# SORTING FLOW CYTOMETER

This application is being filed on 08 February 2013, as a PCT International Patent application and claims priority to U.S. Patent Application Serial No. 61/597,022 filed on 09 February 2012, the disclosure of which is incorporated herein by reference in its entirety.

## BACKGROUND

**[0001]** A flow cytometer is useful for identifying particles and characteristics of particles contained within a fluid. The fluid is typically passed through a small nozzle that generates a narrow fluid stream. A laser beam illuminates the particles in the fluid stream as they pass. Detectors are positioned to detect light transmission and scatter. This information is then used by the flow cytometer to identify the particles and characteristics of the particles in the fluid.

**[0002]** A sorting flow cytometer uses information about the particles to sort the particles into different containers. To do so, the fluid stream is divided into a series of individual drops containing one or more of the particles. Each drop containing one or more particles to be sorted is given an electrical charge based on the particle characteristics. The drops are then passed between oppositely charged deflection plates. Positively charged drops are displaced toward the negatively charged plate, while negatively charged drops are displaced toward the positively charged plate. The larger the charge, the greater the displacement of the drop. The drops are sorted into multiple different containers arranged below and between the plates.

## SUMMARY

**[0003]** In general terms, this disclosure is directed to a sorting flow cytometer. In one possible configuration and by non-limiting example, the sorting flow cytometer identifies an undesirable preassigned drop charge sequence, such as a drop charge sequence that would result in merging of adjacent drops if the drop charges are applied to adjacent drops. The sorting flow cytometer adjusts the charges to be applied to the drops to avoid the formation of the undesired drop charge sequence.

**[0004]** ~~One aspect is a method of operating a sorting flow cytometer, the method comprising: identifying, with a computing device, an undesired drop charge sequence assigned to two or more adjacent drops prior to the separation of the drops from a fluid stream; and aborting a sort operation for at least one of the drops in the fluid stream to avoid the undesired drop charge sequence.~~ According to a first aspect of the present invention, there is provided a method of operating a sorting flow cytometer, the method comprising: generating preliminary sort decisions for segments of a fluid stream, wherein each sort decision includes a charge assigned to a portion of the fluid stream that is predicted to

subsequently form an individual drop; identifying, with a computing device, an undesired drop charge sequence assigned to two or more adjacent drops prior to the separation of the drops from the fluid stream, wherein the undesired drop charge sequence is a sequence of the assigned charges, including at least two adjacent charges of opposite polarity, wherein the magnitude of the difference in charge between the at least two adjacent charges exceeds a predetermined threshold; and generating final sort decisions for the segments of the fluid stream, including aborting a sort operation for at least one of the drops in the fluid stream to avoid the undesired drop charge sequence.

**[0005]** ~~Another aspect is a sorting flow cytometer comprising: a fluid nozzle, a laser, a computing device, sort control electronics, and deflection plates. The fluid nozzle is configured to receive a fluid input and generate a fluid stream along a fluid path. The laser is configured to generate a laser beam and positioned to direct the laser beam at the fluid stream. The acquisition electronics including a sensor analyzer arranged and configured to detect light from the laser after the laser beam has intersected the fluid stream. The computing device receives event data from the acquisition electronics and generates a preliminary sort decisions assigned to segments of the fluid stream; identifies an undesired drop charge sequence assigned to at least two adjacent segments of the fluid stream; generates final sort decisions by modifying the preliminary sort decisions to abort a sorting operation for at least one of the fluid segments; and generates a sort control signal according to the final sort decisions. The sort control electronics receive the sort control signal and selectively apply charges to the fluid stream. The deflection plates are arranged adjacent the fluid path to sort drops associated with the fluid segments from the fluid stream into a plurality of containers.~~ According to a second first aspect of the present invention, there is provided a sorting flow cytometer comprising: a fluid nozzle configured to receive a fluid input and generate a fluid stream along a fluid path; a laser configured to generate a laser beam and positioned to direct the laser beam at the fluid stream; acquisition electronics including a sensor analyzer arranged and configured to detect light from the laser after the laser beam has intersected the fluid stream; a computing device that: receives event data from the acquisition electronics and generates preliminary sort decisions assigned to segments of the fluid stream; identifies an undesired drop charge sequence assigned to at least two adjacent segments of the fluid stream, wherein the undesired drop charge sequence is a sequence of charges assigned to the segments of the fluid stream, wherein two adjacent charges of opposite polarities have a total charge differential exceeding a predetermined threshold; generates final sort decisions by modifying the preliminary sort decisions to abort a sorting operation for at least one of the fluid segments; and generates a sort control signal according to the final sort decisions; sort control electronics that receive the sort control signal and selectively applies charges to the

fluid stream; and deflection plates arranged adjacent the fluid path to sort drops associated with the fluid segments from the fluid stream into a plurality of containers.

**[0006]** ~~A further aspect is a computer readable medium storing program instructions, wherein the program instructions, when executed by a processing device, causing the processing device to identify an undesired drop charge sequence assigned to at least two adjacent drops prior to the separation of the drops from a fluid stream; and abort a sort operation for at least one of the drops in the fluid stream to avoid the undesired drop charge sequence.~~ According to a third aspect of the present invention, there is provided a computer readable medium storing program instructions, wherein the program instructions, when executed by a processing device, causing the processing device to: generate preliminary sort decisions for segments of a fluid stream, wherein each sort decision includes a charge assigned to a portion of the fluid stream that is predicted to subsequently form an individual drop; identify an undesired drop charge sequence assigned to at least two adjacent drops prior to the separation of the drops from the fluid stream, wherein the undesired drop charge sequence is a sequence of the assigned charges, wherein a total charge differential between at least two adjacent charges of opposite polarity exceeds a predetermined threshold; and generate final sort decisions for the segments of the fluid stream, including a decision to abort a sort operation for at least one of the drops in the fluid stream to avoid the undesired drop charge sequence.

**[0007]** ~~Another aspect is a method of operating a sorting flow cytometer, the method comprising: characterizing particles associated with a first drop and a second drop along a fluid path; preassigning a charge to the first drop and the second drop based on the characterization of the one or more particles associated with each drop; and selectively not applying the preassigned charge to one of the first drop and the second drop based at least in part on the magnitude of the preassigned charge of the first drop and the second drop.~~ According to a fourth aspect of the present invention, there is provided a method of operating a sorting flow cytometer, the method comprising: characterizing particles associated with a first drop and a second drop along a fluid path; preassigning a charge to the first drop and the second drop based on the characterization of the one or more particles associated with each drop; and selectively applying a charge to one of the first drop and the second drop that is different than the preassigned charge to the one of the first drop and the second drop based at least in part on the magnitude of the charge that is preassigned to the first drop and the second drop.

**[0008]** ~~A further aspect is a method of operating a sorting flow cytometer, the method comprising: characterizing a first particle and a second particle in a fluid stream; assigning a~~

~~preliminary charge to the first particle and the second particle based on the characterization of the first particle and the second particle, respectively; assigning final charges to the first particle and the second particle based on the preliminary charges assigned to the first particle and the second particle; and sorting the first particle and the second particle based on the assigned final charges.~~ According to a fifth aspect of the present invention, there is provided a method of operating a sorting flow cytometer, the method comprising: characterizing a first particle and a second particle in a fluid stream; assigning a preliminary charge to the first particle and the second particle based on the characterization of the first particle and the second particle, respectively; assigning final charges to the first particle and the second particle based on the magnitude and polarity of the preliminary charges assigned to the first particle and the second particle; and sorting the first particle and the second particle based on the assigned final charges, wherein assigning the final charges includes assigning at least one final charge that is different than the corresponding preliminary charge to at least one of the first particle and the second particle.

**[0009]** ~~Yet another aspect is a method of operating a sorting flow cytometer, the method comprising: a) characterizing a first particle; b) assigning a deflection value to the first particle; c) characterizing a second particle; d) assigning a deflection value to the second particle; e) changing the assigned deflection value of one of the first particle and the second particle if the deflection value of the first particle exceeds a maximum deflection value and the deflection value of the second particle exceeds a maximum opposing deflection value; and f) sorting the first particle and the second particle based on the assigned deflection values.~~ According to a sixth aspect of the present invention, there is provided a method of operating a sorting flow cytometer, the method comprising: a) characterizing a first particle; b) assigning a deflection value to the first particle; c) characterizing a second particle; d) assigning a deflection value to the second particle; e) changing the assigned deflection value of one of the first particle and the second particle if the deflection value of the first particle exceeds a maximum deflection value and the deflection value of the second particle exceeds a maximum opposing deflection value; and f) sorting the first particle and the second particle based on the assigned deflection values.

**[0010]** ~~Another aspect is a method of operating a sorting flow cytometer, the method comprising: a) characterizing a first particle; b) assigning a charge and a priority to the first particle; c) characterizing a second particle; d) assigning a charge and a priority to the second particle; e) changing the charge assigned to the one of the first particle and the second particle having the lower assigned priority, wherein the change is based on the charges assigned to the first particle and the second particle; and f) sorting the first particle and the~~

~~second particle based on the charges assigned to the first particle and the second particle after operation (e).~~ According to a seventh aspect of the present invention, there is provided a method of operating a sorting flow cytometer, the method comprising: a) characterizing a first particle; b) assigning a charge and a priority to the first particle; c) characterizing a second particle; d) assigning a charge and a priority to the second particle; e) changing the charge assigned to the one of the first particle and the second particle having the lower assigned priority, wherein the change is based on differences in the magnitude and the polarity of the charges assigned to the first particle and the second particle; and f) sorting the first particle and the second particle based on the charges assigned to the first particle and the second particle after operation (e).

**[0011]** ~~An additional aspect is a method of operating a sorting flow cytometer, the method comprising: characterizing particles associated with three consecutive drops of the fluid stream, the three consecutive drops including a middle drop between a first drop and a third drop; preassigning a charge to each of the three consecutive drops based on the characterization of the particle associated with each drop; and assigning to at least one of the three consecutive drops a charge that is different than the corresponding preassigned charge if the preassigned charge of the middle drop is greater than a predetermined maximum value and the preassigned charge of the first drop or the third drop is greater than a predetermined maximum opposing value.~~ According to an eighth aspect of the present invention, there is provided a method of operating a sorting flow cytometer, the method comprising: characterizing particles associated with three consecutive drops of the fluid stream, the three consecutive drops including a middle drop between a first drop and a third drop; preassigning a charge to each of the three consecutive drops based on the characterization of the particle associated with each drop; and assigning to at least one of the three consecutive drops a charge that is different than the corresponding preassigned charge if the preassigned charge of the middle drop is greater than a predetermined maximum value and the preassigned charge of the first drop or the third drop is greater than a predetermined maximum opposing value.

**[0012]** ~~Another aspect is a sorting flow cytometer system comprising a contaminant hood, and a sorting flow cytometer. The sorting flow cytometer comprises: a fluid nozzle, a laser, a computing device, sort control electronics, and deflection plates. The fluid nozzle is configured to receive a fluid input and generate a fluid stream along a fluid path. The laser is configured to generate a laser beam and positioned to direct the laser beam at the fluid stream. The acquisition electronics include a sensor analyzer arranged adjacent the fluid beam to detect light from the laser after the laser beam has intersected the fluid stream. The computing device receives event data from the acquisition electronics and generates a~~

~~preliminary sort decisions assigned to segments of the fluid stream; identifies an undesired drop charge sequence assigned to at least two adjacent segments of the fluid stream; generates final sort decisions by modifying the preliminary sort decisions to abort a sorting operation for at least one of the fluid segments; and generates a sort control signal according to the final sort decisions. The sort control electronics receive the sort control signal and selectively apply charges to the fluid stream. The deflection plates are arranged adjacent the fluid path to sort drops associated with the fluid segments from the fluid stream into a plurality of containers.~~ According to a ninth aspect of the present invention, there is provided a sorting flow cytometer system comprising: a contaminant hood; and a sorting flow cytometer arranged within the contaminant hood, the sorting flow cytometer comprising: a fluid nozzle configured to receive a fluid input and generate a fluid stream along a fluid path; a laser configured to generate a laser beam and positioned to direct the laser beam at the fluid stream; acquisition electronics including a sensor analyzer arranged and configured to detect light from the laser after the laser beam has intersected the fluid stream; a computing device that: receives event data from the acquisition electronics and generates preliminary sort decisions assigned to segments of the fluid stream; identifies an undesired drop charge sequence assigned to at least two adjacent segments of the fluid stream, wherein the undesired drop charge sequence is a sequence of charges, wherein a total charge differential between at least two adjacent charges of opposite polarity exceeds a predetermined threshold; generates final sort decisions by modifying the preliminary sort decisions to abort a sorting operation for at least one of the fluid segments; and generates a sort control signal according to the final sort decisions; sort control electronics that receive the sort control signal and selectively applies charges to the fluid stream; and deflection plates arranged adjacent the fluid path to sort drops associated with the fluid segments from the fluid stream into a plurality of containers.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0013]** FIG. 1 is a perspective view of an example sorting flow cytometer system including a flow cytometer.

**[0014]** FIG. 2 is a schematic block diagram of the example sorting flow cytometer shown in FIG. 1.

**[0015]** FIG. 3 is a schematic block diagram illustrating additional aspects of the sorting flow cytometer shown in FIG. 2.

**[0016]** FIG. 4 illustrates an exemplary architecture of a computing device that can be used to implement aspects sorting flow cytometer.

**[0017]** FIG. 5 is a schematic block diagram illustrating an undesirable method of operating the sorting flow cytometer.

**[0018]** FIG. 6 is a flow chart illustrating a method of operating the flow cytometer to avoid the undesirable operation shown in FIG. 5.

**[0019]** FIG. 7 is a schematic block diagram illustrating a desirable method of operating the sorting flow cytometer.

**[0020]** FIG. 8 illustrates an exemplary method of identifying an undesired drop charge sequence.

~~WHAT IS CLAIMED IS:~~ **CLAIMS**

1. A method of operating a sorting flow cytometer, the method comprising:

generating preliminary sort decisions for segments of a fluid stream, wherein each sort decision includes a charge assigned to a portion of the fluid stream that is predicted to subsequently form an individual drop;

identifying, with a computing device, an undesired drop charge sequence assigned to two or more adjacent drops prior to the separation of the drops from ~~a~~ the fluid stream, wherein the undesired drop charge sequence is a sequence of the assigned charges, including at least two adjacent charges of opposite polarity, wherein the magnitude of the difference in charge between the at least two adjacent charges exceeds a predetermined threshold; and

generating final sort decisions for the segments of the fluid stream, including aborting a sort operation for at least one of the drops in the fluid stream to avoid the undesired drop charge sequence.

~~2. The method of claim 1, wherein the undesired drop charge sequence includes at least two adjacent drops assigned to be charged with charges of opposing polarities, wherein a total charge differential between the at least two adjacent drops exceeds a predetermined threshold.~~

~~3~~2. The method of claim 1, wherein the undesired drop charge sequence includes two adjacent drops that will merge to form a single drop if the sort operation is not aborted for at least one of the drops.

~~4~~3. The method of claim 1, wherein the sorting flow cytometer is at least a six-way sorting cytometer including three containers positioned on one side of the fluid stream and at least three containers positioned on another opposite side of the fluid stream, and wherein the undesired drop charge sequence includes a first drop assigned to the most distant container on one side of the fluid stream, and one of the two most distant containers on the other side of the fluid stream.

~~5~~4. The method of claim 1, wherein the sorting flow cytometer stores at least one lookup table listing undesired drop charge sequences, and wherein identifying an undesired drop charge sequence involves identifying a drop charge sequence listed in the at least one lookup table.

~~6~~5. The method of claim 1, wherein identifying an undesired drop charge sequence involves evaluating factors selected from: a fluid nozzle size, a drop fall distance between a drop breakoff point and charged deflection plates, a time that it takes a drop to move the drop fall distance, drop masses, drop charge magnitudes, drop charge differentials between adjacent drops, drop charge polarities, sheath pressure, and stream velocity.

~~7~~6. The method of claim 1, wherein aborting a sort operation for at least one of the at least two adjacent drops comprises assigning a secondary sort decision to the at least one of the drops.

~~8~~7. A sorting flow cytometer comprising:

a fluid nozzle configured to receive a fluid input and generate a fluid stream along a fluid path;

a laser configured to generate a laser beam and positioned to direct the laser beam at the fluid stream;

acquisition electronics including a sensor analyzer arranged and configured to detect light from the laser after the laser beam has intersected the fluid stream;

a computing device that:

receives event data from the acquisition electronics and generates preliminary sort decisions assigned to segments of the fluid stream;

identifies an undesired drop charge sequence assigned to at least two adjacent segments of the fluid stream, wherein the undesired drop charge sequence is a sequence of charges assigned to the segments of the fluid stream, wherein two adjacent charges of opposite polarities have a total charge differential exceeding a predetermined threshold;

generates final sort decisions by modifying the preliminary sort decisions to abort a sorting operation for at least one of the fluid segments; and

generates a sort control signal according to the final sort decisions;

sort control electronics that receive the sort control signal and selectively applies charges to the fluid stream; and

deflection plates arranged adjacent the fluid path to sort drops associated with the fluid segments from the fluid stream into a plurality of containers.

~~9~~8. A computer readable medium storing program instructions, wherein the program instructions, when executed by a processing device, causing the processing device to:

generate preliminary sort decisions for segments of a fluid stream, wherein each sort decision includes a charge assigned to a portion of the fluid stream that is predicted to subsequently form an individual drop;

identify an undesired drop charge sequence assigned to at least two adjacent drops prior to the separation of the drops from ~~a~~ the fluid stream, wherein the undesired drop charge sequence is a sequence of the assigned charges, wherein a total charge differential between at least two adjacent charges of opposite polarity exceeds a predetermined threshold; and

generate final sort decisions for the segments of the fluid stream, including a decision to abort a sort operation for at least one of the drops in the fluid stream to avoid the undesired drop charge sequence.

~~10~~9. A method of operating a sorting flow cytometer, the method comprising:

characterizing particles associated with a first drop and a second drop along a fluid path;

preassigning a charge to the first drop and the second drop based on the characterization of the one or more particles associated with each drop; and

selectively ~~not~~ applying a charge to one of the first drop and the second drop that is different than the preassigned charge to the one of the first drop and the second drop based at least in part on the magnitude of the ~~preassigned~~ charge that is preassigned to ~~of~~ the first drop and the second drop.

~~11~~10. The method of claim ~~10~~9, wherein the first drop and the second drop are adjacent drops.

~~12~~11. The method of claim ~~10~~9, wherein selectively ~~not~~ applying the ~~preassigned~~ different charge includes selectively ~~not~~ applying the ~~preassigned~~ different charge to one of the first drop and the second drop based at least in part on the magnitude of the difference in charge between the preassigned charge of the first drop and the second drop.

~~13~~12. The method of claim ~~12~~11, wherein selectively ~~not~~ applying the ~~preassigned~~ different charge includes selectively ~~not~~ applying the ~~preassigned~~ different charge to one of the first drop and the second drop if the magnitude of the difference in charge between the preassigned charge of the first drop and the second drop exceeds a threshold value.

~~14~~13. The method of claim ~~10~~9, wherein the particles are characterized before the drops break off from a fluid stream.

~~15~~14. The method of claim ~~10~~9, wherein selectively ~~not~~ applying the ~~preassigned~~ different charge is based on a priority predetermined for each type of particle.

~~16~~15. The method of claim ~~15~~14, wherein the priority is an assigned value.

~~17~~16. The method of claim ~~16~~15, wherein the assigned value is an integer.

~~18~~17. The method of claim ~~15~~14, wherein the priority is based on a drop mode for the respective particle.

~~19~~18. The method of claim ~~18~~17, wherein the drop mode is one of single mode, purify mode, and enrich mode.

~~20~~19. A method of operating a sorting flow cytometer, the method comprising:

characterizing a first particle and a second particle in a fluid stream;

assigning a preliminary charge to the first particle and the second particle based on the characterization of the first particle and the second particle, respectively;

assigning final charges to the first particle and the second particle based on the magnitude and polarity of the preliminary charges assigned to the first particle and the second particle; and

sorting the first particle and the second particle based on the assigned final charges, wherein assigning the final charges includes assigning at least one final charge that is different than the corresponding preliminary charge to at least one of the first particle and the second particle.

~~21. The method of claim 20, wherein assigning the final charges includes assigning at least one final charge that is different than the corresponding preliminary charge to at least one of the first particle and the second particle.~~

~~22~~20. The method of claim ~~21~~19, wherein assigning final charges includes assigning at least one final charge that is different than the corresponding preliminary charge to at least one of

the first particle and the second particle if the charge differential between the assigned preliminary charges of the first particle and the second particle is greater than a predetermined threshold value.

~~23~~21. The method of claim ~~21~~19, wherein assigning final charges includes assigning at least one final charge that is different than the corresponding preliminary charge to at least one of the first particle and the second particle if the sequence of preliminary charges assigned to the first particle and the second particle matches a sequence of charges in a lookup table.

~~24~~22. The method of claim ~~21~~19, wherein assigning final charges includes assigning at least one final charge that is one of positive, negative, and neutral.

~~25~~23. The method of claim ~~21~~19, wherein the different final charge is a neutral charge.

~~26~~24. The method of claim ~~20~~19, wherein the first particle and the second particle are contained in adjacent drops.

~~27~~25. The method of claim ~~26~~24, wherein the final charges are applied to the adjacent drops.

~~28~~26. The method of claim ~~27~~25 wherein the final charges are applied to the fluid stream before the adjacent drops break off from the fluid stream.

~~29~~27. The method of claim ~~20~~19, wherein the preliminary charges are relative charges of +/- a, +/- b, or +/- c, wherein a<b<c, and wherein assigning final charges includes assigning a neutral charge to either the first particle or the second particle if the combination of preliminary charges is one of +c and -b; +c and -c; and +b and -c.

~~30~~28. The method of claim ~~20~~19, wherein the assigned preliminary charges and the assigned final charges are the same.

~~31~~29. A method of operating a sorting flow cytometer, the method comprising:

a) characterizing a first particle;

b) assigning a deflection value to the first particle;

c) characterizing a second particle;

d) assigning a deflection value to the second particle;

e) changing the assigned deflection value of one of the first particle and the second particle if the deflection value of the first particle exceeds a maximum deflection value and the deflection value of the second particle exceeds a maximum opposing deflection value; and

f) sorting the first particle and the second particle based on the assigned deflection values.

~~32. The method of claim 31, wherein the assigned deflection values of operation (f) include the changed deflection value of operation (e).~~

~~33~~30. The method of claim ~~32~~29, wherein the first particle is upstream of the second particle in a fluid stream.

~~34~~31. The method of claim ~~32~~29, wherein the first particle is downstream of the second particle in a fluid stream.

~~35~~32. The method of claim ~~31~~29, wherein the maximum deflection value corresponds to a deflection of the first particle into the most distant container on one side of a fluid stream, and wherein the maximum opposing deflection value corresponds to a deflection of the second particle into the second most distant container on the opposite side of the fluid stream.

~~36~~33. The method of claim ~~35~~32, wherein changing the assigned deflection value includes changing the deflection value to a value corresponding to a deflection of one of the first particle and the second particle into a central waste container.

~~37~~34. A method of operating a sorting flow cytometer, the method comprising:

a) characterizing a first particle;

b) assigning a charge and a priority to the first particle;

c) characterizing a second particle;

d) assigning a charge and a priority to the second particle;

e) changing the charge assigned to the one of the first particle and the second particle having the lower assigned priority, wherein the change is based on differences in the magnitude and the polarity of the charges assigned to the first particle and the second particle; and

f) sorting the first particle and the second particle based on the charges assigned to the first particle and the second particle after operation (e).

~~38~~35. A method of operating a sorting flow cytometer, the method comprising:

characterizing particles associated with three consecutive drops of the fluid stream, the three consecutive drops including a middle drop between a first drop and a third drop;

preassigning a charge to each of the three consecutive drops based on the characterization of the particle associated with each drop; and

assigning to at least one of the three consecutive drops a charge that is different than the corresponding preassigned charge if the preassigned charge of the middle drop is greater than a predetermined maximum value and the preassigned charge of the first drop or the third drop is greater than a predetermined maximum opposing value.

~~39~~36. A sorting flow cytometer system comprising:

a contaminant hood; and

a sorting flow cytometer arranged within the contaminant hood, the sorting flow cytometer comprising:

a fluid nozzle configured to receive a fluid input and generate a fluid stream along a fluid path;

a laser configured to generate a laser beam and positioned to direct the laser beam at the fluid stream;

acquisition electronics including a sensor analyzer arranged and configured to detect light from the laser after the laser beam has intersected the fluid stream;

a computing device that:

receives event data from the acquisition electronics and generates preliminary sort decisions assigned to segments of the fluid stream;

identifies an undesired drop charge sequence assigned to at least two adjacent segments of the fluid stream, wherein the undesired drop charge sequence is a sequence of charges, wherein a total charge differential between at least two adjacent charges of opposite polarity exceeds a predetermined threshold;

generates final sort decisions by modifying the preliminary sort decisions to abort a sorting operation for at least one of the fluid segments; and

generates a sort control signal according to the final sort decisions;

sort control electronics that receive the sort control signal and selectively applies charges to the fluid stream; and

deflection plates arranged adjacent the fluid path to sort drops associated with the fluid segments from the fluid stream into a plurality of containers.