Divisional Application Number: US 19/196,123 of parent Patent US 12,324,295 B2

Pertinent Figure:

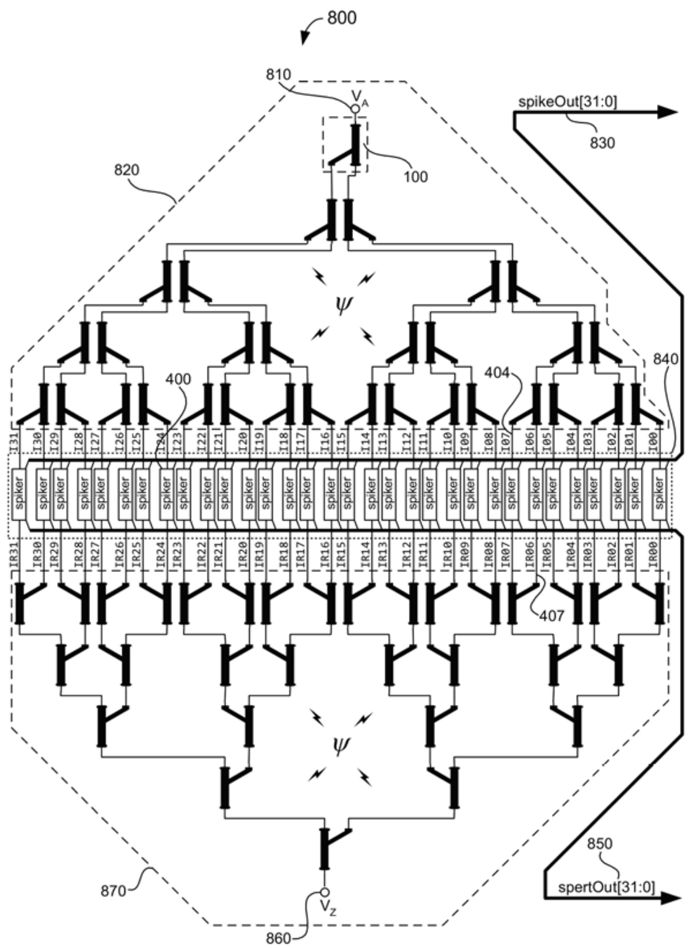

FIG. 8

Listing of Claims:

1-15. (Canceled)

16. A complex nanostructure for sorting a plurality of electrons into a distribution, said complex nanostructure comprising:

a first array of carbon nanotubes joined at points to form binary junctions within the first array, the first array having an input connection and a plurality of output connections;

a plurality of electron-detection spiker circuits connected to the plurality of output connections;

voltage means for creating at least one difference in potential between the input connection and the plurality of output connections;

wherein whenever a voltage potential is present across the first array, each electron in the plurality of electrons flows through the first array of carbon nanotubes and at each junction, follows one of two possible routes toward the plurality of output connections in order to bin-out at a given electron-detection spiker circuit; and

output circuitry for feeding, as information to inputs of an artificial neural network, the distribution of binned-out electrons across the plurality of electron-detection spiker circuits, wherein the artificial neural network is run on a computer as part of an information processing system.

17. The complex nanostructure as recited in claim 16, wherein the first array of carbon nanotubes comprises a plurality of bifurcated nanostructure transistors arranged in a plurality of rows forming the first array, each of the bifurcated nanostructure transistors comprising:

a carbon nanotube trunk having a first end, a second end, and an aperture in a side thereof;

a carbon nanotube L having a first end and a second end, wherein:

the first end of the carbon nanotube L is inserted through the side of the carbon nanotube trunk via the aperture, thereby forming a junction, and

the carbon nanotube L is angled away from the first end of the carbon nanotube trunk;

an electrical input contact at the first end of the carbon nanotube trunk;

a first electrical output contact at the second end of the carbon nanotube trunk; and

a second electrical output contact at the second end of the carbon nanotube L;

wherein a first row of the first array includes a single bifurcated nanostructure transistor, and the electrical input contact of the single bifurcated nanostructure transistor provides an input for the entire first array;

wherein succeeding rows of the first array include twice as many bifurcated nanostructure transistors as a preceding row, and the first and second electrical output contacts of each transistor in the preceding row are electrically connected to the electrical input contact of first and second transistors in the succeeding row;

wherein a last row of the first array includes a plurality of bifurcated nanostructure transistors, and the first and second electrical output contacts of each transistor in the last row are electrically connected to corresponding electron-detection spiker circuits of the plurality of electron-detection spiker circuits;

wherein whenever the voltage potential is present across the first array, electrons flow through the plurality of bifurcated nanostructure transistors and at each junction of each transistor follow one of the two possible routes in order to bin-out at a given electron-detection spiker circuit; and

wherein each spiker circuit of the plurality of electron-detection spiker circuits generates a spike on an output when a charge ~~arriving~~ binning-out from a respective bifurcated nanostructure transistor reaches a pre-programmed upper trigger-point threshold, thereby indicating the distribution of binned-out electrons across the plurality of electron-detection spiker circuits.

18. The complex nanostructure as recited in claim 17, wherein the output circuitry includes a plurality of spert circuits, each connected in parallel with a respective spiker circuit and electrically connected to the first and second electrical output contacts of each transistor in the last row, wherein the spert circuits generate a pulse on an output when the charge binning-out from a respective bifurcated nanostructure transistor reaches a preprogrammed spert trigger-point threshold.

19. The complex nanostructure as recited in claim 17, wherein at least one of the carbon nanotube trunk and the carbon nanotube L of at least one bifurcated nanostructure transistor is decorated with a genetic material.

20. The complex nanostructure as recited in claim 17, further comprising:

a second array connected through the spiker circuits to the first array, said second array for recombining the binned-out, distributed electrons, said second array comprising a second plurality of bifurcated nanostructure transistors arranged in a plurality of rows, wherein each transistor in the second array receives electrons through the first and second electrical output contacts of each transistor and sends electrons through the electrical input contact;

voltage means for creating at least one difference in potential across the second array;

wherein a first row of the second array includes a plurality of bifurcated nanostructure transistors electrically connected to the plurality of spiker circuits, wherein each spiker circuit that is connected to the carbon nanotube trunk of a transistor in the first array is connected to the carbon nanotube L of a transistor in the second array;

wherein succeeding rows of the second array include half as many bifurcated nanostructure transistors as a preceding row, with the electrical input contact of first and second transistors in the preceding row connected to the first and second electrical output contacts of each transistor in the succeeding row;

wherein a last row of the second array includes a single bifurcated nanostructure transistor, and the electrical input contact of the single bifurcated nanostructure transistor provides an output for the entire second array;

wherein the second array recombines the electrons that were distributed by the first array and ensures that electrons flowing through the first and second arrays must pass through at least one carbon nanotube L of a transistor.

21. A complex nanostructure for sorting a plurality of electrons into a distribution, comprising:

a first bidirectional circular nanostructure multiplexer comprising:

a circular carbon nanotube;

an input linear carbon nanotube connected to the circular carbon nanotube thereby forming an axon of the first bidirectional circular nanostructure multiplexer for receiving the plurality of electrons;

a plurality of output linear carbon nanotubes connected to the circular carbon nanotube thereby forming a plurality of dendrites of the first bidirectional circular nanostructure multiplexer for outputting the plurality of electrons; and

voltage means for creating at least one difference in potential between an input end of the linear carbon nanotube forming the axon and an output end of at least one of the linear carbon nanotubes forming the plurality of dendrites, wherein each electron in the plurality of electrons flows through the first bidirectional circular nanostructure multiplexer and at each of the plurality of dendrites, either stays in the circular nanotube or flows out the dendrite;

a first array comprising a plurality of bifurcated nanostructure transistors connected to the plurality of dendrites of the first bidirectional circular nanostructure multiplexer, each of said plurality of bifurcated nanostructure transistors having a single input connection for receiving electrons and a junction forming first and second output connections for outputting electrons;

a plurality of electron-detection spiker circuits connected to the plurality of first and second output connections;

wherein whenever a voltage potential is present across the first array, each electron in the plurality of electrons flows through the plurality of bifurcated nanostructure transistors and at each junction, follows one of two possible routes toward the plurality of output connections in order to bin-out at a given electron-detection spiker circuit; and

output circuitry for feeding, as information to inputs of an artificial neural network, the distribution of binned-out electrons across the plurality of electron-detection spiker circuits, wherein the artificial neural network is run on a computer as part of an information processing system.

22. The complex nanostructure as recited in claim 21, wherein the output circuitry includes a plurality of spert circuits, each connected in parallel with a respective

spiker circuit and electrically connected to the first and second output connections of each bifurcated nanostructure transistor, wherein the spert circuits generate a pulse on an output when the charge ~~arriving~~ binning-out from a respective bifurcated nanostructure transistor output connection reaches a preprogrammed spert trigger-point threshold.

23. The complex nanostructure as recited in claim 21, wherein each of the plurality of bifurcated nanostructure transistors includes:

a first linear carbon nanotube forming a nanostructure trunk having a first end, a second end, and an aperture in a side thereof;

a second linear carbon nanotube forming a nanostructure L, wherein:

a first end of the nanostructure L is inserted through the side of the nanostructure trunk via the aperture, thereby forming a junction, and

the nanostructure L is angled away from the first end of the nanostructure trunk;

a first electrical contact at the first end of the nanostructure trunk;

a second electrical contact at the second end of the nanostructure trunk; and

a third electrical contact at a second end of the nanostructure L;

wherein whenever a voltage potential across two or more of the first, second, and third electrical contacts is present, current flows selectively from any of the electrical contacts having greater potential to any of the contacts having lesser potential, thereby providing a transistor effect.

24. The complex nanostructure as recited in claim 23, wherein at least one of the carbon nanotube trunk and the carbon nanotube L of at least one bifurcated nanostructure transistor is decorated with a genetic material.

25. The complex nanostructure as recited in claim 21, further comprising:

a second array of bifurcated nanostructure transistors connected at their first and second output connections through the spiker circuits to the first array, said second array for recombining the binned-out, distributed electrons into a stream;

a second bidirectional circular nanostructure multiplexer connected through a plurality of dendrites to the input connection of each of the plurality of bifurcated nanostructure transistors in the second array;

voltage means for creating at least one difference in potential across the second array, wherein a voltage potential across the second array causes each electron in the plurality of electrons to flow in reverse through either the first or second output connection of one of the plurality of bifurcated nanostructure transistors and at the junction, to combine with other electrons flowing through the other of the first or second output connection, to exit the bifurcated nanostructure transistor through the input connection, and to enter a respective dendrite of the bidirectional circular nanostructure multiplexer;

wherein a voltage potential across the second bidirectional circular nanostructure multiplexer causes the electrons to enter the circular carbon nanotube of the second bidirectional circular nanostructure multiplexer and to exit the axon of the second bidirectional circular nanostructure multiplexer as a recombined stream.

26. A complex nanostructure for sorting a plurality of electrons into a distribution, said complex nanostructure comprising:

a first array comprising a plurality of nanotubes, the first array having an input connection for receiving the plurality of electrons, and a plurality of output connections for outputting the plurality of electrons, wherein the plurality of nanotubes are joined at points to form alternative routes from the input connection to the plurality of output connections;

voltage means for creating at least one difference in potential between the input connection and the plurality of output connections;

a plurality of electron-detection spiker circuits connected to the plurality of output connections;

wherein whenever a voltage potential is present across the first array, each electron in the plurality of electrons flows through the plurality of nanotubes and at each junction, is sorted to individually follow one of the alternative routes to bin-out at a given electron-detection spiker circuit; and output circuitry for feeding, as information to inputs of an artificial neural network, the distribution of binned-out electrons across the plurality of electron-detection spiker circuits, wherein the artificial neural network is run on a computer as part of an information processing system.

27. The complex nanostructure as recited in claim 26, further comprising:

a second array comprising a plurality of nanotubes for recombining the sorted, distributed electrons into a stream, said second array having a plurality of input connections for receiving the plurality of electrons from the plurality of electron-detection spiker circuits, and an output connection for outputting the plurality of electrons as a recombined stream;

wherein the plurality of nanotubes are joined at points to form alternative routes from the plurality of input connections to the output connection; and

voltage means for creating at least one difference in potential between the plurality of input connections and the output connection.

28. The complex nanostructure as recited in claim 17, wherein at least a portion of the carbon nanotubes in the first array are semiconducting, and the complex nanostructure further comprises gate means for applying to selected semiconducting carbon nanotubes, a charge with field strength sufficient to allow current to flow through the selected semiconducting carbon nanotubes;

wherein application of the charge to one of the selected semiconducting carbon nanotubes applies a weight to the selected semiconducting carbon nanotube proportional to the charge applied by the gate means.

29. The complex nanostructure as recited in claim 21, wherein at least a portion of the output linear carbon nanotubes in the first array are semiconducting, and the complex nanostructure further comprises gate means for applying to selected semiconducting output linear carbon nanotubes, a charge with field strength sufficient to allow current to flow through the selected semiconducting output linear carbon nanotubes;

wherein application of the charge to one of the selected semiconducting output linear carbon nanotubes applies a weight to the selected semiconducting output linear carbon nanotube proportional to the charge applied by the gate means.

30. The complex nanostructure as recited in claim 26, wherein at least a portion of the nanotubes in the first array are semiconducting, and the complex nanostructure further comprises gate means for applying to selected semiconducting nanotubes, a charge with field strength sufficient to allow current to flow through the selected semiconducting nanotubes;

wherein application of the charge to one of the selected semiconducting nanotubes applies a weight to the selected semiconducting nanotube proportional to the charge applied by the gate means.

31. The complex nanostructure as recited in claim 16, wherein each of the carbon nanotubes in the first array includes a plurality of carbon atoms, and at least one of the carbon nanotubes includes at least one carbon atom extracted from a living organism.

32. The complex nanostructure as recited in claim 21, wherein each of the output linear carbon nanotubes in the first array includes a plurality of carbon atoms, and at least one of the output linear carbon nanotubes includes at least one carbon atom extracted from a living organism.

33. The complex nanostructure as recited in claim 26, wherein the plurality of nanotubes in the first array are carbon nanotubes comprising a plurality of carbon atoms, and at least one of the carbon nanotubes includes at least one carbon atom extracted from a living organism.