CLAIMS

1. A method of operating a superconducting channel, the method comprising:

providing a device comprising:

an electrical circuit including an inductor,

a channel defined by a superconducting material, wherein the channel is structured as a wire,

a gate positioned adjacent to the channel, such that an end surface of the gate faces a portion of the channel, wherein a gap exists between the end surface of the gate and the portion of the channel, and

an electrically insulating medium arranged at least within the gap so as to electrically insulate the gate from the channel, and

a control unit connected to the gate and the channel;

rendering the channel superconducting by cooling down the device to a cryogenic temperature;

applying, by the control unit, a voltage difference between the gate and the channel to inject electrons from the end surface of the gate into the channel through the electrically insulating medium, and thereby generate a gate current between the gate and the channel, wherein the electrons are injected with an average energy sufficient to modify a critical current of the channel during operation of the device at the cryogenic temperature;

adjusting, by the control unit, a kinetic inductance of the wire so as to adjust one of a resonant frequency or a cut-off frequency of the electrical circuit;

applying, by the control unit, a signal to the channel and altering the signal applied by modifying the critical current during the operation; and

allowing, by the control unit, a property of the channel or a property implied by the property of the channel to be measured during the operation, and the applied voltage difference to be controllably modified according to the measured property so as to adjust the property of the channel or the property implied by the property during the operation.

2. The method according to claim 1, wherein

the applying the voltage difference lowers the critical current to zero and thereby generates an electrical resistance in the channel at least locally at the portion of the channel.

3. The method according to claim 2, wherein the method further comprises:

switching off the voltage difference applied for the potentially superconducting material to self-reset to a fully superconducting state.

4. The method according to claim 2, wherein the applied voltage difference corresponds to a minimum value required to switch the channel to a normal state thereof, and wherein an impedance of the gate, as determined by the electrically insulating medium, is larger than 1 GΩ.

5. The method according to claim 1, wherein an intensity of the gate current generated upon applying the voltage difference is at least ten times less than the critical current.

6. The method according to claim 1, wherein an intensity of the gate current generated upon applying the voltage difference is between 10 pA and 10 nA.

7. The method according to claim 1, wherein the voltage difference is applied such that the average energy is at least 100 times larger than a superconducting gap of the potentially superconducting material.

8. An apparatus comprising:

an electrical circuit including an inductor;

a device comprising:

a channel defined by a superconducting material, the device configured to be operated at cryogenic temperatures that render the channel superconducting, wherein the channel is structured as a wire,

a gate positioned adjacent to the channel, such that an end surface of the gate faces a portion of the channel, wherein a gap exists between the end surface of the gate and the portion of the channel, and

an electrically insulating medium arranged at least within the gap so as to electrically insulate the gate from the channel; and

a control unit connected to the gate and the channel, the control unit being configured to:

apply a voltage difference between the gate and the channel so as to inject electrons from the end surface of the gate into the channel through the electrically insulating medium, and thereby generate a gate current between the gate and the

channel, wherein an average energy of the electrons is sufficient to modify a critical current of the channel during operation of the device at the cryogenic temperatures,

adjust a kinetic inductance of the wire so as to adjust one of a resonant frequency or a cut-off frequency of the electrical circuit,

apply a signal to the channel and alter the signal applied by modifying the critical current during the operation, and

allow a property of the channel or a property implied by the property of the channel to be measured during the operation, and the applied voltage difference to be controllably modified according to the measured property so as to adjust the property of the channel or the property implied by the property during the operation.

9. The apparatus according to claim 8, wherein the device comprises a substrate forming the electrically insulating medium, and each of the gate and the wire are structured on the substrate.

10. The apparatus according to claim 9, wherein a width of the wire is between 40 and 300 nm, and the gap between the end surface of the gate and the portion of the channel is between 40 nm and 300 nm, the width and the gap being measured parallel to a main surface of the substrate.

11. The apparatus according to claim 8, wherein the potentially superconducting material comprises at least one member selected from the group consisting of: Ti, TiN, Nb, W, WSi, Al, and Mo.

12. The apparatus according to claim 8, wherein the apparatus is configured as a quantum processing apparatus, which additionally include quantum circuits, and the channel of the device is connected to one or more of the quantum circuits.