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(54) Title: SELF-ERASING CHALKBOARD

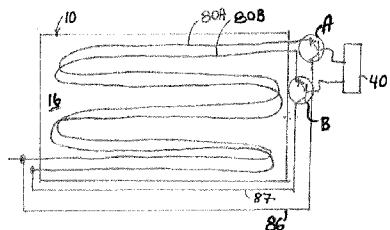


Fig. 7A

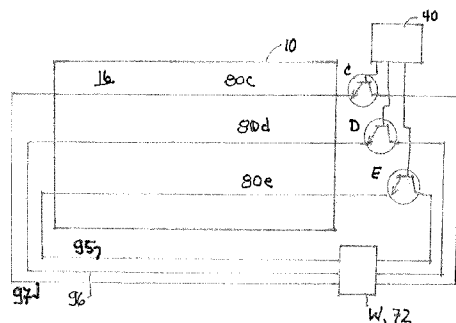


Fig. 7B

(57) Abstract: The present invention relates to a self-erasing chalkboard, methods of using the same, and writing implements and compositions therefor useful with the same. Writing implements used with the self-erasing chalkboard comprise compositions which include a magnetoresponsive constituent which is applied with further constituents to form visible writings on a writing surface, which are subsequently removed by the application of an electromagnetic field which dislodges the visible writings.



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SELF-ERASING CHALKBOARD

5 The present patent application claims the full priority benefit of US Serial No. 62/271782 filed on 28.Dec.2015, the entire contents of which are herein incorporated by reference.

The present invention relates to a self-erasing chalkboard, methods of using the same, and writing implements and compositions therefor useful with the same.

10

For over a century, chalkboards have been used in classrooms. Such chalkboards erase via the physical motion of moving a chalk eraser over the surface of such chalkboards upon which prior writings have been applied using a chalk stick. The chalk stick, substantially primarily calcium carbonate or other frangible inorganic matrix e.g. plaster, are applied against the surface of a chalkboard whereby a part of the chalk stick is
15 abraded and particles are retained upon the surface of the chalkboard due to surface energy. Typically these particles are used to form intelligible symbols, e.g., letters, numbers, figures and the like, which are retained upon the surface until removed by using an eraser. Such erasers may be of the dry type, such as felt pads other fibrous material which when rubbed against these writings, physically releases them from the surface of
20 the chalkboard. Also known are erasers of the wet type, wherein a liquid, typically water or a largely aqueous composition with a minor amount of an organic solvent and/or surfactants are rubbed against chalk writings and are thereby removed. The latter wet type usually also simultaneously provides better overall cleaning of chalkboard surfaces. Such a technique is known to be useful with chalkboards of various types, including those which are formed from naturally occurring or synthetic minerals, such as slate (typically referred to as “blackboards” due to the dark color of the slate), or with chalkboards which are formed from a substrate material such as wood, fiberboard, or other material upon which is a coated surface (often grey or green in color) to which a
25 chalk writings may be applied from a chalk stick.
30

While chalkboards have been in widespread used, globally, for at least the past century, the erasure of the applied chalk on such surfaces remains somewhat unsatisfactory. For example whereas the use of dry type erasers is convenient, they require that the user manually abrade the surface of the chalkboard, which may not result in complete removal of all of the chalk writings (particularly if the chalkboard has not been recently been more thoroughly cleaned using a wet eraser) and the airborne dust particles may linger in the proximity of the chalkboard for several minutes. Also, such manual abrasion is time consuming and may not reach all parts of the chalkboard. The use of a wet eraser typically provides better results as the liquid provides more thorough surface cleaning and the liquid entrains the released chalk from the surface of the chalkboard and limits how much becomes airborne, but again requires that the user manually apply the wet eraser to the surface of the chalkboard. Additionally the use of a wet eraser is disadvantageous as typically at least several minutes are necessary in order to allow the treated chalkboard surface to dry sufficiently before the chalkboard can be reused.

The prior art has suggested a solution to one or more of the above technical shortcomings. For example, US 3509664 describes an immobile blackboard writing surface and a magnetic sheet on a top hinged panel behind it, whereby a ferrous material can be applied in writing on said writing surface and will remain thereon until the magnetic sheet is pulled out of magnetic range, whereupon the ferrous writing material will fall into a receptacle from which it may be reclaimed. While providing certain benefits, the immobile blackboard requires the use of a large magnetic sheet substantially of the same size as that of the chalkboard, both of which must be present.

Also known to the art are the chalk compositions of CN 85106172 which describe certain chalk compositions which comprise a magnetic material. The chalk compositions are applied to a writing surface, but are removed by the use of a hand-holdable eraser which has associated therewith a magnetic base plate. No details concerning the overall composition or manner of making the chalk compositions are disclosed.

Described in CN 103468062 are magnetic chalk compositions which necessarily comprise 3-5 parts NdFeB magnetic powder, plaster powder 15-20 parts, large white powder 15-20 parts, 15-20 parts water; colorant 3-5 parts of the paste by 2-5 parts of polyvinyl acetate emulsion, polyvinyl alcohol 2-3 parts of an aqueous solution of 50 parts water; this product used in conjunction with iron blackboard with writing fluency, writing clear, moderate hardness, no dust flying advantages. These compositions may be particularly difficult to remove due to the high magnetic strength of the NdFeB powder. Also, NdFeB powder may pose unwanted health risks if inhaled.

- 10 The present invention addresses and provides a solution to certain shortcomings known to the art with respect to chalkboards, methods of their use, and writing implements.

In a first aspect there is provided a self-erasing chalkboard having a writing surface to which may be applied a writing implement and/or composition which impart visible but removable marking to the writing surface, and a magnetic field generator rearwardly of the writing surface, which, when operated, provides a magnetic field which dislodges or “erases” removable markings present on the writing surface, without requiring any physical contact or wiping of the writing surface.

20 In a second aspect there is provided a self-erasing chalkboard having a writing surface to which may be applied a writing implement and/or composition which impart visible but removable marking to the writing surface, and as a magnetic field generator a permanent magnet positioned rearwardly of the writing surface, which permanent magnet provides a magnetic field which dislodges or “erases” removable markings present on the writing surface. The permanent magnet may be positioned in a fixed position relative to the writing surface, or may be moveable with respect to the writing surface. The permanent magnet “erases” removable markings present on the writing surface, without requiring any physical contact or wiping of the writing surface.

30 In a third aspect there is provided a self-erasing chalkboard having a writing surface to which may be applied a writing implement and/or composition which imparts visible but

removable marking to the writing surface, and as a magnetic field generator an electromagnet or electrical coil or loop positioned rearwardly of the writing surface, which, electromagnet or electrical coil provides a magnetic field which dislodges or “erases” removable markings present on the writing surface. The electromagnet or
5 electrical coil or loop may be positioned in a fixed position relative to the wiring surface, or may be moveable with respect to the writing surface. The magnetic field generator “erases” removable markings present on the writing surface, without requiring any physical contact or wiping of the writing surface.

10 In a fourth aspect there is provided a self-erasing chalkboard having a writing surface to which may be applied a writing implement and/or composition which imparts visible but removable marking to the writing surface, and as a magnetic field generator one or more parallel spaced apart current conductors, e.g, wires or plates, positioned rearwardly of the writing surface, which, electromagnet or electrical coil provides a magnetic field which
15 dislodges or “erases” removable markings present on the writing surface. The one or more parallel spaced apart current conductors may be moveable with respect to the wiring surface, but are advantageously positioned in a fixed position relative to the wiring surface. The one or more parallel spaced apart current conductors “erases” removable markings present on the writing surface, without requiring any physical contact or wiping
20 of the writing surface.

In a fifth aspect there is provided a magnetic field generator according to any prior aspect of the invention, which further includes a magnetic shielding element or apparatus which operates to diminish or block a part of the magnetic field which emanates from the
25 magnetic field generator from penetrating the self-erasing chalkboard in (at least) the direction of the writing surface.

In a sixth aspect, there is provided a self-erasing chalkboard according to any prior aspect of the invention which additionally comprises a amplifying materials of high magnetic
30 permeability preferably forming part of the chalkboard, and preferably interposed

between the writing surface and the magnetic field generator. The amplifying material enhances the magnetic field emanating from the magnetic field generator.

In a seventh aspect there is provided a kit or assemblage of parts, which comprises a magnetic field generator and a mounting device which facilitates in the mounting or relative positioning of the magnetic field generator to a chalkboard, and thereby provide a self-erasing feature to the chalkboard as described with reference to any prior embodiment of the invention.

An eighth aspect of the invention relates to writing implements and/or compositions useful with the self-erasing chalkboard described with reference to any of the prior aspects of the invention, or otherwise disclosed within this patent specification.

These and further aspects of the invention are described with more particularity in this patent specification, including the drawings which form an integral part thereof.

Fig. 1 depicts a cross-sectional view of a part of a self-erasing chalkboard according to an embodiment of the invention.

Fig. 2 illustrates an embodiment of a self-erasing chalkboard, which includes one form of an X-Y table.

Fig. 3 illustrates a further embodiment of a self-erasing chalkboard which includes a different form of an X-Y table.

Fig. 4 is depiction of an embodiment of a self-erasing chalkboard utilizing a single, peripheral wire loop as a magnetic field generator.

Fig. 5 depicts an embodiment of a self-erasing chalkboard utilizing a plurality of wire loops in a grid-type configuration.

Fig. 6 depicts an embodiment of a self-erasing chalkboard which includes an optional collection device.

Fig. 7 depicts a still further embodiment of a self-erasing chalkboard which includes as a
5 magnetic field generator a plurality of parallel wires, strips or plates.

Figs. 7A and 7B depict further embodiments of self-erasing chalkboards including details of control circuitry.

10 Fig. 8 depicts a side view of a self-erasing chalkboard which further comprises an amplifying materials of high magnetic permeability.

Fig. 9 illustrates one embodiment of a kit of elements which may be used to retrofit a prior art chalkboard to produce a self-erasing chalkboard.

15

The self-erasing chalkboard includes a generally planar surface or construction which comprises a writing surface on at least one side thereof. The materials of construction of the said chalkboard are not critical to the operation of the present invention and any material(s) which do not overly restrict the passage of a magnetic field from a rearward
20 side of the chalkboard to the writing surface may be used. Usually the rearward side is also planar, and substantially parallel to the writing surface but such a geometric relationship is preferred, but not limiting to other possible embodiments of the invention. Non-limiting examples of useful materials of construction include ubiquitous and time-honored materials such as minerals and inorganics including slate plates or sheets. Other
25 materials include substrate materials such as wood, fiberboard, compressed fiberboard, ceramics, glass, or other material upon which is present a writeable surface which may be a coated surface (often grey, green or even white in color) upon which may be imparted removable markings and in particular removable visible writings. Further materials
30 include those consisting of, or comprising one or more synthetic polymers which may be formed into substrates or plates which may comprise a writing surface. Such materials are often those which exhibit a low magnetic permeability, preferably of at ≥ 0.95 , more

preferably ≥ 1.0 which indicates that they exhibit a low propensity for magnetic saturation, viz, exposure to an magnetic field will have little or no induced magnetic effects.

5 The self-erasing chalkboard may be flat, or curved but are preferably generally flat and planar in configuration. The self-erasing chalkboard and/or substrates of self-erasing chalkboards may be substantially rigid or may be flexible. While a substantially planar self-erasing chalkboard is a preferred embodiment of the invention, it is readily understood that the self-erasing chalkboard may take other forms, such as may be curved
10 flexible sheet or film which may be used in curved configuration or may be flattened such as by being stretched or mounted upon a frame and/or mounted upon an underlying surface which may also be a supporting surface. Markings or visible writings are typically provided thereto by the interaction of writing implements and/or compositions as they are passed, pressed or otherwise contacted with the writing surface. Such an
15 interaction, usually a combination of physical compression and friction at the region or part of the writing implements and/or compositions in contact with the writing surface leaves deposits thereon which are visible upon the writing surface. Coordinated use of the writing implements and/or compositions may be used to impart intelligible symbols, such as letters, numbers, figures, depictions and the like which may be understood by a
20 viewer inspecting the writing surface.

Compositions which are useful with the self-erasing chalkboard are essentially any material or composition which may imparted or deposited onto its writing surface, and subsequently may be removed by a magnetic field. Ideally removal also does not require
25 that the writings be removed by the use of conventional eraser, wiping cloth, fibrous substrate or other mechanical element but rather that the magnetic field provided by the magnetic field generator is sufficient to dislodge the writings. While the magnetic field of the magnetic field generator may be an unvarying magnetic field, preferably the magnetic field is variable, such that it fluctuates periodically. The present inventors have
30 found that a variable magnetic field varies its dipole direction (orientation) and reverses it, which redirection or reversal induces similar effects in the dipole direction of the

magnetoresponse material present in the writings, which in turn imparts physical motion within the deposited writings. Such fluctuations, (e.g, oscillations or reversals) in the electromagnetic field of the magnetic field generator advantageously varies from about 0.1 cycles/sec – 10,000 cycles/sec. The induced fluctuations in the magnetoresponse material bonded to one or more other constituents in the composition in turn causes a vibratory effect, and physically dislodges the writings from the writing surface. No manual intervention is thus required to remove the writings. Such fluctuation or oscillation may be achieved by any number of ways, including (but not limited to); rotating/spinning permanent magnet about an axis to thereby reorient it; interspersing a magnetic shield between the magnetic field generator and the writing surface at a desired frequency; controllably delivering electrical currents through a magnetic field generator in order to induce a varying magnetic field, or other suitable means. Of course, combinations of two or more of the foregoing are also contemplated to be useful means to provide fluctuation or oscillation of the magnetic field. Preferably the oscillation of the electromagnetic field of the magnetic field generator advantageously varies from about 0.5 cycles/sec – 500 cycles/sec. The inventors have observed that lower power may be supplied to a magnetic field generator, wherein the oscillation or fluctuation is at a higher frequency, versus a higher power requirement to a magnetic field generator wherein the oscillation of fluctuation takes place at a lower frequency.

The operating parameters of a magnetic field generator may be established without undue experimentation. As it should be recognized that the different possible types of magnetic field generators, e.g, those based on permanent magnets versus those which require an electrical current, and that their placement relative to the writing surface and the properties of any interposed materials, e.g, the substrate of a chalkboard will also effect their properties, operating conditions may be optimized for each configuration of a self-erasing chalkboard by simple experimentation. For example where the magnetic field generator is a permanent magnet, various offsets and distances may be tried. For a magnetic field generator which requires an electrical current to operate, the operating conditions of a suitable power supply which allows for variable control over current, voltage, amperage and/or polarity may be used to determine optimal operating conditions

for a particular self-erasing chalkboard. For example when current density is held at a constant, the voltage may be varied, and/or the polarity reversed at suitable frequency, particularly if a direct current source is supplied. For an alternating current source which inherently varies, other variable factors such as voltage, amperage or other variables may be varied. Ideally a varying, oscillating or reversible magnetic field is generated by the magnetic field generator.

The compositions necessarily include as a constituent thereof a magnetoresponsive constituent which may be essentially any material which may be responsive to a magnetic field, preferably when placed in the near proximity thereof. Such a magnetoresponsive material may be a material which may be polarized or magnetic in nature, and which may exhibit a dipole. The magnetoresponsive material preferably also forms a chemical bond with one or more further constituents present in the composition, preferably one or more further inorganic constituents which may be present. The compositions are such that after they are applied to a wiring surface of the self-erasing chalkboard, that when exposed to a magnetic field provided by the magnetic field generator is associated with the self-erasing chalkboard, are dislodged from the writing surface by the effects of the magnetic field.

Non-limiting examples of magnetoresponsive materials include any magnetic or magnetizable material including ferrous or ferric materials including oxides, iron, nickel, cobalt, or gadolinium alloys or compounds, alnico alloys, hard ferrites, soft ferrites, rare earth magnetic materials including samarium cobalt magnets and neodymium iron boron magnets, spinels such as those comprising aluminum atoms, e.g. MgAl_2O_4 , $\text{Mn}^{2+}\text{Al}_2\text{O}_4$, spinels containing iron atoms, e.g., $\text{ZnFe}^{3+}_2\text{O}_4$, MnFe_2O_4 , $\text{MgFe}^{3+}_2\text{O}_4$, magnetite, Fe_3O_4 , $\text{NiFe}^{3+}_2\text{O}_4$, spinels containing chromium atoms, e.g., FeCr_2O_4 , MgCr_2O_4 , as well as other spinels not elucidated here but which would be suitably operative in the inventive compositions. It is expected that virtually any ferromagnetic, ferromagnetic, paramagnetic, and diamagnetic material may be used as a magnetoresponsive material in the inventive compositions. Preferred are ferromagnetic and ferromagnetic materials,

transition metal alloys/compounds, iron oxide alloys/compounds, alnico alloys/compounds, and hard/soft ferrites.

5 A particularly preferred magnetoresponse material is "Magnetite", a black iron oxide which is presently commercially available from Miniscience, Inc. (Clifton, NJ, USA), which is effective and available at a reasonable commercial cost.

10 In addition to the required magnetoresponse constituent the compositions may, and typically include further constituents as well. Inorganic minerals are typically also present, such as mineral calcites and mineral carbonates, such as calcium carbonate (e.g., 'chalk') which may be present in varying amounts. Clays as well as other calcites and other carbonates may be used as well. As will be recognized by the reader, calcium carbonate is the primary constituent of conventional chalk-based writing implements, such as chalk sticks when used on conventional blackboards. This mineral material is
15 sufficiently rigid, yet sufficiently soft when compressed against the writing surface and leaves a very visible, white marking when applied thereto. Therefore it is preferred. Further constituents which may be present include binding agents such as plasters may also be present with the magnetoresponse constituent and when present, other co-constituents. Nonlimiting examples of such include, those based on gypsum, lime and
20 cement. The advantage of the use of such a binding agent, typically a plaster, include that it may ask to form physical bonds with the magentoresponse constituent present, and when such a binding agent is light in color, or white, it also provides a highly contrasting and thus highly visible deposit when applied to the writing surface of the self-erasing chalkboard, which may be of a contrasting darker color, typically black, gray, or
25 green. In particularly preferred plaster material is known as "plaster of Paris", which is rapidly setting when mixed with a solvent, typically water and forms a rigid, yet erodible article or frangible article when set.

30 In the compositions, and in further addition to the magnetoresponse constituent there may be present one or more contrasting constituents which they being material which improves the visible contrast between the writing surface, and the writings applied if

you're to buy the composition, or writing implement comprising the composition. These may the inorganic particles having high reflectivity such as titanium dioxide, as well as colorants such as pigments or dyestuffs. The use of highly reflective materials, such as titanium dioxide, provide improved contrast to the writings applied to the writing surface.

5 The compositions may also include one or more optical brighteners. By way of nonlimiting examples, such include 4,4'-diamino-2,2'-stilbenedisulfonic acids (flavonic acids), 4,4'-distyrylbiphenyls, methylumbelliferones, coumarins, dihydroquinolinones, 1,3-diarylpyrazolines, naphthalimides, benzoxazole, benzisoxazole and benzimidazole systems, and the pyrene derivatives substituted by heterocycles. Specific examples of
10 such optical brighteners include those sold under the trade name TINOPAL (ex. Ciba) such and as TINOPAL CBS which is described to be disodium 2,2'-bis-(phenylstyryl)disulphonate as well as TINOPAL DMS which is described to be disodium 4,4'-bis-(2-morpholino-4-anilino-s-triazin-6-ylamino)stilbene disulphonate. The use of colorants such as pigments or dyestuffs allow for the provision of the spectrum of colors to be
15 made available if so desired. Such include dyes and pigments known from the Color Index, may also be used, e.g, diazo red pigment, copper phthalocyanine, chlorinated copper phthalocyanine, Irgalite Yellow 2GF, as well as water- or oil-based pigment dye, and pulvurent pigments. Colorants useful in the composition may be in liquid form or solid form, or be a dispersion of solids within a liquid carrier or solvent, or be emulsions,
20 e.g. polyvinyl acetate emulsions. Also, one or more of the pigments or dyestuffs may be added to the composition wherein they are be absorbed or adsorbed onto one or more of the further constituents which are concurrently present.

Additional constituents which may be present include thickening agents, fillers,
25 emulsifiers, and binders. Thickening agents may include organic and/or inorganic thickening agents which can be added to increase the viscosity of a slurry or liquid composition used in the production of writing implements comprising, were based upon the compositions of the invention. Such thickening agents may include those based on polymers such as cellulose which is naturally occurring or chemically modified such as
30 carboxymethylcellulose, starches, as well as naturally occurring or chemically modified gums such as xantham gum and acacia gum. Fillers may be organic or inorganic

materials, and with nonlimiting examples include polyacrylate polymers, including those which are water sorbent, as well as clays such as laponites, bentonites and other clays. Such fillers may also act to increase the viscosity of liquid compositions, such as slurries containing further constituents of the inventive compositions. As binders there may be
5 used any of a variety of polymeric materials, such acetate polymers and copolymers, uncured epoxy, polyester, polyurethane or acrylic resins, or compatible mixtures thereof. In one embodiment the composition (and/or writing implement formed therefrom) contains as the binder an uncured epoxy resin and an uncured polyester resin in a weight ratio of 0.5:1 to 1.5:1. preferably 1:1.

10

Additional constituents which may be present in the compositions are one or more solvents. Solvents are preferably used and may be any liquid material which we used to form a dispersion, slurry, suspension, or other flowable, or pumpable form of the compositions of the invention, although it is to be understood that such liquids are
15 typically substantially driven off such as by drying, evaporation, or other process and are ultimately absent, or present in mobile or fluid form in only very minimal amounts (typically less than 1%wt.) of the ultimate composition when it is formed as a solid composition. The use of solvent preferably aids in the formation of a bond between the magnetoresponsive constituent and one or more further constituents of the invention,
20 preferably one or more of the organic constituent present such as minerals, carbonates, etc., which bond aids in the removal of the writings when exposed to a magnetic field, preferably a varying or oscillating magnetic field as previously described. Such solvents may be protic solvents or aprotic solvents, and may be mixtures of two or more materials. Water, ethanol, ammonia, C₁-C₆ monohydric alcohols acetone, glycols, glycol ethers or
25 other inorganic or organic solvents including polyvinyl alcohols, polyvinyl acetates as well as organic acids such as acetic acid may be use. Polar protic solvents may also be used. It is to be understood that in preferred embodiments a solvent is necessarily required in the formation of the composition, although in the ultimate final form of the composition or writing implement it is no longer fluid or liquid but in a bound form
30 which is no longer considered to be mobile or in fluid form. For example, in cementitious compositions water molecules are bound in the cementitious matrix, and are not

considered to be mobile or in fluid form. Useful solvents of course include water, but may also include organic liquids and fluids which are preferably liquid at room temperature, and at one atmospheric pressure. Nonlimiting examples of such organic solvents include monohydric alcohols, polyhydric alcohols such as glycols, glycol ethers, and the like. Minor amounts of surfactants, e.g. to about 5%wt, such as anionic, cationic, nonionic, or zwitterionic surfactants may also be present, such may aid for example, in assuring the uniform dispersion or distribution of constituents used in forming a composition of the invention either during the production thereof, and/or during the use of a composition or writing implement comprising a composition of the invention.

The foregoing possible constituents is to be understood as illustrative, but not necessarily limiting of the compositions, or writing implements of the present invention. While the essential magnetoresponsive material is present with one or more of the further

constituents recited above, and forms a bond with one or more of the further constituents, the total amounts of each considering present in the relative weight percentages may vary. Writing implements according to the invention comprise the composition which includes a magnetoresponsive constituent optionally but very preferably one or more further constituents described previously. The individual amounts may vary, and may be readily determined by a skilled artisan. Preferably however, in the ultimate final form of the composition, or writing implement, the amount of individual materials such be sufficient such that (a) a visible marking or writing can be imparted to the writing surface of the self-erasing chalkboard, and (b) the applied visible marking can be substantially removed when it is exposed to a magnetic field provided or generated by the magnetic field generator. Advantageously the compositions of the invention ultimately comprise (viz., after the removal of solvents, water, and other liquids): 10 – 90%wt. one or more inorganic constituents, e.g., mineral calcites, mineral carbonates, etc.; 5 – 95%wt. magnetoresponsive material; 0.5 - 40% colorant; 5 - 45%wt. binding agent, and/or gypsum, lime, cement, and 0 – 20%wt. further constituents. Preferred compositions and weight percentages are disclose hereinafter with reference to one or more of the examples set forth in the following.

An exemplary method of forming one format or writing implements of the invention, this case a rigid rod or self-supporting stick of a composition which includes a magnetoresponsive constituent as well as further constituents is described as follows. A first batch of materials is formed by combining calcium carbonate, plaster of Paris, and a dyestuff (e.g. Tempera paint powder and/or liquid dye), wherein the weight ratio of calcium carbonate: plaster of Paris 1:1 – 1:10. Preferably apart from the dye, if it is in a liquid form or in a liquid carrier are dry, pulvurent fine particulates which are substantially anhydrous. A second batch of materials is formed by combining the magnetoresponsive constituent with any further desired optional constituents. Preferably also these further constituents are dry, pulvurent fine particulates which are substantially anhydrous. Advantageously the average particle size of pulvurent constituents is not in excess of 10 microns. At this stage, both the first batch and second batch are combined and mixed to form a homogenous composition. If necessary in order to achieve a desired target average particle size, the first batch and/or the second batch may be subjected to a grinding, or commuting operation in order to achieve a reduction in average particle size in order to meet a desired target average particle size. Preferably, the proportions, of the first batch materials:second batch materials are combined in a respective weight ratio of about 1:3 to about 99.5:0.05, more preferably about 1:1 to about 95:5. While a solvent may be added at this stage, it is also foreseen that any solvents be added only after the first batch materials and the second batch materials are dry blended or mixed in order to form an essentially homogenous blend of dry pulvurent materials which are subsequently optionally but preferably sieved in order to ensure removal of oversized particles. This step may not be required if the first batch materials and the second batch of materials were previously been specified to be within limits for a target particle size, however the practice of this step may act to ensure that the desired range or desired target particle size is maintained. It is also to be clearly understood, that whereas the formation of a first batch materials, the second batch of materials has been described, such is it preferred method, but this is not a required method. That is to say that all of the foregoing described constituents can be provided in a single batch, and mixed in a single (initial) batch and thereafter subjected to subsequent processing.

As previously described a solvent is subsequently added to the materials as, while not wishing to be bound by the following, it is believed that the solvent aids in the formation of a bond between the magnetoresponsive constituent and at least one further constituent, and this bond, most likely a hydrogen bond, which ultimately aids in the removal of the writings of the composition upon the writing surface when subjected to a suitable magnetic field, preferably wherein such a varying or oscillating magnetic field which induces a vibratory effect in the particles of magnetoresponsive constituent which are bound to at least one of the further constituents. Preferably, the solvent is water, and/or an organic solvent such as in the aqueous/ethanol mixture in a blend wt% ratio of between 1:99 to 99:1, which is stirred into the other constituents present. Such forms a fluid mass, which may be a paste, gel or may form a suspension or slurry of the solvent, with the previously dry, pulvurent materials in a respective weight ratio of solvent:materials about 1:20 – 10:1, preferably about 1:5 – 3:1. The provision of the solvent causes hydration of one or more of the inorganic materials present in the composition which may in part entrap or engage particles of the magnetoresponsive constituent with one or more particles of inorganic constituents present, and/or otherwise cause the formation of a chemical bond between the magnetoresponsive constituent with one or more further constituents present, such as one or more of the inorganic constituents. The formation or nature of this association or bond is not yet clearly understood and may be the formation of covalent or ionic bonds between the particles of magnetoresponsive constituent with one or more constituents, such as the calcium carbonate or other inorganic material present, yet it has been observed by the inventors and plays an important role in the interaction of the composition and/or writing implement and the self-erasing chalkboard. The inventors believe that this bond formed may be a hydrogen bond which is formed in the presence of a solvent. The formed paste, gel, slurry or suspension is preferably sufficiently fluid (viz, a fluid mass) such that it can be used to subsequently molded or formed into writing implements, e.g., rods, sticks or crayons from the composition. The fluid mass is substantively solidified in order to form writing implement therefrom. Various processes can be used to effect such a solidification from the fluid mass. In one such process, the fluid mass is provided to a mold and then subjected to appropriate

temperature conditions, typically on the range for approximately 50°F - 160°F, optionally under increased pressure, typically on the order up to about 3 atmospheres, or alternately, at a reduced pressure which may be near vacuum levels, in order to accelerate the removal of solvent present in the fluid mass and thereby to attain a suitable degree of solidification of the composition whereby the solidified composition, is now self-supporting and free standing and sufficiently rigid and may be used as a writing implement. The time required to achieve solidification cores varies upon the process use, but typically times between 0.5 – 96 hours are advantageous.

- 10 Preferably in the foregoing process, during the formation of the writing implements, the constituents or the fluid mass is subject to a magnetic field, preferably during the solidification or drying step used in the formation of the writing implements. Such imparts a uniform orientation of the magnetoresponsive constituents present which is believe to improve the function of the writing implement, particularly its release from a writing surface in response to a magnetic field generator. Such a process step, viz, the exposure to an orienting magnetic field is hitherto unknown in the art.

- Molds used to form writing implements from the compositions may be of any configuration, but ideally are of the familiar cylindrical rod shaped form having dimensions of approximately between about 0.5-10 cm in diameter, and a length of at least approximately 3 times, preferably at least 5 times the maximum diameter. Of course, molds of other shapes and configurations can also be used. For example, larger molds may be used, and in subsequent to solidification and other non-cylindrical and or non-rod shaped forms of the solidified composition may be used as writing implements of the invention. In one variant of a useful process of the invention, writing implements may be also formed using a cutting means, e.g., a cutting wire or saw can be used to shape or form writing implements from the solidified composition. In another process, the fluid mass is subjected to an extrusion or compression process whereby the slurry or suspension is passed through an orifice or die, and subsequently solidified by drying. In such a process and is also foreseen that prior to passing through an orifice, a screen or filter element may be used whereby excess solvent is removed from the fluid mass of the

composition prior to its passage through the orifice or die, and a semisolid precursor of the writing implement is ejected from the orifice or die having a reduced content of the solvent, but which is still sufficiently solid although, not necessarily rigid, it can be handled manually, or by machine apparatus in a subsequent solidification and/or drying step or operation. In a further useful process, the fluid mass is poured out, or cast upon a supporting screen or pad, which allows for the excess solvent to drain therefrom whereby a "cake" is formed, which may be allowed to sufficiently dry or solidify, which is thereafter formed into the shapes of individual writing implements, or alternately, may already be shaped or formed from the wet cake, and these individually formed shapes are then solidified into individual writing implements.

Ideally the individual writing implements are of a size and shape to be easily hand-holdable and of a shape to be conveniently manually apply writings to the self-erasing chalkboard by pressing and/or moving the writing implement against the writing surface of the self-erasing chalkboard. The writing implements may be used with an additional holder which may improve a user's grip upon the writing implement.

Certain and preferred example compositions include the following from which writing implements were formed. In each of the following, a "premix", usually comprising or consisting of dry, pulvurent constituents were first dry-mixed to form a homogenous blend, to which was later added one or more solvents. The constituents were mixed to form a fluid mass which was typically pasty in consistency. The fluid mass was introduced into suitably sized molds and the fluid mass was dried, which permitted the mass to harden into a self supporting stick useful with a self-erasing blackboard according to further aspects of the invention.

Example 1			
Premix (dry constituents)		mass (g)	%wt.
	calcium carbonate	57.5	21.50
	Magnetite	126.75	47.39
	Plaster of Paris	36.37	13.60

	Tempera Powder Dye	46.85	17.52
	Premix Total =	267.47	
	Premix	75.03	74.56
	Water	25.6	25.44
	Total=	100	

In the following, as a solvent was used a commercially available, liquid Tempera Paint product which provided sufficient moisture to form a moldable mass when combined with the Premix constituents:

5

Example 2			
Premix (dry constituents)		mass (g)	%wt.
	calcium carbonate	57.5	21.50
	Magnetite	126.75	47.39
	Plaster of Paris	36.37	13.60
	Tempera Powder Dye	46.85	17.52
	Premix Total =	267.47	
	Premix	38.14	45.68
	Tempera Paint	45.36	54.32
	water	q.s.	
	Total=	100	

In the following, two premixtures were first formed, the second premixture being the combination of the first premixture with Plaster of Paris, which second premixture was subsequently combined with a solvent.

10

Example 3			
Premix 1 (dry constituents)		mass (g)	%wt.

	calcium carbonate	46	38.3
	Magnetite	74.1	61.7
	Premix 1 Total =	120.1	
Premix 2 (dry constituents)			
	Premix 1	27.18	87.88
	Plaster of Paris	3.75	12.12
	Premix 2 Total =	30.93	
	Premix 2	30.93	71.88
	Water	12.1	28.12
	Total=	43.03	

Again, in the following two premixtures were first formed, the second premixture being the combination of the first premixture with Plaster of Paris, which second premixture was subsequently combined with a solvent.

5

Example 4			
Premix 1 (dry constituents)		mass (g)	%wt.
	calcium carbonate	46	38.3
	Magnetite	74.1	61.7
	Premix 1 Total =	120.1	
Premix 2 (dry constituents)			
	Premix 1	25.86	89.48
	Plaster of Paris	3.04	10.52
	Premix 2 Total =	28.9	
	Premix 2	28.9	62.85
	Water	17.08	37.15
	Total=	45.98	

The following was formed using a single premixture of dry constituents comprising only calcium carbonate and Magnetite:

Example 5			
Premix (dry constituents)		mass (g)	%wt.
	calcium carbonate	63.364	69.96
	Magnetite	27.2	30.04
	Premix Total =	90.56	
	Premix	21.70	59.0
	Water	15.08	41.0
	Total=	36.79	

- 5 The following was formed using a single premixture of dry constituents comprising only calcium carbonate and Magnetite, with an aqueous/alcohol solvent:

Example 6			
Premix (dry constituents)		mass (g)	%wt.
	calcium carbonate	63.364	69.96
	Magnetite	27.2	30.04
	Premix Total =	90.56	
	Premix	21.6	56.82
	70% ethanol	16.42	43.18
	Total=	38.02	

- 10 The following was formed using a single premixture of dry constituents; sufficient water was added to form a pasty material:

Example 7			
Premix (dry constituents)		mass (g)	%wt.
	calcium carbonate	6.55	21.84
	Magnetite	19.65	65.55
	Plaster of Paris	3.78	12.61
	Premix Total =	29.98	
	Premix	29.98	
	Water	q.s.	

Similarly, the following was formed using a single premixture of dry constituents; sufficient water was added to form a pasty material:

Example 8			
Premix (dry constituents)		mass (g)	%wt.
	calcium carbonate	13.186	43.62
	Magnetite	13.262	43.87
	Plaster of Paris	3.78	12.51
	Premix Total =	30.23	
	Premix	30.23	
	Water	q.s.	

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With respect to Examples 7 and 8, as the bulk of the water was dried off (except for “bound water” within the writing implement) the above provides a reasonable approximation of its composition.

- 10 The foregoing are non-limiting examples of compositions used to form writing implements, and their final compositions as well. It is to be noted here that the compositions and writing implements of the invention may also be used with conventional chalkboards or blackboards, which are not in accordance with any aspect of

the invention. Likewise, writings imparted by the compositions and writing implements of the invention from chalkboards, whether or not in accordance with any other aspect of the invention, by the use of a conventional eraser, cloth or wipe.

- 5 Self-erasing chalkboards of the invention include a writing surface against which is contacted a writing implement and/or composition which imparts a visible but removable marking to the writing surface, and a magnetic field generator rearwardly of the writing surface, which, when operated, provides a magnetic field which dislodges or “erases” removable markings present on the writing surface. Certain embodiments are disclosed
- 10 with reference to the following drawings. In the drawings, like numbered elements relate to the like element which may be present in several of the different drawing figures. Also, elements or parts may be used in different embodiments although not necessary depicted in a specific drawing figure.
- 15 Turning now to the drawing figures, Fig. 1 depicts a cross-sectional view of a part of a self-erasing chalkboard 10 having a front writing surface 12 upon a substrate 14, and a rear surface 16 opposite from the writing surface 12, and further rearwardly at the back of the chalkboard 10 a magnetic field generator 50, which when operative, imparts a magnetic field through the substrate 14 and the writing surface 12. A writing implement
- 20 1 is also shown pressing against the writing surface 12, which writing implement 1 deposits a visible marking 2 on the writing surface 12.

- Operation of the magnetic field generator 50 causes the formation of a magnetic field in its locus which operates to repel the visible markings 2 formed from the composition of
- 25 the writing implement away from the writing surface 12, viz., “erases” the writing surface 12 in this locus, or proximity of the rearwardly positioned magnetic field generator 50.

- The magnetic field generator in this or any other depiction, or for that matter, any other embodiment of the invention, can be any article or device which generates a sufficiently
- 30 strong magnetic field so to cause removal of the visible markings 2 from the writing surface 12 as generally discussed with reference to Fig. 1. Preferably a magnetic field

generator emits a magnetic field, of between about 1 – 40,000 Gauss, preferably between about 100 and 25,000 Gauss and particularly preferably between about 10,000 – 25,000 Gauss. Preferably also, (and in preferred embodiments, is essential thereto,) as discussed, the magnetic field generator 50 also imparts a reversing or oscillating

5 magnetic field permeating to the writing surface 12, and thereby imparts a vibratory effect to the magnetoresponsive constituent forming part of the writings on the writing surface 12. Such a magnetic field generator may include, without limitation one or more of: a permanent magnet, one or more current-carrying conductors, e.g. one or more wires or plates, an electromagnet or electrical coil, or a looped current carrying wire, or any of
10 the above of which generates a magnetic field. Also any self-erasing chalkboard of the invention may include, or have associated therewith a plurality of individual magnetic field generators which may be all the same type, or which may be of two or more different types. A magnetic field generator may be provided within a fixed position relative to a part or all of a self-erasing chalkboard and its writing surface and thus be
15 immobile in relation thereto and/or a magnetic field generator may be mobile or movable with relation to a part or all of a self-erasing chalkboard and its writing surface. In the case of the former, in certain embodiments it is conceived that a magnetic field generator is either affixed thereto, or forms part of the substrate 14 and/or the writing surface 12 of a self-erasing chalkboard 10, or that it may be otherwise mounted using an intermediate
20 element or fastening means, such as the frame or holder, and/or by a fastening means such as mechanical fastener (e.g. a screw, bolt, pin, rivet) and/or chemical fastener (e.g. adhesive material, glue, adhesive tape strip). In the case of the latter, an additional transport means, or a transport apparatus can be provided whereby a magnetic field generator can be movably repositioned relative to a self-erasing chalkboard 10 and its
25 writing surface 12. Two or more such transport means, or transport apparatus can be concurrently present. Such transport means may be manually operable, or be operated by a controller means. For example a keypad, coupled to a suitable motor controller means can be used to control the relative positioning of one or more magnetic field generator in response to input presented on the keypad, which interprets its received input as
30 command functions and in response thereto, causes the repositioning of the magnetic field generator in accordance with the command function. The suitable motor controller

means may include a computer or processor and a computer memory which may be used to store control functions, e.g, a sequence of preprogrammed control commands sent to motor controllers which drive a transport apparatus which controls the relative position of a magnetic field generator such as in accordance with a sequence of preprogrammed movement steps. The controller means however may be of simpler type, and include a joystick controller or directional buttons which directly send suitable control commands directly to the transport means, without necessarily requiring a computer or processor and a computer memory.

Fig. 2 illustrates a depiction of a self-erasing chalkboard 10, showing its rear surface 16 opposite from the writing surface 12 (not shown). Also depicted is an embodiment of a transport apparatus 20, here a device which is an 'X-Y table' which in a broadest sense, allows for the controlled positioning and repositioning, viz., movement, of a magnetic field generator 50 in two axial directions, in an "x" direction (or in relative terms a "horizontal" direction) as well as in a "y" direction (or in relative terms, a "vertical" direction) as is represented by suitably labeled bidirectional arrows. Relative positioning of the magnetic field generator 50 moveable with respect to the support bar 25 can be established by manually and physically moving control elements or motors 24, relative to frame bars 21A, 21B, 22A, 22B, but more conveniently a controller system 40 is in electronic communication (e.g, via control wires 41) with operative elements of the transfer apparatus and can be used to establish, as well as to change the relative positioning of the magnetic field generator 50 with respect to one or more parts of the rear surface 16. The magnetic field generator may be a permanent magnet, or may be a magnetic field generator which requires an electrical current to be operative, e.g, a wire loop, coil or solenoid. When the magnetic field generator 50 is a permanent magnet, an additional motor (not shown) may be included to spin the permanent magnet about an axis which thus generates a variable or revering magnetic field which extends to the writing surface. Alternately or additionally where the magnetic field generator 50 is a permanent magnet, its position or distance from the writing surface may also be varied; such variation in the distance particularly when repeating or oscillating also provides a variable magnetic field at the writing surface. Such may also be provided by an

additional motor (not shown) which may move the permanent magnet in a direction perpendicular to the writing surface, or which may oscillate the magnet by spinning the permanent magnet mounted on an offset shaft attached to the additional motor. When the magnetic field generator 50 requires an electrical current when an electrical current is applied to the magnetic field generator 50 advantageously such is "switchable", that is to say it is not a permanent magnet nor does it emit a permanent magnetic field unless it is energized, the control system 40 may also act to energize the magnetic field generator 50 so that it emits a magnetic field through the self-erasing chalkboard 10 and to repel or release writings 2 (not shown) from the writing surface 12 (not shown) and thereby "erasing" these writings 2 opposite from the magnetic field generator 50. Again, it is preferred that the magnetic field generator 50 also be operative such that it emits a variable, oscillating or reversible magnetic field. Preferably the control system 40 includes a keypad, touchscreen, or other input means 42 whereby the relative position or positions of the magnetic field generator 50 and its operation can be generally controlled. For example, the input means 42 may include directional arrows which will, when selected or depressed, cause the relative movement of the magnetic field generator 50 via the transfer apparatus 20 in a desired direction. Additionally, or alternately, the input means 42 may be used to initiate the operation of preprogrammed functions, such as would cause the transfer apparatus 20 to cause the magnetic field generator 50 to transit over parts of or "zones", or over the entirety of the rear surface 16 of the self-erasing chalkboard 10, which would thus dislodge the writings 2 present on the writing surface 12 in said zones or entirety thereof. In this manner, some or, or all of the writing surface 12 would be "erased".

The input means 42 may also operate in conjunction with (or be replaced by) a remote-control unit 40A which provides a similar function as part of the control system 40, and preferably includes an input means 42A which provides for a means to control the operation of the self-erasing chalkboard without necessarily being directly adjacent thereto and/or operating it using the input means 42 of the control system 40. Such a remote-control unit 40A may be in uni-directional communication or bi-direction communication with the control system 40 and/or the self-erasing chalkboard 10 and

thereby direct its operations. Such communications protocols are well known, e.g., infrared, or Bluetooth. The remote-control unit 40A may also be connected to the control system 40 and/or the self-erasing chalkboard 10 which provides for limited movement as well. The remote-control unit 40A may be a dedicated device which functions only to
5 operate the control system 40 and/or the self-erasing chalkboard 10, or may be a more general purpose computing and/or communications device, e.g., suitable programmed computer or smart phone, e.g. Android tablet, smartwatch or telephone, Apple tablet, smartwatch or telephone, executing instructions of a suitable computer program. Such a remote-control unit 40A may be used with any embodiment of the invention.

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Fig. 3 provides a further depiction of a further embodiment of a self-erasing chalkboard 10 similar in many respects to that of Fig. 2. In the current embodiment, the transport apparatus 20, here a device which is an 'X-Y table' of a different configuration, here different substantially in that no support frame is are present, rather two motors 25, which
15 may be stepper motors, each engage a linear shaft 26, one being oriented to allow for movement in the "x" or relative "horizontal" direction, the other in the "y" or relative "vertical" direction. Each of linear shafts 26 controls thereby the relative position of a pair of support bars 25, whose placement relative to the rear surface 16 also establishes the position of the magnetic field generator 50 relative thereto, and the opposite writing
20 surface normal 12 (not shown) having markings or writings 2 thereupon. Again, while each of the motors 24 can be individually, or simultaneously controlled (or for that matter, the placement of the support bars 25 can be moved and established manually) again preferably the operation of the motors 24 can be controlled by a control system, and operated in a manner as described previously with respect to Fig. 2.

25

The embodiment of the present figure additionally includes a magnetic shield 60 which is movable, such as about an axis 61 in a rotatable direction as depicted by bidirectional arrow "a", whereby it can be interposed between the magnetic field generator 50 and the back 16 of the self erasing chalkboard 10. The magnetic shield 60 blocks the
30 electromagnetic fields which would otherwise pass through the self-erasing chalkboard 10 when the magnetic shield 60 is positioned to obscure the operating magnetic field

generator 50. It too may be manually positioned, but is preferably also concurrently controlled by the control system. Providing a magnetic shield 60 can be advantageous particularly when the magnetic field generator 50 is a permanent magnet and it is desired that at certain regions or positions, the effects of the provided electromagnetic field should be blocked from passing through the self-erasing chalkboard 10 at such a position or locus. In such an instance, the magnetic shield 60 can be positioned to be static and interposed in order to block the magnetic field by being physically interposed between the magnetic field generator 50 and the rear surface 16 opposite from the writing surface 12 (not shown) where the effect of the magnetic field which would otherwise cause the erasure removal of the writings 2 is not desired. The use of the magnetic shield 60 may also be useful in imparting variations or oscillation in the magnetic field of the magnetic field generator 50. For example the magnetic shield 60 could be caused to act as a shutter or be interposed between the magnetic field generator 50 and the writing surface 12, and when quickly operated could block and then expose the writing surface to the magnetic field, which in turn would induce vibratory effects in the magnetoresponsive constituent present in the writings, and thereby dislodge them. Such can be performed, for instance, by rotating the magnetic shield 60 in and out of interposition, preferably at a rapid rate, e.g. between 1 – 200 cycles/second, but even higher rates may be possible. Of course, with respect to the embodiment of Fig. 3, the use of any other device, mechanism, other than a rotatable axis 61 or pin can be utilized as well to effectuate the repositioning of the shield 60 with respect to the magnetic field generator 50. It is also to be understood that a shield 60 can be used with magnetic field generators 50 which are not permanent magnets, e.g. are selectively energizable, such as current loops, or electromagnets, or solenoids, and the like. The material of construction of the magnetic shield 60 is advantageously a material which exhibits a high resistance to magnetic permeability. Many such materials are known to the relevant art. Non-limiting examples include steel, Giron and Mu-Metal.

The inventors have observed that the writings 2 formed by the deposition of the inventive compositions are released from the writing surface of a self erasing chalkboard when there is a variation, e.g, oscillations, reversal in the magnetic field provided by the

magnetic field generator 50. This may be caused by varying the frequency of electrical current passing through the magnetic field generator, wherein such comprises one or more wires, or wire loops, or comprise a core such as may be the case where such is a solenoid. The frequency of such oscillation or reversal can be any which is found to be effective. In the case where the magnetic field generator is a permanent magnet, such effect can be provided by spinning or rotating the permanent magnet to provide a similar oscillation in the magnetic field generated. Alternately this effect may be attained by varying the distance of the permanent magnet from the writing surface, such as moving it towards and away from the writing surface as such would also provide a varying or oscillating magnetic field. Alternately a varying or oscillating magnetic effect can be attained by using a permanent magnet, and by varying the rapid interposition of a shutter as described reference to Fig. 3, viz., a rapid “shuttering”. While not wishing to be bound by the following, is believed that improved disassociation of the writings 2 from the writing surface 12 is achieved under such conditions as, the magnetic field oscillates and/or reverses or otherwise fluctuates, such induces physical vibratory effects within the magneto-responsive component of the deposited composition present with the writings 2, and thus more effectively dislodge them from physical contact with the writing surface 12.

Fig. 4 illustrates a further embodiment of a self-erasing chalkboard 10 of the invention, which utilizes a loop 70 extending at or beyond the edges 11 thereof, which single loop 70 attached to a current source 72. When a sufficient current is passed through the loop 70, it operates as the magnetic field generator 50 causing the markings 2 to be released from the writing surface 12 of the self erasing chalkboard 10. While depicted in Fig. 4 as a single wire loop 70, it is to be understood that single wire, or a number of wires or windings can be used to form the loop 70. The use of plurality of wires or provision of the multiple wire loops increases the magnetic field strength generated by this form of a magnetic field generator 50. The current passed through the magnetic field generator 50 may also be caused to reverse, e.g., by utilizing an alternating current source, or by controlling the waveform of a direct current passed through the magnetic field generator 50 so to introduce a non-steady state mode of operation, that is to say to impart a varying,

oscillating or reversing electromagnetic field emanating from the magnetic field generator 50.

Fig. 5 illustrates a self-erasing chalkboard 10 of the invention, of a still different configuration than those previously described. In the depicted embodiment, the surface of the self-erasing chalkboard 10 is divided into a plurality of contiguous individual zones, each labeled "z" a subset of these which are both labeled, and indicated by broken lines. Such zones "z" divide the surface into separate, but contiguous surface regions. It is to be understood that the surface regions are of the same dimensions at both the writing surface, and at the rear surface 16. A number of individual magnetic field generators 50 also depicted and provided in several of these zones "z". (It is stated here that such a limited depiction is purely for the sake of clarity in order to better understand this embodiment of the invention, viz, an individual magnetic field generator is not depicted in each of the zones "z".) It is also to be clearly understood that individual magnetic field generators 50 may be placed within some, or in all of the individual zones "z" as desired. In this embodiment the individual and separate magnetic field generators 50 act independently of each other, and for example may be controlled by a control system 40 such as described with reference to previous embodiments. In this embodiment, each of the individual and separate magnetic field generators 50, provided as separate, closed loops (70A, 70B, 70C, 70D, 70E) which can be energized in order to generate a magnetic field which extends through the self-erasing chalkboard 10. When energized, the writings 2 present (not shown) are repelled from the writing surface (not shown) and thus are effectively "erased" as described previously. An advantage of this depicted embodiment allows for the elimination of the requirement of a electromechanical device, such as an x-y table as previously described, and also provides for selective removal or erasure of writings 2 present on one or more zones corresponding to surface regions of the writing surface 12. Each of the closed loops may be separately operated by a controller 40. Preferably also, when operating, the electrical current passed through the magnetic field generator 50 may also be caused to reverse, e.g., by utilizing an alternating current source, or by controlling the waveform of a direct current passed through the magnetic field generator 50 so to introduce a non-steady state mode of operation, that is to say to

impart a varying, oscillating or reversing electromagnetic field emanating from the magnetic field generator 50. In this manner, part of a writing surface 12 can be "erased", without disturbing writings 2 in other surface regions or zones, where the preservation of such writings may be desired. Thus, selective erasure is made possible, without requiring a mechanical device to movably position a magnetic field generator 50 relative to parts of the writing surface normal 12 of the chalkboard 10. In this embodiment, and also in the embodiment of Fig. 4 which also does not require that a separate electromechanical device such as an x-y table be provided, the wire loop or wire loops, (which may also be substituted by one or more solenoids particularly with regard to the embodiment of Fig. 5) which function as the magnetic field generator 50 may be properly affixed relative to the self erasing chalkboard 10, such as may be adhered to, or even be integrated in its construction. In one such nonlimiting embodiment, one or more wire loops can be affixed to, or embedded at the periphery of the margins 11 of the self erasing chalkboard 10 of Fig. 4, and/or at the margins of individual zones "z" as shown in Fig. 5.

It is also perceivable that combinations of the embodiments described with reference to one or more of the foregoing figures may also be provided, and fall within the ambit of the present invention. For example, there may be provided a self-erasing chalkboard which includes the features of both Fig. 4, and Fig. 5 whereby the self-erasing chalkboard 10 could be operated in different modes, that is to say where is desired to rapidly "erase" any writings present over the entirety of the writing surface then the magnetic field generator 50 depicted as the wire loop 70 of Fig. 4 could be energized and thereby activated to act upon the entirety of the writing surface 12. In a second operational mode, only one or more of the separate closed loops 70A, 70B, 70C, 70D, 70E could be activated and operate as magnetic field generators 50 in order to provide erasure of only parts of the writing surface normal 12.

Not dissimilarly electric field generators 50 of the loop or solenoid type, such as described in Fig. 5 can be combined with a further electric field generator, as described and depicted with reference to Figs. 2 and 3 and both types could be used in a single embodiment of a self-erasing chalkboard 10.

The inventors have also observed that the dislodged particles are also poorly buoyant and descend quickly in a downward direction. To facilitate cleanliness use of self-erasing chalkboards 10, optionally but preferably a collection trough 90 is provided as is depicted on Fig. 6. The collection trough 90 may be U- or V-shaped in cross-section, but only requires that it have one or more upper openings which are adapted to receive falling particulates of the dislodged writings 2 which option but preferably are connected to a vacuum 92 which provides a reduced pressure in the region of the trough 90 thereby withdrawing these collected particulates and further transporting them into a collection canister 94. To further facilitate the capture of the dislodged particles, the collection trough may also comprise a magnet, or electromagnet. In certain the vacuum 92 and collection canister 94 may be omitted, and one or more magnets placed within the collection trough 90 may operate to satisfactorily collected dislodged writings.

Fig. 7 illustrates a still further embodiment of a self-erasing chalkboard 10 according to the present invention. In the present embodiment, a series of parallel, spaced apart individual wires 80 (or thin strips 80, or thin plates 80) are positioned beneath and rearwardly of the writing surface 12. Such are current-carrying conductors. The wires 80 may form an integral part of the construction of the self erasing chalkboard 10, or may be affixed to the rear surface 16 (not shown) opposite from the writing surface 12. The wires 80 operate as the magnetic field generator and operate under the control of a controller system 40 via one or more wires or a circuit 41. In operation the controller system 40 functions to control the current in the wires, which in turn controls the generation of a magnetic field in one or more of the individual wires 80, which magnetic field acts to induce physical vibrations in the writings 2 (not shown) as described previously, which writings 2 are dislodged, and thus the writing surface 12 is "erased". Thus, when current passes through one of the wires 80, it becomes a magnetic field generator 50. Preferably when operating, each of the wires 80/magnetic field generators 50 also may also be caused to oscillate, vary or reverse as has been previously described with reference to Fig. 5, e.g., by utilizing an alternating current source, or by controlling the waveform of a direct current passed through the wires 80/magnetic field generator 50

so to introduce a non-steady state mode of operation, that is to say to impart a varying, oscillating or reversing electromagnetic field emanating from the magnetic field generator 50. In this manner, part of a writing surface 12 can be "erased", without disturbing writings 2 in other surface regions or zones, where the preservation of such writings may be desired. Thus, selective erasure is made possible.

With regard to the spaced apart wires 80, while shown to be in a horizontal orientation, such is a non-limiting arrangement and other orientations including vertical, diagonal and even intersecting wires may be provided. The spacing between adjacent wires 80 may vary, or may be consistent therebetween, and such spacing may vary significantly and in part is dictated by the strength of the magnetic field provided by an individual current carrying wire 80 which itself is a magnetic field generator. Usually, adjacent wires 80 which are more closely spaced require less electrical current to provide an effective magnetic field, while more widely spaced apart adjacent wires usually require more electrical current to provide a similarly effective magnetic field. Advantageously the spacing between adjacent wires is between about 0.1 cm to about 10 cm, preferably between about 0.2 cm and about 2.5 cm.

According to a preferred embodiment the direction of the flow of electrical current in adjacent wires 80 is concurrent, but having countercurrent directional flow in adjacent wires 80 is also foreseen.

Fig. 7A depicts schematic, albeit simplified, embodiment of a self-erasing chalkboard according to the present invention, which includes a pair of S-shaped wires 80a, 80b affixed to the rear surface 16 of a self-erasing chalkboard 10. As is visible, the wires 80a, 80b are overlapping in part, and each is one end connected to a transistor "A" or "B", and the second end attached to the second leg of each respective transistor by a conducting wire, 86, 87 as appropriate and as depicted. The operation of the transistors A, B (which may be of any variety, such as PnP, or NpN) is controlled by the controller 40 which may advantageously alternate the passage of current through the respective wires. The control over the current passing through an individual wire as depicted in Fig. 7A

allows for high degree of control over the nature of the magnetic field generated, as when a current passes through the individual wires 80a, or 80b, each operates as a magnetic field generator 50 of its own accord, as has been discussed generally with reference to the parallel wires of Fig. 7. Thus, the provision of the transistors provides for a way to particularly rapidly and controllably pass electrical current through individual wires, and in one mode of operation one of the wires, e.g, wire 80a forms a completed circuit (with a power source, not shown) and has a current passing through it, while in a physically adjacent wire, e.g, wire 80b does not as the circuit is open. The controller 40 may rapidly then open the circuit which includes wire 80a, and close the circuit of which wire 80b forms a part, which then forms some completed circuit (with a power source, not shown) and has a separate current passing through it which generates a magnetic field. This behavior can be rapidly alternated, and particularly where adjacent wires are within near physical proximity to each other, a varying, or oscillating magnetic field can be generated, and such could induce suitable complementary vibratory effects in the magnetoresponse materials forming part of the writings present on the self-erasing blackboard 10, and dislodge them from the writing surface.

Fig. 7B illustrates an a simplified embodiment of the self-erasing chalkboard 10 of Fig. 7, which also includes circuitry components as described in Fig. 7A. In this simplified embodiment of Fig. 7B, several spaced apart, straight wires 80c 80d and 80e are present on the rear surface 16 of a self-erasing chalkboard 10. Akin to the embodiment of Fig. 7A, wire 80c forms a circuit via wire 95 with a power supply W, and a transistor C, wire 80d forms a separate circuit via wire 96 with power supply W and transistor D, and wire 80e forms a further separate circuit via wire 97 with power supply W and transistor E. Each of transistors C, D and E are operatively controlled by the controller 40. As discussed with reference to Fig. 7A, the presence or absence of electrical current within any one of the parallel, spaced apart wires 80c, 80d and 80e is controlled via the transistors C, D, E and the controller 40. The controller may operate to generate a varying, or reversing magnetic field via control of the individual transistors C, D, E. As is further depicted in Fig. 7B, the power supply W is also operatively connected to the controller 40, which imparts control their over. In this manner, the controller 40 may also

alternate the polarity and hence the direction of current passing through any of the circuits and the individual space apart wires 80c, 80d and 80e.

5 An alternative embodiment of the construction of a self-erasing blackboard 10 according to the invention is discussed further with reference to Fig. 8. As can be seen Fig. 8 is similar in almost all respects to that of Fig. 1, but additionally includes a laminar sheet , or layer 15 of an amplifying material. Such may be placed adjacent to the substrate 14, and opposite the writing surface. It is also foreseen that in certain embodiments, the amplifying material 15 of high magnetic permeability may take the place of the substrate
10 14 if a writing surface 12 can be formed upon a surface of the amplifying material. The amplifying material is one which enhances the magnetic field generated by a magnetic field generator 50 adjacent thereto, such that the magnetic field extending there from and to the writing surface 12 is amplified or enhanced. In such a manner, the operating efficacy of a magnetic field generator 15 can be enhanced, and approved, thereby
15 lowering overall required power requirements necessary to operate the self-erasing blackboard 10.

Non-limiting examples of amplifying materials of high magnetic permeability include: include one or more of: amorphous metal alloys such as METGLAS (e.g. METGLAS
20 2714A), iron, preferably highly pure annealed iron, cobalt-iron alloys, NANOPERM, “Mu-Metal”, PERMALLOY, ferritic stainless steel (preferably also annealed), martensitic stainless steel (preferably also annealed), magnesium-zinc alloys, nickel-zinc alloys, nickel, and alloys of any one or more of the above.

25 A further aspect of the invention is a “kit”, which includes all elements necessary to form a self-erasing blackboard 10 as described herein, and as depicted in one or more the foregoing figures, which however omits the writing surface 12 and substrate 14, viz, the parts of a conventional blackboard. It is easily foreseen that the required elements or parts necessary to provide any of the embodiments of the self-raising blackboard is described
30 herein, can be suitably packaged and provided for later assembly whereby these required elements or parts are used to retrofit a currently existing installation having a

conventional blackboard. One such embodiment is depicted on Fig. 9 which depicts a flexible film 102 having adhered thereto, forming a part thereof a series of parallel, spaced apart wires 80 which, are operatively connected to a suitable controller 40. Such provides one embodiment of a “kit”, based upon the embodiment depicted on figures 7, 7A and/or 7B. The film 102 may include an adhesive on all or parts of a surface thereof, (not shown) such that the film 102 can be unrolled, and adhered directly to a surface of a conventional blackboard. Thereafter, once installed, the controller 40 can be used to operate the flexible film 102 and the array of parallel spaced apart wires 80, thus converting or retrofitting the otherwise prior conventional blackboard to a self-erasing blackboard in accordance with the present invention.

While not depicted, is to be clearly understood that a similar “kit” can be formed of the essential elements as depicted in any prior discussed embodiment of the present invention, or as may be otherwise made in accordance with the inventive teaching’s recited herein.

The foregoing description and accompanying figures are to be understood as describing certain preferred or otherwise advantageous embodiments, but that the scope of the present invention is only limited by the following claims.

Claims:

1. A self-erasing chalkboard having a writing surface to which may be applied a writing implement and/or composition which imparts visible but removable markings to the writing surface, and a magnetic field generator rearwardly of the writing surface, which, when operated, provides a magnetic field which dislodges or “erases” removable markings present on the writing surface, without requiring any physical contact or wiping of the writing surface.
2. A self-erasing chalkboard according to claim 1, wherein the magnetic field generator emits an oscillating or reversing magnetic field.
3. A self-erasing chalkboard according to claim 1 or 2, wherein the magnetic field generator includes a permanent magnet.
4. A self-erasing chalkboard according to claim 1 or 2, wherein the magnetic field generator includes an electromagnet, electrical coil or loop or current-carrying wire.
5. A self-erasing chalkboard according to claim 4, wherein the magnetic field generator includes parallel spaced apart current conductors, such as wires or plates.
6. A self-erasing chalkboard according to any one of claims 1 – 5, which further includes a magnetic shielding element or apparatus which operates to diminish or block a part of the magnetic field which emanates from the magnetic field generator from penetrating the self-erasing chalkboard in (at least) the direction of the writing surface.
7. A self-erasing chalkboard according to any of claims 1 – 6, which additionally includes an amplifying material of high magnetic interposed between the writing surface and the magnetic field generator.

8. A kit or assemblage of parts, which comprises a magnetic field generator and a mounting device which facilitates in the mounting or relative positioning of the magnetic field generator to a chalkboard, and when mounted provides a self-erasing chalkboard according to any of claims 1 – 7.

5

9. A writing implement adapted for use upon the self-erasing chalkboard according to any of claims 1 – 8, which comprises the following constituents:

10 – 90%wt. one or more inorganic constituents, e.g., mineral calcites, mineral carbonates;

10 5 – 95%wt. magnetoresponsive material;

0.5 - 40% colorant;

5 - 45%wt. binding agent, and/or gypsum, lime, cement;

0 – 20%wt. of further constituents.

15 10. A writing implement according to claim 10, wherein the writing implement is formed in a process wherein, during the solidification the constituents are exposed to an orienting magnetic field.

20

An eighth aspect of the invention relates to writing implements and/or compositions
25 useful with the self-erasing chalkboard described with reference to any of the prior aspects of the invention, or otherwise disclosed within this patent specification.

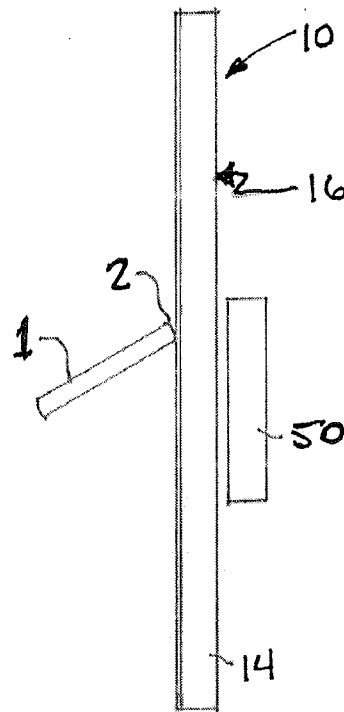


Fig. 1

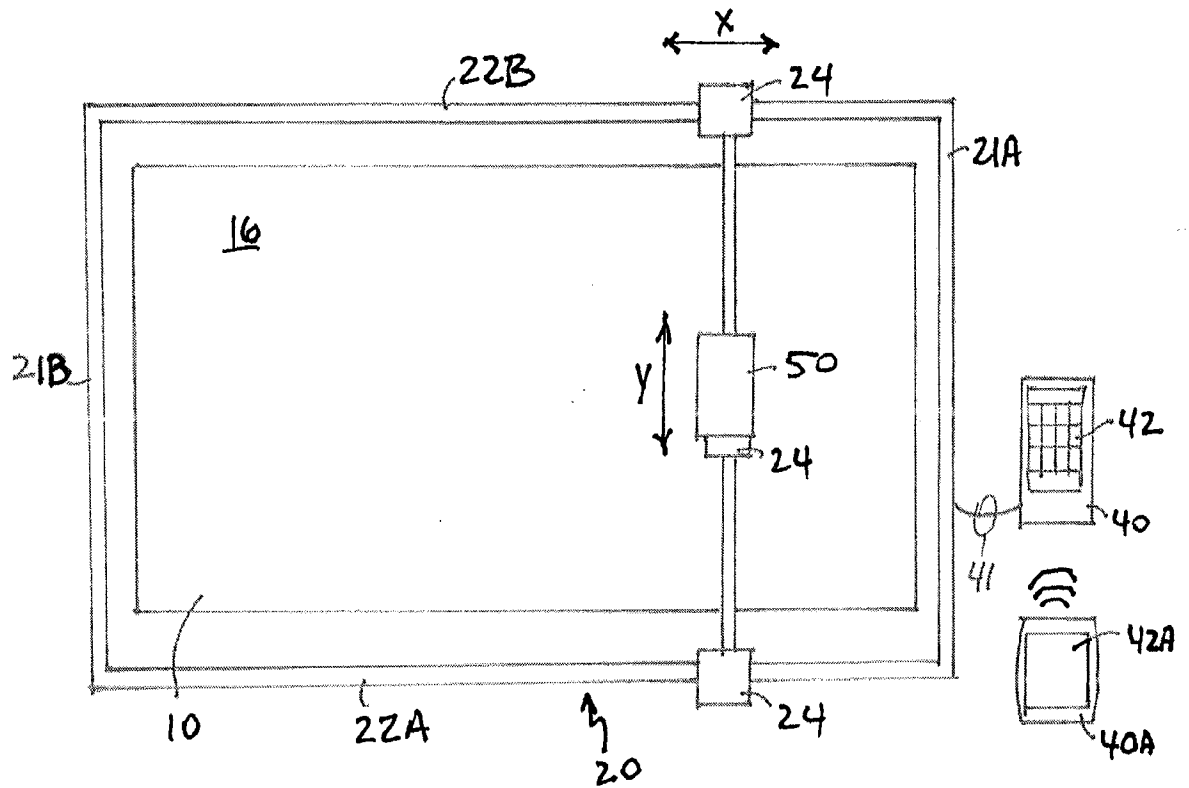


Fig. 2

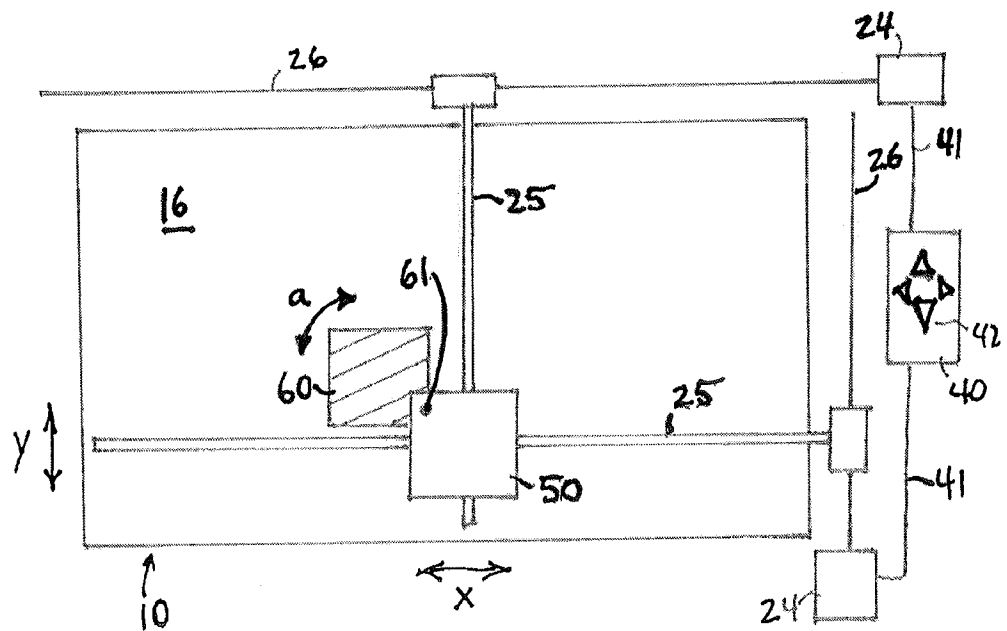


Fig. 3

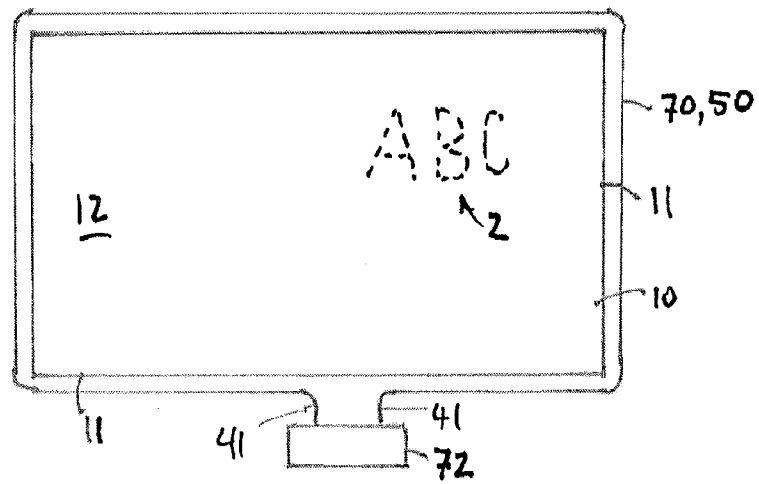


Fig. 4

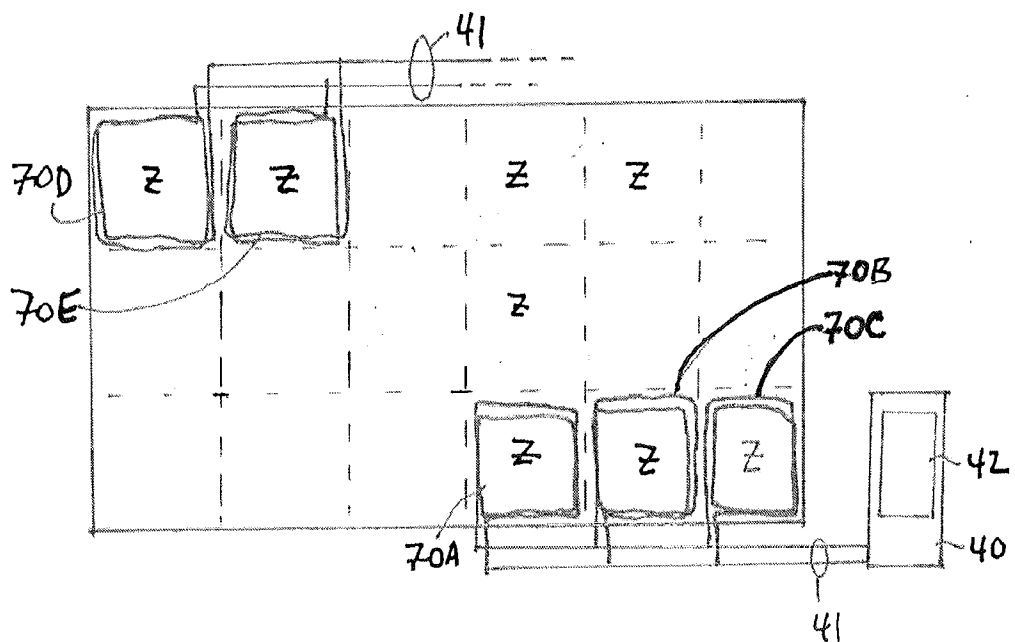


Fig. 5

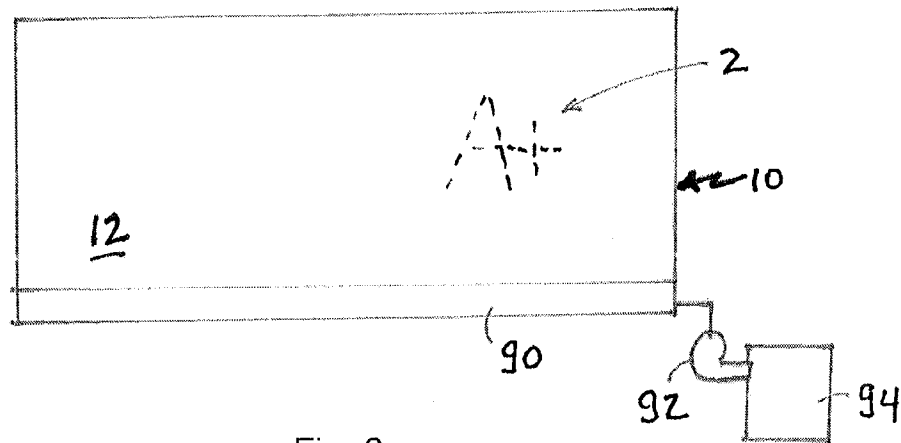


Fig. 6

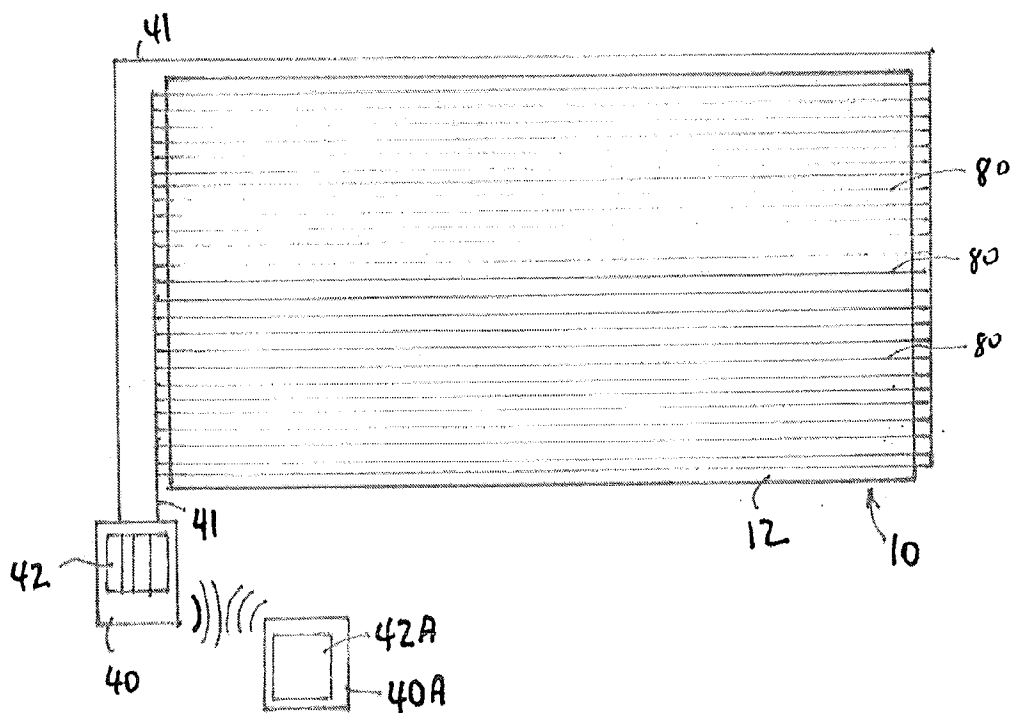


Fig. 7

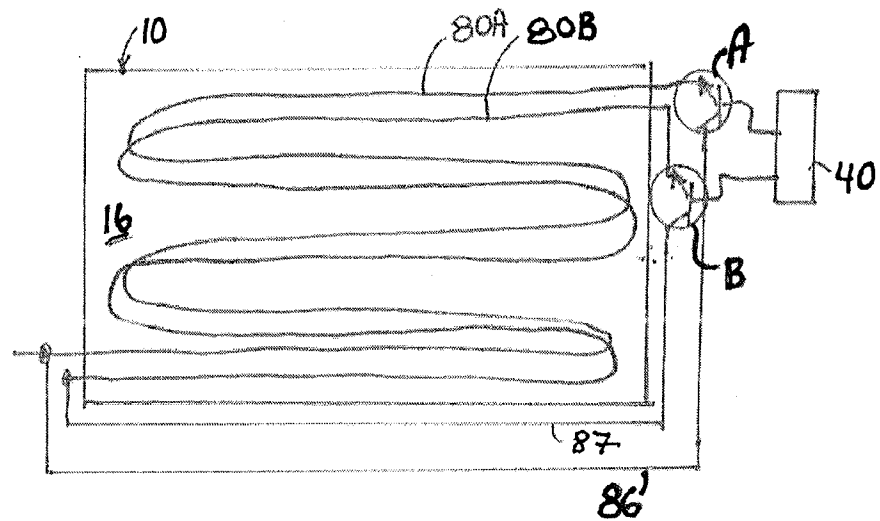


Fig. 7A

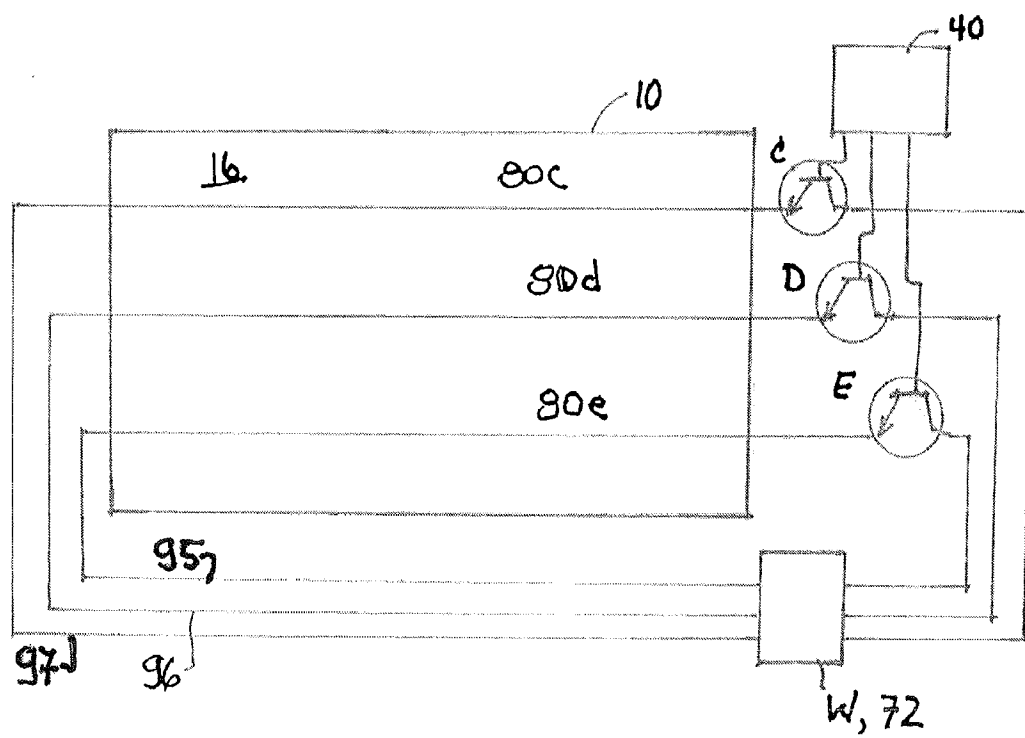


Fig. 7B

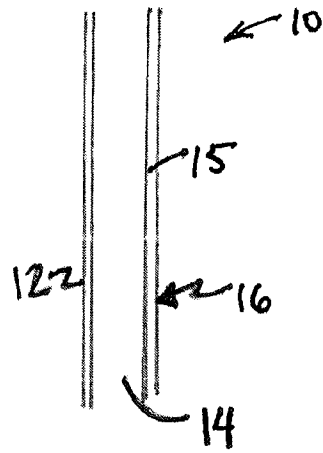


Fig. 8

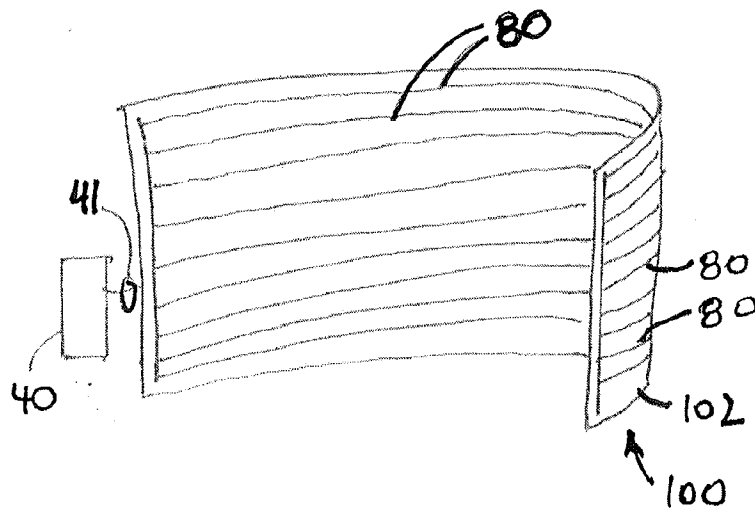


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/068329

A. CLASSIFICATION OF SUBJECT MATTER

INV. B43K19/00 B43L1/00 B43L1/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B43L B43K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2015/025491 A1 (SONY CORP [JP]) 26 February 2015 (2015-02-26) page 5, paragraph 15 - page 15, paragraph 45; figures 1-9C -----	1-10
X	US 5 607 312 A (ZHOU JIE-ZHANG [US]) 4 March 1997 (1997-03-04) the whole document -----	1,8,9
X	US 6 948 210 B1 (SHAH CHIRAG [US]) 27 September 2005 (2005-09-27) the whole document -----	1,8,9
X	US 3 731 335 A (CHRISP B) 8 May 1973 (1973-05-08) the whole document -----	1,8,9
	-/--	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

6 March 2017

Date of mailing of the international search report

20/03/2017

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/068329

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8 191 197 B1 (HUNSUCKER MICHAEL J [US]) 5 June 2012 (2012-06-05) the whole document -----	1,8,9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/068329

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2015025491	A1	26-02-2015	CN 105474079 A 06-04-2016
			EP 3036583 A1 29-06-2016
			JP 2015041080 A 02-03-2015
			TW 201508408 A 01-03-2015
			US 2016202507 A1 14-07-2016
			WO 2015025491 A1 26-02-2015
US 5607312	A	04-03-1997	CN 2177602 Y 21-09-1994
			US 5607312 A 04-03-1997
US 6948210	B1	27-09-2005	NONE
US 3731335	A	08-05-1973	NONE
US 8191197	B1	05-06-2012	NONE