A Solution Looking for a Problem - Generalised Hallway Switches

Arne Bergstrom*

B&E Scientific Ltd, BN25 4PA, United Kingdom
 *Corresponding author: arne.bergstrom@physics.org

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Abstract The properties of hallway switches are discussed with emphasis on how special types of such switch systems with arbitrarily many switches can be constructed and systematically become conducting/nonconducting by simply turning on/off any arbitrary switch in the system, and then become nonconducting/conducting again by turning off/on any arbitrary switch in the system, etc. A question is whether in physics, biology, genetics, economics, sociology, or traffic management, there might exist - or preferably would exist - complex such systems, the global state of which could thus be switched by a local action anywhere in the system and then switched back by another local action anywhere in the system.

Keywords: *arbitrarily large switch systems, on/off activation at arbitrary switch, applications searched*

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1. Introduction

A hallway switch is a system of switches such that, *e.g.*, a lamp in a hallway can be systematically turned on/off using any one of several switches, and then turned back off/on again independently using any arbitrary one of the switches, *etc.* This problem is known to have simple solutions in the case of up to three switches [1,2,3], but gets somewhat more complicated when more numerous switches are involved.

Nevertheless, the problem in itself might have unexpected, other applications. Having a system that can be alternatingly switched between a conducting state and a nonconducting state and back again repeatedly by simply switching any arbitrary switch in the system, this makes it an intriguing object. Alternatively, the system would be maintained in conducting mode even if the states of any two arbitrary switches in the system are changed. One may wonder what kind of physical phenomena or biological mechanisms might possibly have exploited such a concept – and/or if it is possible to conceive of unexpected technical or other applications of this technique.

In this paper we will study two basically different hall-switch structures, one based on a parallel arrangement of switches, the other (possibly better) on a serial arrangement.

2. Parallel Hallway-Switch Structures

We will here first discuss switch configurations with parallel switches (the impatient reader might want to jump to Sec. 3 right away). The simplest such switch configuration has four switches and can be represented as follows,

$$A = \begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix},$$

where we assume a power/signal cable is coming in from the left and leaving from the right, and in this case having an unbroken connection through the two upper switches. Here and in the following we assume 1 to represent a closed, conducting switch and 0 an open, nonconducting switch. The configuration A above is obviously equivalent to the following configuration, which is just a vertical mirror image,

$$A' = \begin{bmatrix} 0 & 0 \\ 1 & 1 \end{bmatrix}.$$

The corresponding configurations in nonconducting state are given as follows,

$$a = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, a' = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}.$$

Note that each parallel switch pair (here vertical) is constructed so that one switch is always in a conducting state and the other in a nonconducting state, *i.e.* a column with only ones or zeros is not permitted in this particular type of configuration (as different from what is discussed in Sec. 3).

We can now extend the scheme above to contain configurations like A and a as its elements,

$$B = \begin{bmatrix} A & A \\ a & a \end{bmatrix}, b = \begin{bmatrix} A & a \\ a & A \end{bmatrix},$$

or in detail, and where for clarity the connections between the groups of switches have also been introduced,

$$B = \left[\begin{array}{c} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right],$$

$$b = \left[\begin{array}{c} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right].$$

Configuration B above should thus be interpreted as a top branch that is conducting due to four closed switches (and where the connected switches parallel to them are open, but that is irrelevant), and which is parallel to a nonconducting bottom branch consisting of eight switches in two nonconducting configurations.

We note that configuration b is nonconducting, as it contains four rows of switches in nonconducting combinations. Configuration b is identical to configuration B except for the last column, which is a variant of the corresponding column in B , but where conducting and nonconducting switches have all been interchanged.

As this example shows, we can thus change a switch configuration from conducting to nonconducting state, or vice versa, by interchanging conducting and nonconducting switches for every element in an arbitrary column. Two such successive changes bring back the original state of the switch configuration.

On the next hierarchical level, we can combine configurations like in B and b to produce more complicated configurations in the same vein as above, *i.e.*,

$$C = \begin{bmatrix} B & B \\ b & b \end{bmatrix}, c = \begin{bmatrix} B & b \\ b & B \end{bmatrix},$$

or after inserting the expressions for B and b from above,

$$C = \left[\begin{array}{c} \left[\begin{array}{cc} A & A \end{array} \right] \left[\begin{array}{cc} A & A \end{array} \right] \\ \left[\begin{array}{cc} a & a \end{array} \right] \left[\begin{array}{cc} a & a \end{array} \right] \\ \left[\begin{array}{cc} A & a \end{array} \right] \left[\begin{array}{cc} A & a \end{array} \right] \\ \left[\begin{array}{cc} a & A \end{array} \right] \left[\begin{array}{cc} a & A \end{array} \right] \end{array} \right],$$

$$c = \left[\begin{array}{c} \left[\begin{array}{cc} A & A \end{array} \right] \left[\begin{array}{cc} A & a \end{array} \right] \\ \left[\begin{array}{cc} a & a \end{array} \right] \left[\begin{array}{cc} a & A \end{array} \right] \\ \left[\begin{array}{cc} A & a \end{array} \right] \left[\begin{array}{cc} A & A \end{array} \right] \\ \left[\begin{array}{cc} a & A \end{array} \right] \left[\begin{array}{cc} a & a \end{array} \right] \end{array} \right].$$

or after further inserting the expressions for A and a (and explicit connections) from above,

$$C = \left[\begin{array}{c} \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \end{array} \right]$$

$$c = \left[\begin{array}{c} \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \end{array} \right]$$

It should be noted that configurations of the type discussed here have very specific characteristics due to their particular combinations of open and closed switches, and which are not present in any arbitrary such configuration. These characteristics are responsible for the particular properties that will be described in the following for the specific example of the configurations in C and c above.

Changing one switch pair to an equivalent state, as from A to A' above, of course does not change it from conducting to nonconducting state, or vice versa. In contrast, the operation discussed above when changing B to b shows the characteristic property of the type of hallway-switch configurations we are discussing here. Interchanging *every* element in *one* arbitrary column from conducting to nonconducting state and vice versa thus switches a configuration from a conducting state to a nonconducting state or inversely.

This can be further exemplified by interchanging every element in an arbitrary column, say column 3, in c above from conducting to nonconducting state and conversely, which thus again gives a conducting configuration as seen below, where all elements in the third column in c have been changed from conducting to nonconducting state and conversely. The conducting row 5/6 is displayed in boldface (remember the equivalence of configurations of type A and A' discussed in the beginning of Sec. 2 above),

$$C_1 = \left[\begin{array}{c} \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} \mathbf{1} & \mathbf{1} \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} \mathbf{1} & \mathbf{1} \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} \mathbf{1} & \mathbf{1} \end{array} \right] \left[\begin{array}{cc} \mathbf{1} & \mathbf{1} \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \end{array} \right]$$

Changing every element again in an arbitrary column (in this case column 1) from conducting to nonconducting state and conversely, gives again a nonconducting configuration c_2 ,

$$c_2 = \left[\begin{array}{c} \left[\begin{array}{cc} \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \end{array} \right] \end{array} \right] \\ \left[\begin{array}{cc} \left[\begin{array}{cc} 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{cc} \left[\begin{array}{cc} 1 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \end{array} \right] \end{array} \right] \end{array} \right]$$

and changing an arbitrary column (in this case column 7) yet again, gives a new conducting configuration C_2 ,

$$C_2 = \left[\begin{array}{c} \left[\begin{array}{cc} 0 & 1 \\ 1 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \\ 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \\ 1 & 1 \end{array} \right] \left[\begin{array}{cc} 1 & 1 \\ 0 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 1 \\ 1 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \\ 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 0 & 0 \\ 1 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \\ 1 & 0 \end{array} \right] \end{array} \right] \left[\begin{array}{c} \left[\begin{array}{cc} 1 & 1 \\ 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \\ 1 & 1 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 0 \\ 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \\ 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 1 \\ 0 & 0 \end{array} \right] \left[\begin{array}{cc} 0 & 1 \\ 1 & 0 \end{array} \right] \\ \left[\begin{array}{cc} 1 & 0 \\ 0 & 1 \end{array} \right] \left[\begin{array}{cc} 0 & 0 \\ 1 & 1 \end{array} \right] \end{array} \right]$$

The interchange from conducting to nonconducting states, and conversely, in any arbitrary column in order to get alternately conducting and nonconducting configurations can be further checked by successively performing it on arbitrary columns in more complex configurations in order to get back a conducting configuration again.

This systematic, repetitive change from conducting to nonconducting configuration and back again, is the crucial characteristic of this kind of structure. The procedure described for hallway switches in the special cases above can be validated for the general case of arbitrarily large configurations of this type.

3. Serial Hallway-Switch Structures

In contrast to the structures discussed in Sec. 2, we will here discuss structures where there are two connections between groups (and not invariant under rotation as above).

In order to permit comparison with the structures discussed in Sec. 2, the example presented below contains four basic switch pairs too, but can be seen to be much less complicated as a result of the minute modification with two connections instead of only one between groups.

Unless in a special application there are other advantages with the method previously described, the method that will now be described seems definitely the method to be expected if such switch systems would be encountered in nature. It is both simpler and requires much fewer switches, only at the expense of a somewhat more complex wiring arrangement between the basic modules (two connecting wires instead of only one as in Sec. 2). In addition, it will be shown also to permit two separate such serial systems in parallel with each other. Serial systems of this type can also be easily generalized to systems in two or more dimensions.

As discussed in Sec. 2 above, a nonconducting combination Aa as element in parallel configurations may be given as:

$$\left[\begin{array}{cc} 1 & 1 \\ 0 & 0 \end{array} \right] \left[\begin{array}{cc} 1 & 0 \\ 0 & 1 \end{array} \right]$$

In serial configurations, this will be represented by the following combination, here shown in a more explicit representation (note that there are now two leads between the groups):

This configuration is thus also nonconducting in the serial wiring discussed in the present section. However, it can be transformed into a conducting system by, *e.g.*, simply transforming the second group, or by transforming the first group:

The point here is thus that this serial structure is much simpler to manipulate than the parallel structure described in Sec. 2 above. Consider for instance a sequence of four groups, *i.e.* the same number of groups as discussed in Sec. 2, but in this case with the new serial structure with two wires connecting the groups instead of just one as in Sec. 2.

In the example below, the groups are combined to give the system a conducting state:

By simply changing any arbitrary group, for example the third group from the left, the system becomes nonconducting:

Changing again an arbitrary group, say this time the fourth group from the left, we again get a conducting system:

By changing again an arbitrary group, *e.g.* the first group from the left, again makes the system nonconducting:

And so we can go on. Changing next time the third group from the left gives again a conducting state, *etc.*:

These simple and transparent steps thus perform the same steps as the rather intricate operations described above for the matrices in Sec. 2. We thus see that the configurations with this serial structure are much easier both to implement and change compared to the configurations with the parallel structure discussed above in Sec. 2.

It should also be noted that in the serial method we have actually two parallel systems, one lower and one

upper system (black and grey, respectively, in the above diagrams), which are both alternately conducting or nonconducting at the same time.

One further important difference between the parallel method discussed in Sec. 2 and the serial method discussed in this section is the following.

In the parallel method, the alternations between conducting and nonconducting systems as described in Sec. 2 will not work for any arbitrary system of switches; it will only work for a system that originally was conducting, and then for all systems derived from it by transforming arbitrary columns as discussed in Sec. 2. But an arbitrary system of parallel switches will not have this property, as can be understood by considering a system with all switches nonconducting. Such an arbitrary system will not (except in the trivial case of two switches) become conducting by transforming a row. So in large parallel systems, most systems will not have the property of switching from conducting to nonconducting mode as described above; only few will have this property.

In the serial method, on the other hand, any arbitrary sequence of switches will either be in a conducting or nonconducting state, and will always be changed into the other state by the operation described in this section.

In addition, the serial method allows for an extension to two-dimensional systems or further to systems of arbitrary dimensionality, as will now be outlined.

The diagram below shows an element of a horizontal system with a switch in conducting mode, and with an independent vertical system also with a switch in conducting mode. This diagram thus shows two independent systems, both in conducting mode, and which happen to cross each other over a switch in each system.

However, the serial representation permits a simple connection between the systems so that the horizontal system is transformed and continued in the vertical direction.

This can happen in two variants, where the next diagram shows the other variant.

The connection scheme described here is easily extended to configurations in arbitrary many dimensions. Such configurations may thus involve a network of extensive branches in arbitrary dimensions and where, as above, each branch can be converted from conducting mode to nonconducting mode and back again by changing an arbitrary group from conducting state to nonconducting state (or allowing the system to stay in conducting mode even if the states of two arbitrary groups are changed, as discussed above). This is thus a powerful, virgin technology looking for applications – or finding the applications that may perhaps already be out there in nature.

4. Concluding Remarks

The above discussion thus shows that it is possible to build arbitrarily large switch structures according to the special wiring techniques described in Secs. 2 or 3, and that such configurations can be repeatedly converted from conducting/nonconducting state to nonconducting/conducting state by successively changing arbitrary switches from conducting state to nonconducting state, and conversely.

These are thus intriguing structures, which thus have some similarity to, *e g*, the way the wave function of a particle disappears [4] from the rest of the universe when the particle is observed at some point. Also quantum entanglement, “spooky action at a distance” [4], has characteristics of this type. Maybe, for some reason, spacetime indeed has some kind of structure as discussed here. Or, when considering the reason why DNA has the structure it has, maybe some clues could be given by considering mechanisms of the type discussed in this paper.

New results in science and technology can broadly speaking be classified into two main categories: either finding a solution to your problem [5], or finding a problem to your solution [6].

The first approach often leads to much better chances for success. The second approach is often more intellectually stimulating and challenging, and often leads to solutions no-one would have thought of. However, results in this approach may not materialise for a very long time - if ever (in the case of the project described in ref. [6], for example, it took some thirty years for the touch screen of the invention to appear in mobile phones, iPads and the like).

The solution described in the present article feels very much to be of this second kind, and is thus published here as food for thought for the readers.

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