addition.

30. A calculating machine comprising a plurality of orders of keys, a plurality of counting devices one associated with each order of keys, a multioutput pulse generator, an electronic multicathode stepping tube driven by said pulse generator, means responsive to the actuation of any of said keys for establishing an electrical connection to an output of said pulse generator corresponding to the value of the actuated key in its order, means for retaining the glow in said stepping tube on a first predetermined cathode, means responsive to the actuation of any of said keys for disabling said glow-retaining means and thus allowing the glow to be stepped successively among the cathodes, means controlled by the potential on a plurality of the cathodes of said stepping tube for coupling the orders of keys successively to their respective associated counting devices, and means controlled by the potential on a second predetermined cathode of said stepping tube for stopping said pulse generator.

31. A calculating machine comprising a plurality of orders of keys, a plurality of counting devices one associated with each order of keys, a separate gating device between each order of keys and its associated counting device, a multicathode electronic stepping tube, and means for driving said stepping tube, wherein the potential on each of at least some of the cathodes of said

stepping tube is operative to open a respective one of said gating devices when the glow is on said cathode.

32. A calculating machine comprising a plurality of orders of keys, a plurality of counting devices one associated with each order of keys, a gating device between each order of keys and its associated counting device, a plurality of multicathode electronic stepping tubes, means for driving said stepping tubes sequentially, and connections between at least some of the cathodes of each stepping tube and respective ones of said gating devices, whereby each gating device is opened when the glow is on the cathode connected thereto.

33. A calculating machine comprising a pulse generator, a plurality of orders of keys coupled to said pulse generator, a plurality of counting devices one associated with each order of keys, a separate first gating device between each order of keys and its associated counting device, two multicathode electronic stepping tubes, means coupled to said pulse generator for driving each of said stepping tubes, a separate second gating device between the pulse generator and each of said driving means, a connection between at least one cathode of each stepping tube and the second gating device controlling the driving means of the other stepping tube, whereby each second gating device is opened when the glow is on a cathode connected thereto, and connections between at least some of the cathodes of each stepping tube and respective ones of said first gating devices, whereby each first gating device is opened when the glow is on the cathode connected thereto.

34. A calculating machine comprising a plurality of pulse-operated counting devices, an electronic pulse generator, a plurality of orders of keys coupled to said pulse generator each order being associated with one of said counting devices and each key being operative, when actuated, to select during each cycle of operation of the pulse generator a number of pulses equal to the value of that key in its order, a timing device controlled by said pulse generator and operative to couple the orders of keys successively to their respective associated counting devices, a series of multiplier keys each of which is operative, when actuated, to initiate the operation of the timing device and to stop the pulse generator when the timing device has performed a number of cycles equal to the value of the actuated multiplier key, latching means for retaining any actuated multiplier key in its operated position, and means controlled by the pulse generator for releasing said latching means when the pulse generator stops.

35. A calculating machine according to claim 34 wherein said pulse generator comprises a multicathode electronic stepping tube driven by a free-running oscillator and wherein a voltage is derived from said oscillator and used to control a solenoid which when energised holds said latching means in the locked position.

36. A calculating machine according to claim 34, wherein said pulse generator comprises a multicathode electronic stepping tube driven by a free-running oscillator, wherein a voltage is derived by means of a rectifier from said oscillator and is applied to the control electrode of a trigger tube, and wherein a solenoid, which when energised holds said latching means in the locked position, is included in the anode circuit of said trigger tube.

37. A calculating machine including a series of pulse-operated counting devices, carry means operative between adjacent counting devices in said series, an electronic pulse generator adapted to produce groups of pulses, means for applying pulses from a separate one of said groups of pulses to each counting device until it is full and for applying the remainder of said group of pulses to the next higher counting device in said series.

38. A calculating machine as claimed in claim 37, including means for applying one additional pulse to the lowest counting device in said series, wherein pulses from a first one of said groups of pulses are applied to the

highest counting device in said series, the remainder of that group after the highest counting device is full being applied to the lowest counting device in the series, and wherein pulses from succeeding groups of pulses are applied successively to the remaining counting devices in order from the second highest in the series to the lowest.

39. A calculating machine including a series of pulse-operated counting devices, a plurality of orders of keys associated with said counting devices, a pulse generator which comprises a multicathode electronic stepping tube driven by a free-running oscillator, a gating circuit between each order of keys and its associated counting device, and a transformer the primary winding of which is energised from the circuit of said oscillator and the secondary of which supplies a drive voltage for each of said gating circuits.

40. A calculating machine as claimed in claim 39, wherein each gating circuit comprises a first resistor, a first asymmetrically conducting device and a second resistor connected in series between a terminal of the secondary winding of said transformer and one of the guide electrodes of said multicathode electronic stepping tube, an output terminal connected to the junction between the first asymmetrically conducting device and the second resistor, and a plurality of input terminals connected to the junction between the first resistor and the first asymmetrically conducting device through individual second asymmetrically conducting devices directed oppositely to said first asymmetrically conducting device, wherein the output terminal of each gating circuit is operatively connected to the input of the associated counting device, and wherein one of the input terminals of each gating circuit is operatively connected through its associated order of keys to the output of the pulse generator.

41. A key operated calculating machine comprising a series of pulse-operated counting devices, means for initiating shift cycles during each of which the content of the highest counting device in the series is shifted into the lowest counting device in the series, and for shifting the content of each counting device except the highest in the series into the next higher counting device in the series, a multicathode electronic stepping tube, a control terminal, means for connecting said control terminal to any selected one of the cathodes of said stepping tube, means for driving said stepping tube so that the glow is advanced by one cathode during each shift cycle, and means coupled to said control terminal for terminating a series of shift cycles when the glow in the stepping tube reaches the cathode connected to said control terminal.

42. A calculating machine comprising a plurality of pulse-operated counting devices, carry means effective between adjacent ones of said counting devices, an electronic stepping tube having a plurality of cathodes, a plurality of orders of keys coupled to said cathodes, each order being uniquely associated with one of said counting devices, an "add-subtract" switch, means responsive to the actuation of any of said keys for establishing an electrical connection substantially simultaneously to a number of said cathodes, said number being equal to the value of the actuated key in its order when the add-subtract switch is in the add position and equal to the complement of the value of the actuated key when the add-subtract switch is in the subtract position, means for driving the stepping tube, and means for initiating a cycle of operation of the machine during which the orders of keys are successively coupled to their respective associated counting devices to cause a number of pulses equal to the number of connected cathodes to be fed from the connected cathode to the counting device associated with the order of that key.

43. A calculating machine including a series of pulse-operated counting devices, carry means operative between adjacent counting devices in said series, an electronic pulse generator adapted to produce groups of pulses, means for applying pulses from successive ones of said

75

groups of pulses to successive pairs of adjacent counting devices in said series until that one of said adjacent counting devices which is lower in said series is full.

44. A calculating machine including a series of counting devices arranged as a register, means for entering a plural-digit dividend into said register, divisor-storing means, means for performing repeated subtraction of a number stored in the divisor-storing means from the dividend entered in the register, means for counting the number of subtractions performed, means for ascertaining when said repeated subtraction has caused the number in the register to be reduced below zero, and means operated in response to said ascertaining means for stopping the repeated subtraction and causing the digits of the number in the register to be shifted into counting devices of higher order in said register and complemented.

45. A key operated calculating machine comprising a series of pulse-operated counting devices, a series of cold-cathode display tubes one associated with each counting device for displaying the numbers registered in said counting devices, a multicathode electronic stepping tube, a series of cold-cathode indicating tubes one located in association with the space between each pair of adjacent display tubes and adapted to light when the glow in the stepping tube rests on the cathode of the stepping tube

76

associated with such indicating tube, a plurality of decimal point keys associated with the cathodes of said stepping tube arranged to determine the cathode on which the glow rests, a plurality of multiplier keys, repeating means for causing the machine to perform a number of addition cycles equal to the value of an actuated multiplier key, and means operable after one of said decimal point keys has been actuated for applying a pulse to the drive electrodes of said stepping tube for each depression of a multiplier key.

References Cited by the Examiner

UNITED STATES PATENTS

2,442,428	6/1948	Mumma	235—160
2,556,200	6/1951	Lesti	307—88.5
2,557,729	6/1951	Eckert	307—88.5
2,845,597	7/1958	Perkins	235—154 X
2,986,333	5/1961	Thomas	235—160
3,104,316	9/1963	Allen et al.	235—160

MALCOLM A. MORRISON, *Primary Examiner.*

ROBERT C. BAILEY, *Examiner.*

M. P. ALLEN, M. J. SPIVAK, *Assistant Examiners.*