

March 2, 1971

H. HALLMANN

3,566,637

MAGNETIC LOCK

Original Filed Aug. 1, 1966

2 Sheets-Sheet 1

FIG. 1a

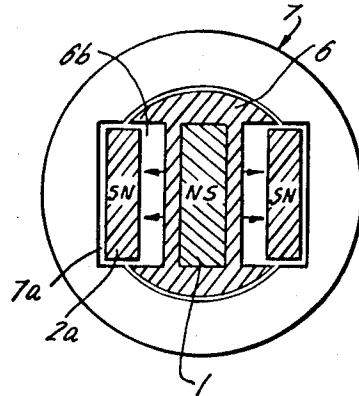
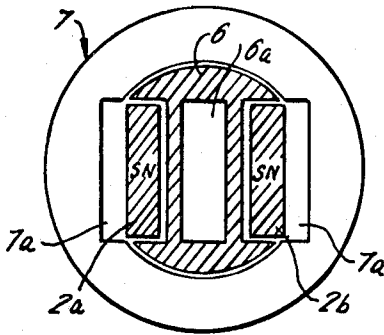


FIG. 1b

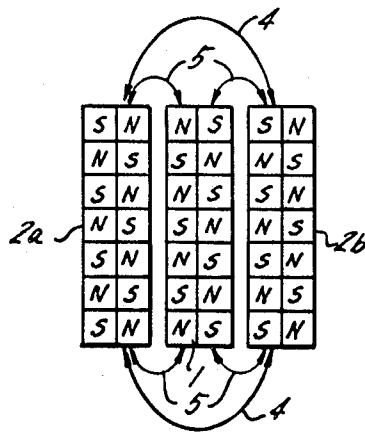


FIG. 2

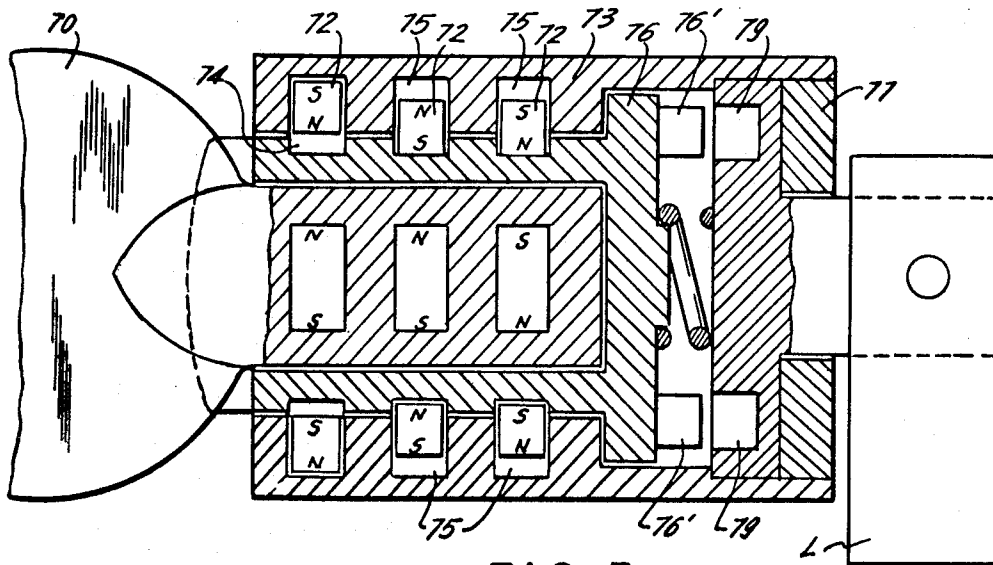


FIG. 5

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MAGNETIC LOCK

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2 Sheets-Sheet 2

FIG. 3b

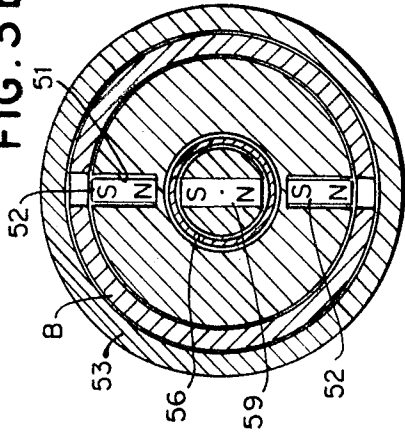
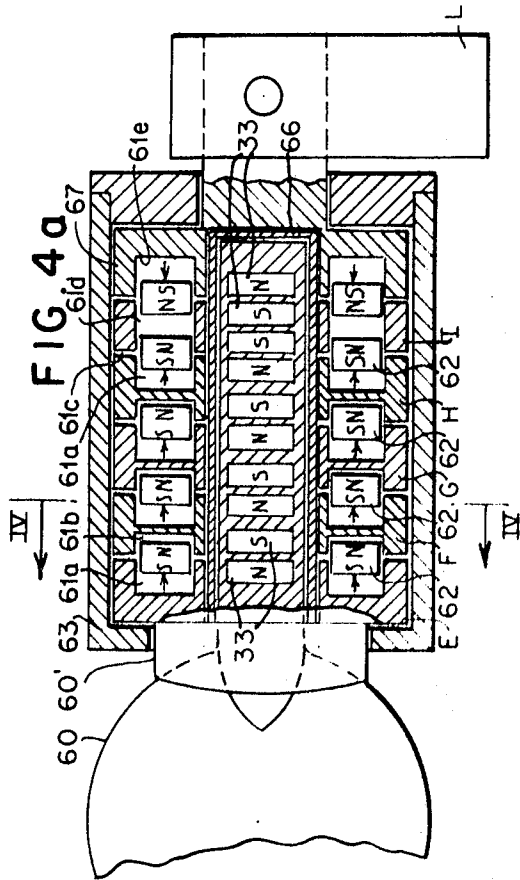
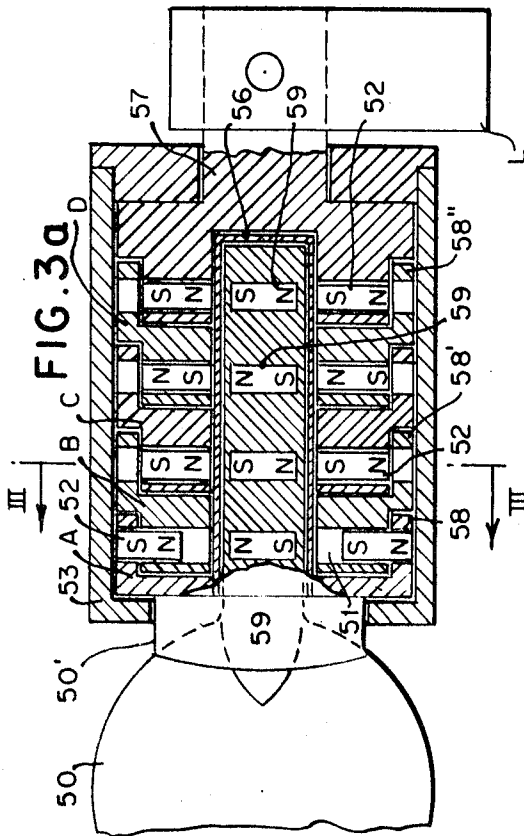
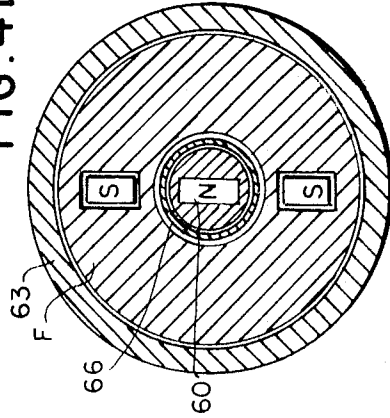


FIG. 4b



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MAGNETIC LOCK

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Original application Aug. 1, 1966, Ser. No. 569,212, now Patent No. 3,495,425. Divided and this application Oct. 17, 1969, Ser. No. 867,186

Claims priority, application Germany, July 31, 1965, H 56,738; Feb. 3, 1966, H 58,460

Int. Cl. E05b 47/00

U.S. Cl. 70—276

20 Claims

ABSTRACT OF THE DISCLOSURE

A housing retains a coupling cylinder, to which a bail or locking element is attached, and a key cylinder, the key cylinder being freely movable within the coupling cylinder in the absence of a key. The key and coupling cylinders are formed with at least a pair of matching chambers receiving magnetic elements, one of the chambers being large enough to wholly accommodate the magnetic element so that the key cylinder may spin freely when the key is absent, or of the wrong combination. The magnetic properties of the proper key cause the elements to move for example by repulsion, into a position spanning the chambers of key cylinder and coupling cylinder to couple the key through the coupling cylinder to the locking element so that operating forces can be transmitted from key to locking element only upon presence of the proper key.

This application is a division of application U.S. Ser. 569, 212, filed Aug. 1, 1966, now U.S. Pat. 3,495,425; for cross reference see application Ser. No. 867,272, filed Oct. 17, 1969.

The present invention relates to a magnetic lock and more particularly to a cylinder lock containing therein movable magnetic elements.

Magnetic locks have previously been proposed in which the locking tumblers consist of magnetic pins, movable in radial bores within a housing and a key, or inner cylinder. In the locking position, these pins engage both parts and are retained in their locking position by further magnets, which close off the bores of the housing towards the outside. In order to close such a lock, a key is inserted into the inner cylinder which is arranged to be permanently magnetized, or have permanent magnets supplied thereto. The location of these permanent magnets is such that they are opposite to the locking pins in order to attract the pins into the unlocked position. This requires that the force of the magnets closing off the housing must be overcome by the magnetic force of the key, in turn requiring substantial strength on the key magnets. Further, it is possible to break these pins when using the wrong key, or a screwdriver for example, since the magnetic material usually is brittle.

It is an object of the present invention to provide a magnetic lock which is simple to build, resistant against destruction or forcing, and can be used with an easily magnetized key.

SUBJECT MATTER OF THE INVENTION

Briefly, in accordance with the present invention, a magnetic lock is provided which consists of a rotatable key cylinder located within a housing cylinder, separated from the housing by an intermediate cylinder to which the locking bolt is attached. At least one magnetic element, and preferably a plurality of magnetic elements, are movable between a locking and an unlocking position to couple the intermediate cylinder to the key. When the key is removed the intermediate cylinder and the key cylinder are uncoupled so that the key cylinder may rotate freely. Coupling between the intermediate cylinder and the key cylinder is effected by the magnetic elements. These elements are preferably a single body of magnetic material having impressed thereon different zones of magnetization. The zones of magnetization are arranged to match zones of magnetization on the key. In some embodiments the polarity of adjacent zones on the magnetic element and on the key will be similar, so that the magnetic elements are repelled. In the other embodiments, the zones are dissimilar so that the magnetic elements will be attracted. The magnetic elements themselves can move within the lock in chambers, cut into at least two of the three cylinders in the lock; the housing cylinder, the key (or inner) cylinder, and the coupling (or intermediate) cylinder. The chamber (or chambers, if provided) in one of the cylinders is large enough to accommodate the entire magnetic element—the chamber in the other, or matching cylinder, is of smaller size. When in the freely rotatable (i.e. uncoupled cylinders), or locked position, these elements are all contained within the chamber, or chambers of one cylinder; when in the coupled position in which the key operates the bolt of the lock, the elements project from one chamber into the other and interconnect the two adjacent cylinders together.

If there should be non-coincidence of the predetermined pattern of zones of magnetization of the key with the pattern of magnetization of the magnetic elements—or total absence of the key which is the equivalent of non-coincidence—then the key cylinder will be movable freely without permitting engagement of the key cylinder to the coupling cylinder, and thus to the locking elements which operate the lock bolt.

The magnetic elements may be slidable axially of the cylinder, radially of the cylinder, directly engage the intermediate or coupling cylinder, or engage additional coupling rings. Various internal arrangement of the lock is possible.

The principle of the present invention may be applied not only to cylinder locks, but also to other locks, such as for example sliding locks, and the term "cylinder" as used herein is intended to cover not only a rotatable unit, but also relatively slidable units having a shape other than round. Ordinarily, the cylinders will be co-axial and rotate one within the other; the cylinders may, however, also be arranged to be axially slidable. And while the key would ordinarily be inserted within the cylinder along the axis thereof, the lock can also be arranged such that the magnetic field of the key influences the locking elements from a different position.

The invention will be described with reference to the accompanying drawings, in which:

FIGS. 1a and 1b are a schematic cross-sectional view of the magnetic lock in accordance with the present invention, FIG. 1a being in the uncoupled (locked) and FIG. 1b in the coupled (unlocking) position with a key inserted;

FIG. 2 illustrates in schematic form an arrangement of permanent magnets for a key and magnetic elements, and an arrangement of polarity;

FIG. 3 is a longitudinal (a) and cross-sectional (b) view of another embodiment of the present invention;

FIG. 4 is a cross-sectional view of another embodiment of the present invention, (a) taken longitudinally, (b) taken transversely;

FIG. 5 is a longitudinal cross-sectional view of another embodiment.

Referring now to the drawings: an inner, or key cylinder 6 has a central opening 6a therein, to form a guideway or keyway for the key 1 fitting therein. The circumference of the cylinder 6 is formed with a pair of recesses 6b, located opposite each other. These recesses, or chambers 6b, are large enough to wholly accommodate a magnetic element 2a, 2b therein. Magnetic elements 2a, 2b are in forms of axially extending, elongated longitudinal bars. The magnetic coupling elements 2a, 2b are magnetized to have poles as shown, with opposite poles adjacent each other. The inner cylinder 6 is surrounded by an intermediate, or coupling cylinder 7, which in turn is rotatable within a housing, not shown in FIG. 1. The locking element L (FIGS. 3-4) which operates the key bolt, or itself forms part of the bolting arrangement of the lock, is attached to this intermediate or coupling cylinder 7. Coupling cylinder 7 is formed with oppositely located chambers, or recesses 7a, matching the chambers 6b in the key cylinder, but of smaller size. They are of such depth that the magnetic elements 2a, 2b can enter into the recesses or chambers 7a only to a limited extent.

FIG. 2 illustrates a longitudinal view of magnetization arrangements for the key 1 and locking elements 2a, 2b. The key may consist of a flat elongated surface of magnetic material, magnetized as shown in FIG. 2, or of a strip of support material to which permanent magnets are attached. The key is subdivided, artificially, into predetermined zones which are magnetized to have their magnetic orientation in a predetermined pattern. As shown, the pattern alternates, but adjacent zones may have the same magnetic orientation, that is a pole may extend over more than one zone length of the key. Thus, a large variety of combinations can be obtained. The pattern of magnetic orientation of the key is matched by the pattern of magnetic orientation of the locking elements 2a, 2b.

Referring again to FIGS. 1a and 1b, as seen in FIG. 1, opposite poles of the magnetic elements 2a, 2b attract each other. Thus, the magnetic elements 2a, 2b will lie wholly within the key cylinder 6, which can rotate freely within coupling cylinder 7 and the lock cannot be operated. If key 1 is inserted up to its end in keyway 6a (FIG. 1b) the magnetic coupling elements 2a, 2b are urged towards the outside, forming a coupling connection between the key cylinder 6 and the coupling cylinder 7. Rotation of the key will thus cause rotation of locking element or bolt L, not shown in FIG. 1. Upon removal of the key, the inner elements again attract each other and the lock cannot be operated since key cylinder 6 will again rotate freely. Insertion of a screwdriver will not cause the elements to move into coupling position; insertion of a magnet will only cause the elements to more firmly remain in the position of FIG. 1a.

If a key is inserted which has a pattern of magnetization which does not match that of the lock—that is if an incorrect key is used, some of the zones of magnetization of elements 2a, 2b will be positively attracted to the key, thus overcoming any repelling force and again preventing engagement of the magnetic elements 2a, 2b with a chamber 7a of the coupling cylinder 7. The repulsion

of like poles opposite each other upon insertion of a key is illustrated by arrows 5 in FIG. 2; the attraction of unlike poles upon removal of the key by arrows 4 in FIG. 2. Repulsion of the magnetic elements 2a, 2b will occur only when there is exact coincidence of the pattern of magnetization of the key and the pattern of magnetization of the movable magnetic elements 2a, 2b. To obtain proper orientation, a pre-formed keyway, as is customary in locks, can be used. The key 1 itself can be polarized as shown; polarization diagonally, point polarization and circular polarization may also be used, provided that the pattern of magnetic orientation on the key matches the pattern of orientation on the elements of the lock.

Manufacture of the key itself is simple, particularly if it is made flat as shown in cross-section in FIG. 1b, and magnetized across so that the poles appear on the flat surfaces of the key, providing large magnetic surfaces and a magnetic field of sufficient strength. The inner cylinder, as well as the coupling cylinder, may be made of any non-magnetic material including plastics.

The invention permits a large number of different construction arrangements internally of the lock, and thus provides good variety and a large number of possible combinations.

Embodiment of FIG. 3: A key 50 can be inserted into a central keyway. In this embodiment, a circular key in the form of a pin may be used. The central, or inner, or key cylinder is then formed as a hollow tube 56, surrounded by a group of coupling rings A-D, coupling ring A being part of the key cylinder and rings B-D being part of the coupling cylinder. The coupling cylinder has a terminal coupling element 57 provided with locking element or bolt L. The inner or key cylinder, the coupling rings A-D and the coupling cylinder 57 are co-axial and are rotatably located within a housing cylinder 53. The tube 56, forming the key cylinder and the first ring A are securely joined. Ring A is formed with a rearwardly directed projection 58. Projection 58 extends over the portion of the next adjacent ring B, as clearly appears from FIG. 3. Likewise, ring B is formed with a rearwardly extending projection 58' extending over the next ring, and so on.

The rings are formed with radial recesses, or chambers 51, which match similar chambers within the projection 58 of the preceding ring. The final coupling cylinder element 57 is formed with a similar radial chamber, just beneath the matching hole in the preceding projection 58' of the preceding ring D. Magnetic coupling elements 52 are located within the chambers 51. The coupling elements in the chambers are so dimensioned that the coupling elements 52 fit wholly within the chambers 51 in the rings A-D, and in the similar chamber formed in the coupling element 57. Coupling elements 52 are poled in such a manner that oppositely located coupling members attract each other across the diameter of the lock.

Key 50 is formed with transversely extending magnets, as shown in FIG. 3 at 59, arranged such that the outer poles on the key match the poles of the elements 52 inserted within chambers 51, when the proper key is inserted.

If the proper key is inserted, all of the elements 51 are repelled from the central axis of the lock, causing engagement of inner tube or key cylinder 56 and its associate ring A with the adjacent ring B of the coupling cylinder; ring B with ring C; and so on until the last ring D is connected by the outwardly directed magnet to the coupling element 57 of the coupling cylinder and hence to the locking element L. FIG. 3 illustrates the position of the magnetic elements, which may be termed tumblers, when an improper key is inserted. The first zone of magnetization—beneath ring A and to connect with ring B—is proper. Like poles repel each other and there is engagement between ring A and ring B. Rotation of key 50 will thus cause rotation of ring A and ring B. The other poles, however, are incorrect and there will be no coupling be-

tween the projection 58' of ring B and the next adjacent ring C. Thus, the coupling between the key and eventually the coupling cylinder element 57 is interrupted, and the key will turn without taking along lock element L. Only if all the zones of magnetization of the key match the polarity of the inserted magnetic elements or tumblers 52 will all rings be coupled thus transmitting motion from the key to locking element L.

Key 50 may have a flattened portion of take along the key cylinder 56 and transmit rotation; alternatively it can be completely round and rotation of the locking element L can be effected, upon insertion of the proper key, by turning a projecting handle 50' secured to the ring A.

EMBODIMENT OF FIG. 4

A key 60 is again inserted inside a hollow tube 66 forming the key cylinder. The coupling cylinder is formed of a plurality of coupling disks F-I surrounding the key cylinder 66, and terminating at the rear of the lock, in a coupling cylinder element 67. A disk E, similar to disks F-H is secured to key cylinder 66. Coupling cylinder element 67 is again formed with the locking element or bolt L; its inner shape is similar to that of the disks E-I. The entire lock is contained within a housing 63.

Disks E-I, and the terminal portion 67 of the coupling cylinder, are formed with recesses or chambers 61a, 61b. Magnetic coupling elements, or tumblers 62, are located within these chambers. One of the chambers, on disks E to H, chamber 61a, is large enough to wholly receive an entire magnetic element, whereas the other chamber in these disks is of smaller size. The chambers are not circumferential. Coupling disk I illustrates another possibility with this embodiment of the present invention—it is formed with a pair of chambers 61c, 61d, both of equal size and neither large enough to wholly receive a magnet element 62.

When the key is not inserted, the magnetic elements are wholly contained within the chambers of larger size. The elements which can be received in chambers 61c, 61d of disk I are so poled that they repel each other and thus enter the chambers 61b of disk H and 61e of coupling cylinder element 67, respectively. The poles of the coupling element 32 are arranged side by side and not from top to bottom, as in the embodiment in FIG. 3. Poles formed on the key 60 are also side by side and not from top to bottom (FIG. 3) but rather adjacent each other, as illustrated in FIG. 4. The polarity on the key and the polarity of the elements are so arranged that a north pole on the key is always opposite a south pole of an element, so that the key magnets and the coupling magnets attract each other and move the coupling element towards the left in FIG. 4 upon withdrawal of the key, that is within the chambers 61a in each instance, except for the last coupling element which will be repelled and moved into chamber 61e of the cylinder element 67.

Upon insertion of key 60, coupling elements 62 are moved to align the magnets. South to North and North to South with the position of the key. When the key is received entirely within the keyway of the key cylinder 66, all of the elements 62 will couple adjacent disks, and locking element L will rotate upon rotation of the key 60 due to a continuous connection between cylinder element 67 and the first disk E of key cylinder 66. In the alternative, rotation of the disk E, can be provided by means of a handle 60', similar to handle 50' of FIG. 3. FIG. 4 illustrates the position of the magnetic element with the correct key.

A coupling disk similar to disk I and having only shallow chambers 61c, 61d on both sides, can be arranged in any convenient position between the coupling disks E-H. Its effect is a reversal of motion of the associated coupling element 62. If any of the elements 62 does not couple adjacent disks due to a mismatch of magnetic polarity, no motion can be transmitted from key cylinder 66 to coupling cylinder 67.

The lock has been described in connection with a cyl-

inder lock, but it may have other shapes. Thus, while the key may be of the conventional form, that is have a small grip and an elongated flat keying surface, it can have different forms as well as, such as a flat strip of material having magnetic zones affixed, or impressed thereon. Such a flat strip of material, rather than being inserted into a keyway or bore within a cylinder, may be placed against a holding element having the same function as the ordinary cylinder in a cylinder lock, namely to retain the magnetic elements; these magnetic elements, by being selectively attracted, or repelled by the magnetic zones on the strip of the key, then can release and oppose element, corresponding to the coupling cylinder.

The matching recesses need not be in the key cylinder and in the coupling cylinder. If the key cylinder is axially movable to engage the coupling cylinder, there will be a reversal of the position of the magnetic elements depending on the key position, with respect to the previously described embodiment, namely when the key is removed, the magnetic elements will span the two matching chambers to inhibit axial movement, whereas when the key is present, the elements are wholly in one chamber, so that the key cylinder can move axially to engage with the coupling cylinder. This embodiment similar to those previously described but operating reversely with respect to the embodiment of FIGS. 1-4 is shown in FIG. 5.

A key is shown inserted into a keyway within a key cylinder 76. Intermediate or coupling cylinder 77 is connected to locking element L. The housing 73 is in form of a cylinder and surrounds the entire lock. It holds both the key cylinder 76 and the coupling cylinder 77 rotatably therein. The housing cylinder 73 is thicker than that which may be necessary for any of the embodiments previously described. It is formed on the inside with oppositely located chambers 75, of sufficient size to wholly accommodate magnetic elements 72 therein. The key cylinder 76 is formed with circular grooves 74, located oppositely and matching the chambers 75, but of lesser depth.

Key cylinder 76 is provided at its inner end with projecting pin 76' adapted to engage matching blind bores or recesses formed in coupling cylinder 77. The key cylinder 76, and the coupling cylinder 77, are held apart by means of a spring 80.

Oppositely located magnetic elements or tumblers 72 are poled oppositely so that they will attract each other when the key is removed from the keyhole. Thus, they will engage the grooves 74 in the key cylinder 76, and key cylinder 76 will rotate freely. Further, any axial movement of the key cylinder is prevented by engagement of the magnetic tumbler element 72 within grooves 74.

Key 70 is arranged to have zones of magnetization in a pattern which matches that of the tumbler element 72, and in such a manner that the magnetization is similar to that of the element 72, as shown in FIG. 7. Thus, when the proper key is inserted, all of the tumbler elements will be repelled from the central axis, and will locate wholly within the chambers 75 formed in housing 73. Thus axial movement of key cylinder 76, that is depression towards the right in FIG. 7 is possible, permitting engagement of pins 76' with bores 79 of intermediate or coupling cylinders 77 and operation of the locking member L.

If a key which is not proper for the lock to be used is inserted—as shown in FIG. 7—only the one or the other pair of magnetic tumblers 72 will be repelled to locate within the chambers. The first such tumbler, from the left on FIG. 7, is so repelled. Anyone of the other tumblers will, however, not only be repelled but be attracted positively to seat within the grooves 74 to positively prevent axial motion of central or key cylinder 76.

After insertion of the proper key, and operation of the lock, the key cylinder 76 is returned to the disengaged or rest position by spacing 80, the magnetic elements 72 attract each other and again lock the central or key cylin-

der against further axial motion. The key cylinder can be rotated, but cannot be engaged with the coupling cylinder which operates the locking element L.

I claim:

1. Magnetic lock for use with a key having predetermined zones of magnetization, said lock comprising:
 - a housing;
 - a locking element;
 - a key cylinder freely movable within said housing in the absence of a key for said lock;
 - at least one element having a predetermined magnetization, and movable between key-in and key-out positions;
 - a coupling cylinder located within said housing and adjacent said movable key cylinder, said coupling and said key cylinders being formed with at least a pair of matching chambers receiving said magnetic elements, one of the chambers of a pair being of sufficient size to wholly accommodate the said magnetic element when said element is in key-out position to uncouple said key cylinder and said coupling cylinder and permit movement of said key cylinder freely within said lock independently of said coupling cylinder, between its unlocked and locked position, said elements spanning said chambers when in the key-in position to couple said key cylinder and said coupling cylinder together;
 - the position of said elements being controlled by a magnetic field applied to said key cylinder and said locking element being connected to said coupling cylinder.
2. Lock as claimed in claim 1 wherein said key cylinder is rotatable in said housing and said coupling cylinder surrounds said key cylinder.
3. Lock as claimed in claim 1 wherein said magnetic elements are located with respect to each other to be influenced by the magnetic field of an adjacently located magnetic element and to move to the uncoupling position upon absence of, or non-coincidence of the predetermined pattern of magnetization of a key with the pattern of magnetization of said elements.
4. Lock as claimed in claim 1 wherein said elements within said lock are arranged to be repulsed by the magnetic field from the key upon movement of the elements to a coupling position.
5. Lock as claimed in claim 1 wherein a plurality of magnetic elements are provided, said elements comprising a bar of magnetic material having zones of magnetization arranged thereon oriented in a predetermined pattern.
6. Lock according to claim 1 wherein said key cylinder is at least partly surrounded by said coupling cylinder.
7. Lock as claimed in claim 1 wherein said cylinders are circular and rotatable in said housing, said key cylinder is at least partly surrounded by said coupling cylinder, and said chambers extend axially and radially and form facing recesses located in the respective cylinders, the radial depth of one of said chambers being sufficient to wholly accommodate said magnetic element.
8. Lock according to claim 1 wherein said cylinders are formed with two chambers each located diametrically opposite each other, each said chambers containing a magnetic element having predetermined zones of magnetization impressed thereon.
9. Lock according to claim 1 in combination with a key, said key comprising an elongated shaft, said shaft being magnetized in zones to provide regions of magnetic orientation along said shaft arranged in a predetermined pattern.
10. Lock in combination with a key according to claim 9 wherein said elongated shaft is a flat strip and the north and south poles are arranged transverse to the thickness of said shaft.
11. Lock as claimed in claim 1 wherein said coupling cylinder includes a plurality of coupling rings, independ-

ently rotatable of each other, located to surround said key cylinder;

- said key cylinder includes an additional coupling ring;
- adjacent coupling rings being formed with axial projections overlapping a portion of the next adjacent coupling ring, the last of said coupling rings being secured to said locking element;
- said coupling rings and said coupling cylinder being formed with said matching recesses extending radially in the region of said projection and said overlapping portions;
- and the magnetic elements are magnetic tumblers radially movable in said recesses to interconnect said coupling rings when in the coupling position.
12. Lock as claimed in claim 11 in combination with a key, the orientation of the pattern of magnetization of said key and magnetization of said tumblers being determined such that like poles of the key and of the tumblers are located opposite each other when the proper key is engaged in said lock.
13. Lock as claimed in claim 1 wherein said coupling cylinders includes a plurality of coupling disks, independently rotatable of each other, located to surround said key cylinder;
- said key cylinder includes an additional disk;
- adjacent coupling disks being formed at their faces with said matching recesses, said recesses facing each other, the last one of said coupling disks being secured to said locking element;
- and the magnetic elements are magnetic tumblers axially movable in said recesses to interconnect said coupling disks when in the coupling position.
14. Lock as claimed in claim 13 wherein the recess in one face of the disk is of sufficient size to entirely accommodate said magnetic tumblers and the recesses on the other face of the disk are of such size as to only partially accommodate the tumblers.
15. Lock claimed in claim 13 wherein the recesses of both faces of at least one of the disks are of such size as to only partly accommodate a tumbler to permit coupling by tumblers with adjacent disks from both sides.
16. Lock as claimed in claim 13 in combination with a key, the orientation of the pattern of magnetization of said key and the polarity of the magnetization of the magnetic tumblers being parallel to the axis of the cylinder, adjacent portions of the key and of the tumblers being oppositely poled.
17. Lock as claimed in claim 1 wherein said lock has a key side and a rear side, said coupling cylinder embracing said key cylinder from the rear of the lock.
18. Magnetic lock for use with a key having predetermined zones of magnetization, said lock comprising:
 - a housing cylinder; a locking element;
 - a key cylinder freely movable within said housing cylinder in the absence of a key for said lock;
 - at least one element having a predetermined magnetization, and movable between key-in and key-out positions;
 - a coupling cylinder located within said housing cylinder and adjacent said movable key cylinder, said key cylinder and another one of said cylinders being formed with at least a pair of matching chambers receiving said magnetic elements, one of the chambers of a pair being of sufficient size to wholly accommodate the said magnetic element to uncouple said key cylinder and said other one of said cylinder, and permit movement of said key cylinder within said lock independently of said other cylinder when the proper key is in a first position respect to the lock, said elements spanning said chambers when in the key is in a second position with respect to the lock to couple said key cylinder and said coupling cylinder together;
 - the position of said elements being controlled by a magnetic field applied to said key cylinder and said

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locking element being connected to said coupling cylinder.

19. Lock as claimed in claim 18 wherein said key cylinder is rotatable in said housing cylinder and said coupling cylinder is formed with a chamber matching the key cylinder.

20. Lock as claimed in claim 18 wherein said cylinders are made of non-magnetic material, and said elements are located with respect to each other to be influenced by the magnetic field of an adjacently located magnetic element and to move to the uncoupling position upon absence of, or non-coincidence of the predetermined pat-

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tern of magnetization of a key with the pattern of magnetization of said elements.

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