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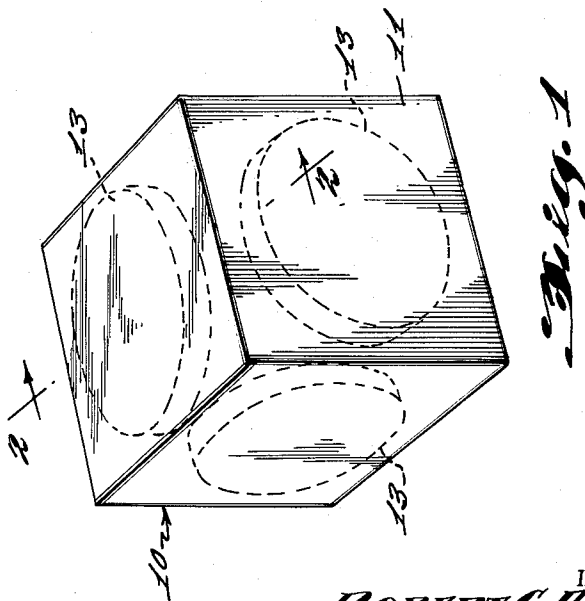
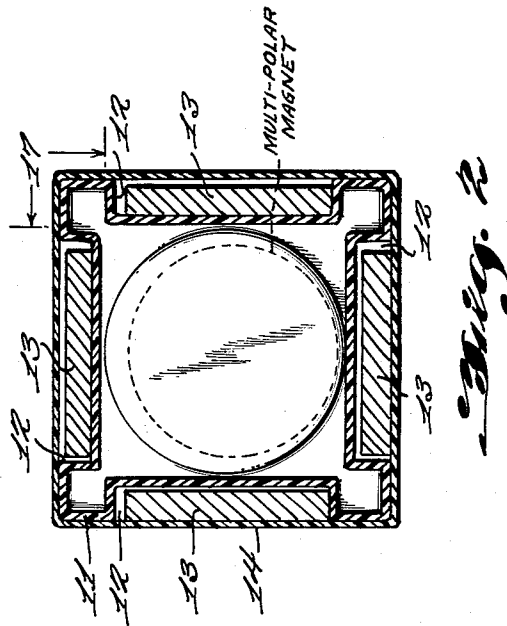
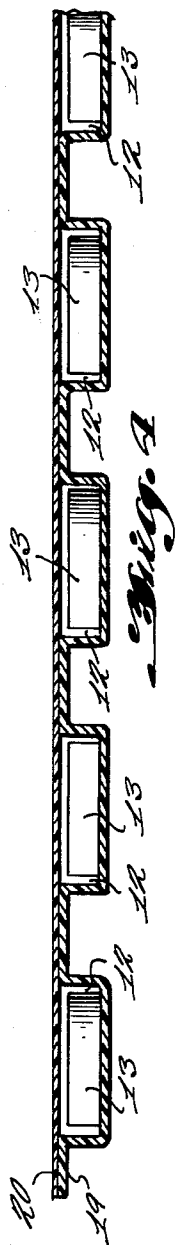
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3,254,440

MAGNETIC TOY BUILDING BLOCKS

Filed May 21, 1962

2 Sheets-Sheet 1



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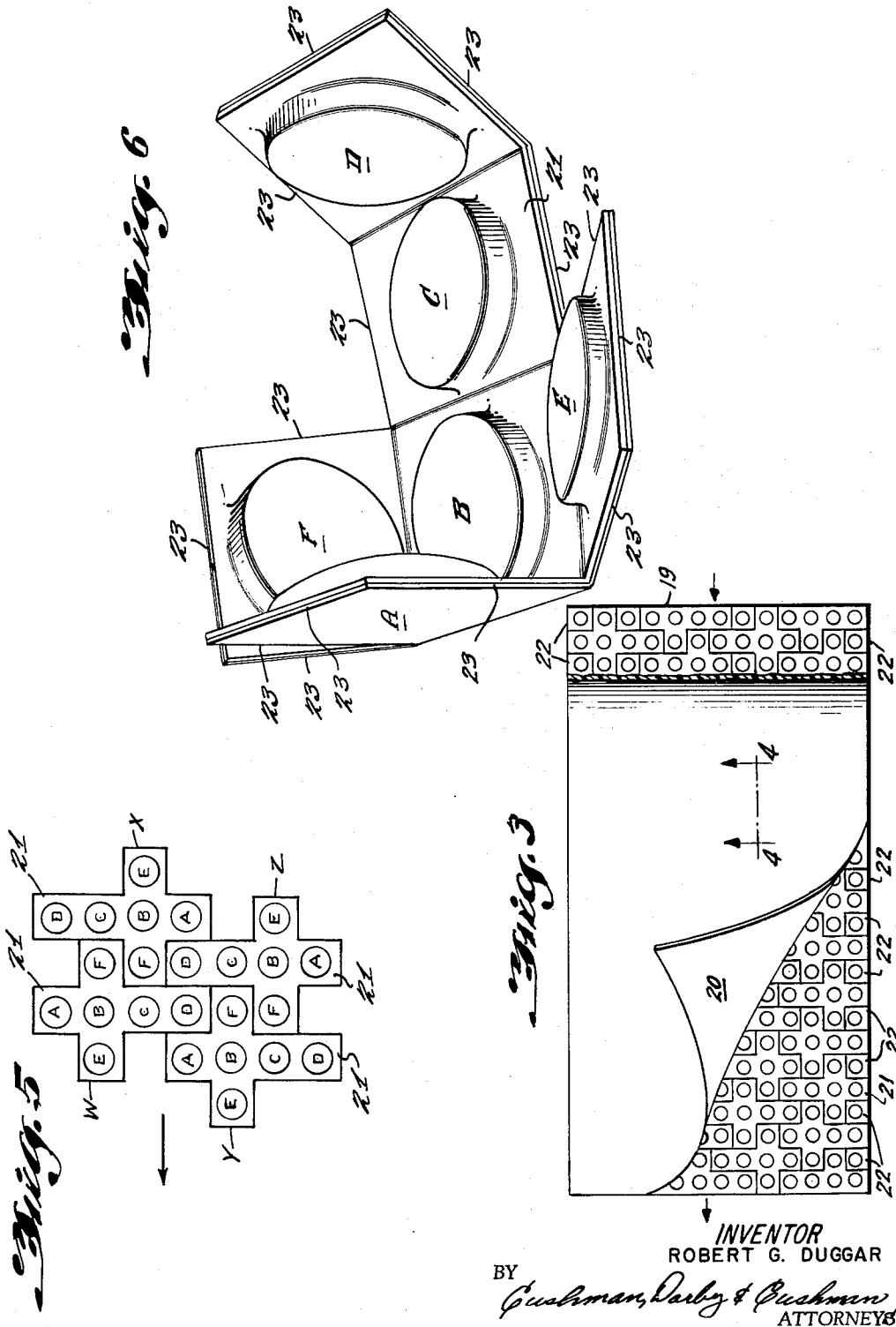
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2 Sheets-Sheet 2



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MAGNETIC TOY BUILDING BLOCKS
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This invention relates to building blocks and more particularly to hollow building blocks whose walls contain and support rotatable permanent magnets, said blocks being an improvement over those disclosed in my earlier Patent No. 2,939,243, granted June 7, 1960.

Blocks of type shown in the patent referred to were molded or cast in two sections, one section being all of the sides of the block except one, and the other being the remaining side. In a separate operation a rotatable magnet was mounted on a headed pin and the pin was secured to the inner face of one side of a block section. In the same manner magnets were mounted adjacent the inner faces of the remaining sides. The block was then completed by bonding the two block sections together.

The walls of a block so constructed had to be of a thickness greater than that necessary to cause the block to be rugged, and retain its shape during rough handling by the amount necessary to provide an adequately strong securing base for the magnet mounting pins. The wall thickness necessary not only dictated a high product cost but more important, it also substantially reduced the field strength of the magnets as measured outside the block wall, and therefore diminished the usefulness of blocks when they were used in association with similar blocks as a toy building block set.

It is therefore an object of this invention to provide hollow building blocks having freely rotatable permanent magnets contained within the walls thereof without the necessity of pin mountings for the magnets.

It is a further objects of this invention to provide hollow building blocks, the walls of which are formed from two superimposed sheets of plastic material, said superimposed sheets defining pockets which contain and support freely rotatable permanent magnets.

It is another object of this invention to provide hollow building blocks having both thick inner walls and thin outer walls, and having permanent magnets mounted for rotation in pockets defined by the thin outer walls and the thick inner walls of the block.

It is a further object of this invention to provide hollow building blocks of the type described where the magnetic fields in attracting magnets of other magnet containing blocks do not have to pass through the thick walls which impart strength to the blocks, but only through thin walls which constitute the outer surfaces of the hollow building blocks.

Still another object of the present invention is to provide hollow building blocks of the type described having a wall configuration which supplements the wall thickness in furnishing a rugged block construction.

These and other objects of this invention will be most clearly understood from the following detailed description, the appended claims and the accompanying drawings in which:

FIGURE 1 is a perspective view of a hollow building block embodying my invention;

FIGURE 2 is a sectional view through line 2—2 of FIGURE 1;

FIGURE 3 is a plan view of the magnet containing composite sheet material before it has been sheared into block blanks. A corner of one of the sheets is partially folded back to show the magnets and a preferred block blank pattern;

FIGURE 4 is a fragmentary sectional view through line 4—4 of FIGURE 3;

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FIGURE 5 is a plan view of the basic repeatable unit of the block blank pattern shown in FIGURE 3; and

FIGURE 6 is a perspective view of a block of my invention partially folded into block form.

Referring now to the drawings, a hollow building block embodying my invention is generally indicated at 10. It is comprised of a relatively thick walled inner block 11, having depressions 12 formed therein, a permanent magnet 13 positioned without securement in each depression, and a relatively thin, outer block 14 formed from plastic sheet material which is secured to the undepressed areas of the outer surface of the inner block, covering the magnets 13 and containing them in the depressions 12.

The hollow building blocks of my invention are generally used in conjunction with like blocks as a construction or building block set. When used together the blocks are removably secured to each other through the attraction of the magnets which are contained within the several block walls.

It is a well known fact that the thicker the wall a magnet must attract through, the weaker will be its attraction through the wall. The magnets in the blocks of my invention are not positioned so that they must send their magnetic fields through the thick, strength-giving walls of the blocks as is the case with the blocks of former constructions, but the magnets in blocks of my invention are supported outside the thick strength-giving walls of the blocks in pockets defined by depressions in the thick walls and thin outer block walls that form the protective, decorative exterior of the blocks. The thin outer block walls being relatively permeable to magnetic fields because of their thinness.

By supporting the magnets used in the blocks of my invention in pockets rather than mounting each of the magnets on a headed pin, as is taught by the prior art, a great saving in manufacturing cost is obtained. The saving in manufacturing cost is partially due to the fact that whereas blocks of the type disclosed in my prior patent necessarily had their magnets mounted manually in a separate manufacturing step, the blocks of my present invention may be fabricated on a continuous, automatic production line for continuous sheets of plastic material.

In a preferred embodiment of my invention the inner and outer blocks are each formed from plastic sheet material such as styrene or cellulose acetate. The plastic sheet material which comprises the inner and outer blocks may be opaque, translucent or transparent. In the latter alternative the positions of the magnets may be observed. Any indicia may be applied to the sheet material which comprises the inner and outer blocks either before or after the sheet material is formed into blocks.

The inner block 11 imparts strength, dimensional stability and ruggedness to the unit through the thickness and variable section modulus of its walls. The walls of the inner block 11 are preferably formed from a sheet having a thickness of approximately 0.030 inch.

The depressions 12 in the inner block are preferably vacuum formed in the thicker sheet of plastic material before the block is assembled in a manner hereinafter described.

Each magnet 13 supported by a depression 12 has a diameter slightly less than the width of the depression and a thickness slightly less than the depth of the depression so that it may rotate freely within the depression. The magnets 13 are preferably ceramic magnets which are formed by incorporating minute particles of magnetizable material in a ceramic matrix, having the ability to be magnetized so that many poles are formed in each magnet. I prefer to use multipoled ceramic magnets in the hollow

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building blocks of my invention because a magnet of this type need rotate through only a small angle in order to be in a position of attraction with respect to another magnet.

The magnets used are preferably disk shaped or ring shaped although any shape or type that would allow the magnets to rotate within the depressions is suitable.

The outer block 14 is formed from a sheet of plastic material having a thickness of approximately 0.015 inch. A hollow block completely constructed of plastic sheet material of the thickness of the outer block would not be so rugged as to be a practical toy for rough use because it would not have sufficient dimensional stability, however, in a hollow building block of my invention the wall thickness of the inner block and the variable section modulus created by the depressions in the walls of the inner block impart strength to the entire hollow block structure and the main factor in determining the minimum thickness of the outer sheet which comprises the outer block is its resistance to being punctured or torn during reasonable use of the block. The outer block 14 is not primarily a strength-imparting member but is useful in containing the magnets 13 within the depressions 12 in the inner block 11 and is most important in providing a relatively thin surface through which the magnets can attract those contained between the inner and outer walls of similar blocks.

In operation, as two blocks of my invention are brought closer to each other, the magnet in each block which is contained by the block face nearest the other magnet containing block rotates to a position of opposite polarity with respect to the other magnet, i.e., to a position of attraction. As a result the two blocks, upon touching, are removably secured to each other. Alternately, when the magnet contained by a block face is moved toward a body of ferrous material that is not a magnet, the magnet contained by the block face attracts the body, but does not rotate.

In a preferred continuous process for forming hollow building blocks of my invention pellets of styrene, cellulose acetate or any other suitable plastic material, of any color are blended in a mixer to a desired homogeneity, then rolled or equivalently formed into a continuous sheet 19 approximately 0.030 inch in thickness. The edges of the sheet are trimmed so that they are parallel and the sheet is of a constant width. The scrap that is trimmed from the edges of the sheet is returned to the mixer. The sheet is conveyed to a continuous vacuum forming machine which has a plurality of vacuum forming dies mounted in rows that are parallel to the width of the plastic sheet and in columns that are parallel to the direction of travel of the plastic sheet. The rows of vacuum forming dies are mounted on a cylindrical drum that has its longitudinal axis parallel to the width of the plastic sheet and rotates on this axis in the same direction as the direction of travel of the plastic sheet, and at a speed adjusted so that the outermost portion of each vacuum forming die has a tangential velocity equal to the speed of the advancing plastic sheet.

The distance between the centers of two vacuum forming dies is spaced longitudinally in the same row on the drum, is substantially the same as the distance 17 between the depressions 12 of any two adjacent faces of any cube shaped hollow building block, said distance being measured across the faces of the block. As the sheet 19 is conveyed past the vacuum forming machine a row of vacuum forming heads comes into contact with the sheet and draws depressions therein which conform to the shape of the working surfaces of the vacuum forming dies. As the sheet 19 is conveyed further, the row of vacuum forming dies which has just formed depressions in the sheet rotates away from the moving sheet, and the next row of vacuum forming dies circumferentially spaced on the drum in a direction opposite the direction of the rotation of the drum rotates into contact with the moving sheet and draws depressions therein. The distance between the centers of

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adjacent vacuum forming dies in a column on the vacuum forming machine drum is such that the depressions formed by successive vacuum forming dies in a column is substantially equal to the distance between the centers of adjacent depressions in the traveling sheet which were formed by adjacent vacuum forming dies spaced longitudinally in the same row on the drum.

After the continuously traveling plastic sheet 19 has had depressions formed in it, it is conveyed to an area where permanent magnets 13 that are slightly narrower in their broadest dimension than the width of a depression and slightly thinner than the depth of a depression are simply deposited, either manually or by a suitable dispensing machine, in each depression, one of said magnets being deposited in each of said depressions. In this process the sheet may continue to advance as the magnets are placed in the depressions therein.

Another sheet of the same or another plastic material 20 is rolled in the same manner as the first, but thinner than the first to a thickness of approximately 0.015 inch. The edges of this sheet are trimmed so that this thinner substantially planar continuous sheet 20 is of a width substantially equal to the width of the depression containing thicker sheet 19. The thinner sheet is conveyed above, in the same direction as and at the same speed as the thicker sheet. At a point on the assembly line just after the magnets 13 have been deposited in the depressions in the thicker sheet, the thinner sheet 19 is brought into contact with the thicker sheet 20, and heat sealed or otherwise suitably secured to the surface of the thicker sheet in the area between the depressions.

The now composite sheet, as shown in FIGURES 3 and 4, having magnets contained within the pockets defined by the depressions in the thicker sheet, and the thin covering sheet which is secured to the thicker sheet is conveyed to a shear. The composite sheet is cut by the shear into block blanks 21 having the configuration that will cause the loss of the smallest amount of sheet area. Where the block blank desired is one that may be assembled to produce a cube shaped hollow building block, I have found that the most efficient block blank with respect to material loss and ease of assembly is one having four (A, B, C, D) of the six block sides attached to one other in a single row and the remaining two sides (E, F) attached one at each edge of the second block face from one end of the row of four. The block blank so formed resembles a cross.

Four cube building block blanks constitute a repeatable pattern in the most efficient configuration of blanks on a sheet. One such repeatable unit is shown in FIGURE 5 where the faces of each blank have been lettered A, B, C, D, E, F for purpose of illustration, each face having a letter corresponding to the same face in each other block. The arrow shows the direction of travel of the sheet material from which the blanks are cut. Each blank of the repeatable unit is cut from the plastic sheet material so that its longitudinal axis is parallel to the transverse dimension of the plastic sheet material. Each block blank that succeeds another on the sheet is inverted with respect to the one that precedes it WX, YZ and overlaps the area of an imaginary rectangle circumscribing each blank by one face of each block blank on the left side of the sheet YZ as the sheet advances is displaced in the direction of movement of the sheet by one row of faces from the blank to its immediate right WX as the sheet advances. Each former blank has the same orientation on the sheet as each latter blank (W and Y, X and Z), and each blank overlaps the area of an imaginary rectangle circumscribing the blank adjacent to it in the direction transverse to the travel of this sheet by faces A and D of each blank. This pattern of four blanks is the most efficient configuration with respect to area lost as waste. It is repeated both longitudinally and transversely on the sheet as shown in FIGURE 3.

In the most efficient configuration of cube building

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block blanks on the composite sheet as shown in FIGURE 3 only the area 22 equivalent to one block face in each row of block faces on the composite sheet lies outside a block blank and is waste. In adjacent rows of block faces the area 22 that is waste is located at alternate edges of the composite sheet. As the waste is severed by the shear it is returned for reprocessing.

As each block blank 21 is severed from the composite sheet it is folded, either manually or by suitable machinery, to form a hollow block 10. The edges 23 of each block that were formed from edges of each block blank are heat sealed or equivalently adhered to each other producing a hollow building block whose contained magnets are supported by a strong inner block wall, said magnets being free to rotate within the depressions and extend their magnetic fields through the thin outer wall of the block substantially undiminished.

While a cube shaped hollow block has been shown for the purpose of illustration, it is within the contemplation of my invention to produce blocks of other shapes as well. Also the invention is not restricted to producing blocks with only a single magnet contained in a single pocket in each block face, but may, as in the case of oblong blocks, include the use of more than one magnet containing pocket in each block face.

It should be realized that the process for assembling the building blocks set forth hereinbefore is merely exemplary and is susceptible of modification or replacement as a whole or in part by other process steps.

While I have set forth a specific embodiment for the purpose of illustrating the principles of my invention, it should be understood that many changes may be made in the specific embodiment without departing from the principles thereof. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

What is claimed is:

1. In a hollow polygonal block defined by a plurality of walls which are joined to one another at the peripheral edges of said walls so that each wall constitutes a face of the block, the improvement wherein at least one wall of said walls comprises: a first sheet of non-magnetic material having first and second oppositely facing surfaces, means defining a relatively deep, with respect to the thickness of said sheet, depression in said sheet; said depression being of generally cylindrical shape and having the longitudinal axis thereof normal to said surfaces; a second, substantially planar sheet of non-magnetic material secured by a first surface thereof to said first surface of said first sheet and overlying said depression; and a magnet loosely disposed in said depression, said magnet being retained in said depression by said second sheet, said magnet having a thickness substantially smaller than the distance between the first surfaces of said first and second sheets and an extent in the direction perpendicular to the longitudinal axis of said depression smaller than the diameter of said depression whereby said magnet is rotatable in said depression.

2. A hollow block of the type described comprising an inner hollow block having a plurality of walls with outer faces, said faces having depressions therein, a plurality of

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matching permanent magnets, one in each of said depressions, and means securing said magnets in their respective depressions but allowing free rotation of said magnets therein, said means including a substantially planar outer covering, said covering being thin relative to said inner hollow block walls, said coverings being secured to each said block face peripherally of said depressions and covering said magnets, said coverings defining pockets with the depressions in said inner hollow block, said walls and coverings being non-magnetic and the relation between the thicknesses of said walls and coverings constituting means whereby the building block has structural strength materially exceeding that of a similar building block having walls as thin as said coverings and whereby the magnets exert through said coverings a force materially exceeding that exerted through said inner walls.

3. A hollow block according to claim 2 wherein the permanent magnets are multipolar ceramic magnets having a generally cylindrically curved outer periphery.

4. A set of hollow building blocks of the type described, each comprising a thick walled inner hollow block of non-magnetic material having a plurality of faces, means defining a depression in each of said faces, a permanent magnet supported for rotation in each of said depressions and a relatively thin walled outer block, with respect to the thick walled inner hollow block, of non-magnetic material secured to the undepressed areas of said inner block thereby surrounding said inner block and containing said magnets within said depressions so that when any of said faces of one of said building blocks is moved into engagement with any of said faces of any other of said building blocks at least one of the associated magnets is free to rotate into a position of polar attraction with respect to the other of the associated magnets to thereby retain the engaged of said faces of said blocks together by magnetic attraction.

5. A set of hollow building blocks as in claim 4 wherein the associated magnets are multipolar magnets such that one of the associated magnets need rotate through only a small angle to be in a position of polar attraction with respect to the other of the associated magnets.

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