United States Patent

Kikuchi et al.

[15] **3,690,432**

[45] **Sept. 12, 1972**

[54] **MAGNETIC KEY DEVICE**

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[22] Filed: **March 30, 1970**

[21] Appl. No.: **23,865**

[30] **Foreign Application Priority Data**

April 4, 1969	Japan	44/30473
June 6, 1969	Japan	44/44378
Aug. 29, 1969	Japan	44/82831
Aug. 29, 1969	Japan	44/82832

[52] **U.S. Cl.** **197/98,** 235/145, 335/206

[51] **Int. Cl.** **B41j 5/08**

[58] **Field of Search** 197/98; 235/145; 335/206

[56] **References Cited**

UNITED STATES PATENTS

3,363,737	1/1968	Wada et al	197/98
3,457,368	7/1969	Houcke	197/98 X

Primary Examiner—Edgar S. Burr

Attorney—Flynn & Frishauf

[57] **ABSTRACT**

A key device for business machines and the like is provided which increases linearly the load smoothly when the key button or knob is depressed and can give a snap action, irrespective of the magnitude of force applied to the key device. The key device comprises a drive member slidably fixed to a retaining member and a follower member which is normally attracted to the retaining member by a permanent magnet. A spring is interposed between the drive and follower members. When the drive member is depressed into the retaining member, the spring is compressed, thereby accumulating the energy. When the accumulated energy overcomes the strength of the permanent magnet, the follower member is immediately pushed outwardly from the retaining member by the spring.

10 Claims, 13 Drawing Figures

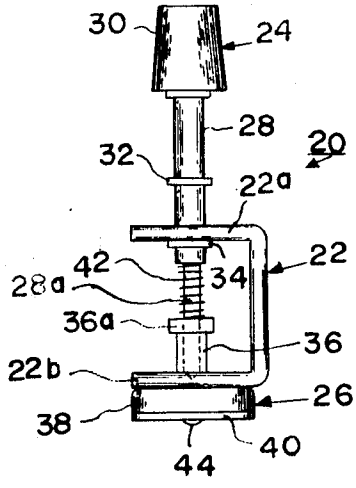


Fig. 1

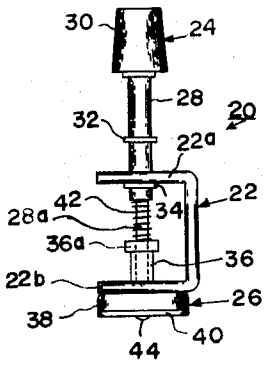


Fig. 2

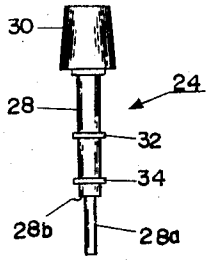


Fig. 3

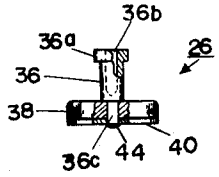


Fig. 4A

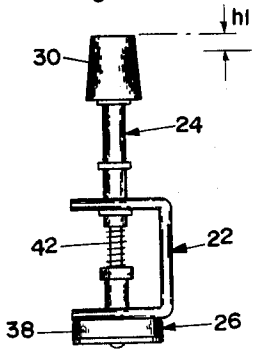


Fig. 4B

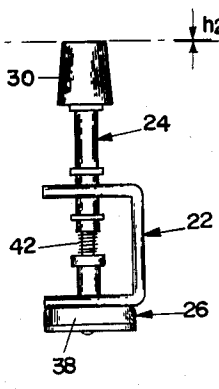


Fig. 4C

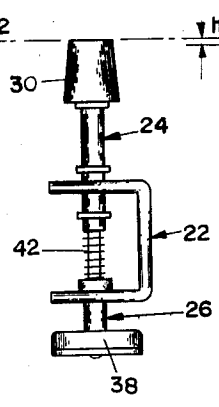


Fig. 4D

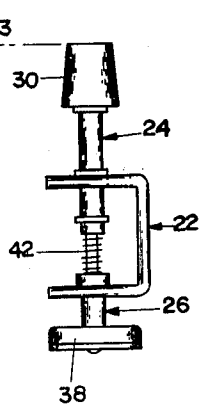


Fig. 5

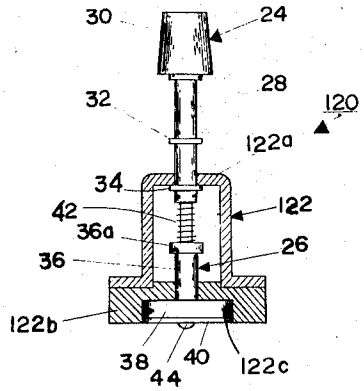


Fig. 6

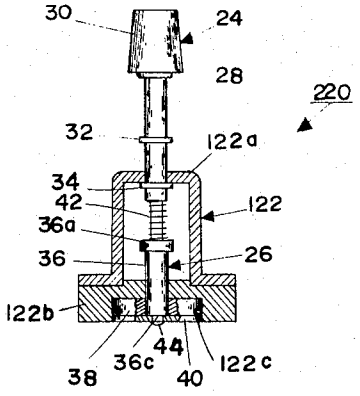


Fig. 7

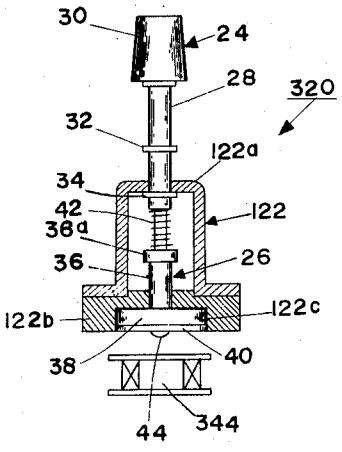


Fig. 8

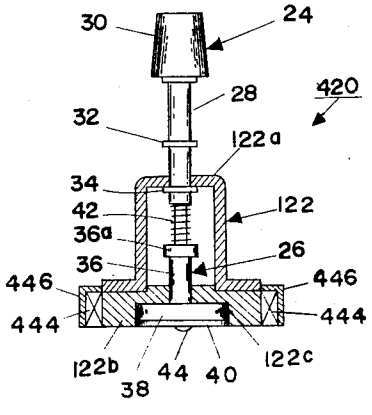


Fig. 9

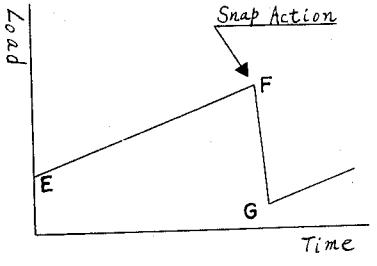
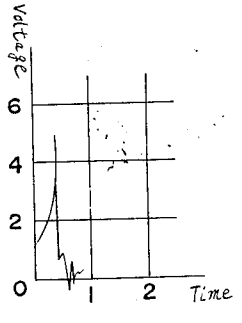


Fig. 10



MAGNETIC KEY DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a key device for use in electric typewriters, desk computers, keysets, etc.

The keys for these machines must cause a desired operation irrespective of a magnitude of force applied thereto for depression. There have been proposed keys of the type described with a wide variety of constructions which can satisfy the demands as described above. But recently developed machines or the like requires the keys to make more complex functions. That is, the load is linearly increased when the key is depressed; the key operates smoothly; and the key must transmit to an operator the feeling or "snap action" that the key has been depressed to a desired degree. But there has been proposed no key device which can satisfy all of the demands such as described above. It is therefore the broad object of the present invention to provide a key device whose load upon depression is linearly and smoothly increased and which can provide the "snap action" and make a desired constant function irrespective of a magnitude of force applied to the key.

It is another object of the present invention is to provide an electronic type contactless key device requiring no power source (which will be referred to as "electronic type contactless-non-power key device") comprising the key device in accordance with the present invention and a coil for that the abrupt flux variation in the coil due to the depression of the key may be detected as a voltage variation.

It is a further object of the present invention is to provide an electronic type contactless-non-power key device comprising the key device in accordance with the present invention and a coil so that the abrupt flux variation in the coil due to the depression and return of the key may be detected as a voltage variation. It is a further object of the present invention of the key device of the character described hereinabove which is simple in construction, highly reliable in operation and inexpensive to manufacture. To attain the above and other objects of the present invention, the present invention provides a novel key device comprising a retaining member, a drive and follower members both of which are slidably fixed to the retaining member, the follower member being normally attracted toward the retaining member by a permanent magnet and held in position, the drive and follower members being so arranged as to coact with each other through a spring, the spring being compressed upon depression of the drive member into the retaining member thereby accumulating the energy, that is the returning force, whereby when the energy or the returning force of the spring overcomes the strength of the permanent magnet, the follower member may be immediately pushed outwardly of the retaining member. According to one embodiment of the present invention, a coil is disposed in opposed relation with the follower member on the side of its outward movement from the retaining member.

According to another embodiment of the present invention, a coil is disposed around the outer periphery of the retaining member. Therefore, the flux variation in the coil due to the depression of the key may be detected as a voltage variation or the flux variation in the coil when the key is depressed and returned may be detected as a voltage variation.

The above and other objects, features and advantages of the present invention will become more apparent from the following description of the preferred illustrative embodiments thereof taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING:

FIG. **1** is a front view, partly in section, of one embodiment of the present invention;

FIG. **2** is a front view of a drive member thereof;

FIG. **3** is a front view of a follower member thereof;

FIGS. **4A**, **4B**, **4C** and **4D** form a sequence line diagram for explanation of the mode of operation thereof;

FIG. **5** is a front view, partly in section, of a second embodiment of the present invention;

FIG. **6** is a front view, partly in section, of a third embodiment of the present invention;

FIG. **7** is front view, partly in section, of a first embodiment of an electronic type contactless-non-power key device in accordance with the present invention;

FIG. **8** is a front view, partly in section, of a second embodiment of an electronic type contactless-non-power key device in accordance with the present invention;

FIG. **9** is a graph illustrating the relation between the load and time for explanation of the improved characteristics of the key device in accordance with the present invention; and

FIG. **10** is a graph illustrating the output voltage waveform obtained by the electronic type contactless-non-power key device of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1** illustrating one embodiment of the present invention, a key device generally designated by **20** comprises a retaining member **22** made of a magnetic material, a drive member **24** slidably fitted into the retaining member **22** from the upper side thereof and a follower member **26** slidably fitted into the retaining member **22** from the lower side thereof.

As best shown in FIG. **2**, the drive member **24** comprises a stem **28** and a knob **30** integrally fitted over the upper portion of the stem **28** with a pair of spaced apart upper and lower stopper rings **32** and **34** fitted over the stem **28**. The stem **28** has a reduced diameter portion **28***a*. As best shown in FIG. **3**, the follower member **26** comprises a stem **36** having a flange **36**a formed at the upper end and a blind hole **36***b* drilled coaxially of the stem **36** and a permanent magnet **38** fitted over the reduced diameter portion **36**c of the stem **36**. The permanent magnet **38** is rigidly connected to the stem **36** by means of a magnet retainer **40** screwed over the reduced diameter portion **36***c*. These drive and follower members **24** and **26** are fitted into the retaining member **22** from the upper and lower side thereof as shown in FIG. **1**. In assembly, the permanent magnet **38** and the retainer **40** are detached from the stem **36** of the follower member **26** and the stem **36** is fitted into the hole formed through the lower bracket **22** *b* of the retaining member **22** from the inner side thereof. Thereafter the permanent magnet **38** is fitted over the reduced diameter portion **36***c* and then the retainer **40** is screwed thereover.

The vertical movement of the follower member **26** is limited to the distance between the flange **36***a* whose lower surface contacts with the inner surface of the bracket **22***b* and the permanent magnet **38** whose upper surface contacts with the outer surface of the bracket **22***b*. The attracting force of the permanent magnet **38** is so selected that the magnet **38** normally attracts the lower bracket **22***b*, thereby normally holding the follower member **26** in its upper position as shown in FIG. **1**.

In assembling the drive member **24**, the lower stop ring **34** is removed and then the reduced diameter portion **28***a* of the drive member **24** is fitted into the hole formed through the upper bracket **22***a* of the retaining member **22**. Thereafter a spring **42** is fitted over the reduced diameter portion **28***a* and compressed between the stepped portion **28***b* of the stem **28** and the upper end of the stem **36** of the follower member **26** while the reduced diameter portion **28***a* of the stem **28** is fitted into the blind hole **36***b* of the stem **36** of the follower member **26**. Thereafter the lower stop ring **34** is fitted over the stem **28**. Thus, the drive member **24** is fitted into the hole of the upper bracket **22***a* of the retaining member **22** slidably relative thereto. This vertical movement of the drive member **24** is limited to a distance between the upper and lower stop rings **32** and **34** and the drive member **24** is normally held in its upper position as shown in FIG. **1** under the returning force of the spring **42**.

Next the mode of operation of the first embodiment will be described hereinafter. When the key device **20** is not operated, the relative positions of the components are shown in FIG. **4**-A. By depressing the knob **30** by one finger, the drive member **24** compresses the spring **42** thereby charging it. This means that the returning force of the spring **42** is increased. For example when the knob **30** is depressed by a distance H_1 as shown in FIG. **4**-B, the returning force of the spring **42** becomes substantially equal to the magnet strength or attractive force of the permanent magnet **38** of the follower member **26**. When the knob **30** is further depressed by a distance h_2, the returning force of the spring **42** overcomes the attractive force of the magnet **38** so that the follower member **26** is immediately forced downwardly by the returning force of the spring **42** as shown in FIG. **4**-C. Subsequently, in response to the downward movement of the follower **26**, the drive member **24** is depressed further compressing the spring **42** by a distance H_3 as shown in FIG. **4**-D.

When the finger is released from the knob **30** at its position shown in FIG. **4**-D, the follower member **26** is immediately moved upwardly by the force of the permanent magnet **38** so that the drive member **24** is immediately returned to its initial position (FIG. **4**-A) through the spring **42**.

FIG. **9** is a graph illustrating the relation between the load acting upon the knob **30** and the time. During the time interval from the point E where the depression of the knob **30** starts to the point F where the returning force of the spring **42** becomes equal to the strength of the permanent magnet **38**, the spring **42** is gradually compressed as the knob **30** is depressed so that the load exerting upon the knob **30** is linearly increased. At the point F, the returning force of the spring **42** overcomes the force of the permanent magnet **38** so that the follower member **26** is pushed outwardly at high speed as described above so that the load exerting upon the knob **30** is rapidly decreased from the point F to the point G. Since the drive member **24** is depressed further so as to compress the spring **42**, the load acting upon the knob **30** is again increased linearly from the point G.

Thus, upon depression of the knob **30**, the load is linearly and smoothly increased and a snap action is generated when the follower member **26** is pushed outwardly by the release of the energy stored in the spring **42** so that this snap action remains substantially unchanged irrespective of the force applied to the knob **30**. That is, the operator always feels the same snap action.

Since the function of the spring **42** providing this "key touch feeling" is much affected by the strength of the permanent magnet **38**, it is preferable to select the strength of the permanent magnet after a desired design "key touch feeling" is previously determined.

From the foregoing, it will be seen that the key device in accordance with the present invention may be applied not only to the business machines but also to a wide variety of fields such as a method for picking up or detecting a voltage utilizing the variation in magnetic flux, the piezo-electric element, the Hall-effect element, etc.

Next the second embodiment of the present invention will be described hereinafter with reference to FIG. **5**. In the key device generally designated by **120**, a retaining member **122** is different from that of the first embodiment only in that the retaining member **122** comprises a cap body **122***a*, a magnet holder **122***b* made of a magnetic material and fixed to the lower end of the cap body **122***a* and the magnet holder **122***b* is provided with a recess **122***c* formed in the lower surface for receiving therein the permanent magnet **38** of the follower member. The mode of operation of the second embodiment is substantially similar to that of the first embodiment described hereinabove. However, the return of the follower member **26** by the permanent magnet **38** to its initial position can be made at a higher speed and the permanent magnet **38** is attracted only to the magnet holder **122***b* so that Mylar film or the like is not required to be applied to other magnetic components, thereby enhancing the durability of the device.

Next the third embodiment **220** of the present invention will be described with reference to FIG. **6**. The third embodiment **220** is different from the second embodiment shown in FIG. **5** only in that the permanent magnet **38** is fixed to the magnet holder **122***b*. The mode of operation is substantially similar to that of the first and second embodiments described hereinabove. The special feature of the third embodiment having the permanent magnet **38** securely fixed to the magnet holder **122***b* lies in the fact that the permanent magnet **38** can be advantageously prevented from the secular variation and especially from de-magnetization due to the cracking, impact, etc.

FIG. **7** illustrates an electronic type, contactless-non-power key device **320** which is a variation of the devices shown in FIGS. **5** and **6** and has an coil **344** disposed below the follower member **26** for detecting the variation in the magnetic field.

In an electronic type, contactless-non-power key device **420** shown in FIG. **8** which is a variation of the devices shown in FIGS. **5** and **6**, coil **444** for detecting the variation in field is disposed around the magnet holder **122***b* and is surrounded by a cover **446**. The mode of operation of the devices **320** and **420** is similar to that of the embodiments described hereinabove, but when the follower member is pushed outwardly in the device **320** and when the follower member **26** of the device **420** is pushed outwardly and is returned into the magnetic holder **122***b*, the magnet field is changed and is detected by the coils **344** and **444**. The voltage induced in the coil **344** or **444** is given by

$$V = d\phi/dt$$

where ϕ is the flux in the coil.

It is therefore necessary that the instantaneous change of the magnetic field will substantially remain constant irrespective of the magnitude of the force applied to the knob **30**. When the key device of the present invention is used, the follower member **26** is pushed outwardly and returned very rapidly so that a voltage waveform having a sharp rising edge and falling edge as shown in FIG. **10** may be obtained.

In order to more effectively cause the flux variation in the coil **344** or **444**, it is preferable to form a projection **44** at the undersurface of the follower member **26** so as to concentrate the flux and to use a retainer **40** made of a metal having a high permeability. Since the polarity in the devices **320** and **420** may be switched in a simple manner by the key devices **320** and **420**, the present invention may be used as an input key for electronic circuits in various fields.

The present invention has been described above with particular reference to the preferred illustrative embodiments thereof, but it will be understood that variations and modifications can be made without departing from the true spirit of the present invention as described hereinabove and as defined in the appended claims.

What is claimed is:

1. A key device comprising:

a retaining member (**22**, **122**) of magnetic material and having a bore therein;

a drive member (**24**);

a follower member (**26**), said drive member (**24**) being slideably and coaxially engaged with said follower member (**26**) and said follower member (**26**) being slideably engaged through the bore in said retaining member (**22**, **122**);

a permanent magnet (**38**) attached to said follower member (**26**) and attracting said retaining member (**22**,**122**) to serve as the sole force urging said follower member toward said retaining member, said magnet directly contacting said retaining member to retain said magnet in position;

a spring (**28***a*) interposed between and urging apart said drive (**24**) and follower (**26**) members, said spring being compressed upon depression of said drive member to accumulate energy, said magnet snapping away from said retaining member when said accumulated energy overcomes the attraction force of said permanent magnet to said retaining member, and the magnetic attraction of said magnet to said retaining member serving as the sole returning force when said depression force is released, to return said magnet into direct contact with said retaining member.

2. A key device according to in claim **1** wherein

a recess is formed in said retaining member for receiving therein said permanent magnet.

3. A key device according to claim **1** wherein said drive and follower members include means to limit movement thereof relative to said retaining member.

4. A key device according to claim **1** including signal generating means spaced from said magnet, said magnet moving toward said signal generating means when snapped away from said retaining member to cause said signal generating means to generate an electrical signal.

5. A key device according to claim **4** including a projection (**44**) extending from the center of said magnet (**38**) on the side thereof remote from said retaining member to concentrate the magnetic flux.

6. A key device comprising:

a retaining member (**22**, **122**) of magnetic material;

a drive member (**24**);

a follower member (**26**) slideably engaged with said drive member (**24**), said drive member (**24**) and said follower member (**26**) being slideably mounted to said retaining member (**22**, **122**) in coaxial relation with each other;

a permanent magnet (**38**) coupled to said follower member (**26**) for attracting said follower member (**26**) toward said retaining member (**22**, **122**) and serving as the sole force urging said follower member toward said retaining member, said magnet directly contacting said retaining member (**22**, **122**) to hold said follower member in position;

a spring (**42**) interposed between and urging apart said drive member (**24**) and follower member (**26**) and being compressed upon depression of said drive member to accumulate energy;

a coil (**344**) spaced from said follower member (**26**) and spaced from said magnet (**38**);

said spring (**42**) being compressed upon depression of said drive member (**24**) by a predetermined amount, said magnet (**38**) and follower member (**26**) snapping away from said retaining member and moving quickly relative to said coil (**344**) when the energy accumulated in said spring (**42**) overcomes the attraction force between said magnet and said retaining member the flux variation in said coil due to the displacement of said follower member and permanent magnet being detected as a voltage variation across said coil, and when said depression force is released, the magnetic attraction of said magnet to said retaining member serving as the sole returning force t o return said magnet into direct contact with said retaining member and to return said follower member back to its inoperative position.

7. A key device according to claim **6** wherein said coil is disposed so as to oppose said magnet and said follower member in the direction of movement thereof from said retainer member, said magnet snapping toward said coil when said accumulated spring energy overcomes the attraction force between the magnet and the retaining member to close a magnetic field therewith.

8. A key device according to claim 7 wherein said magnet impacts said coil after it snaps away from said retaining member.

9. A key device according to claim 6 wherein said coil is disposed around the outer periphery of said retaining member and around said permanent magnet when said key device is inoperative.

10. A key device according to claim 6 wherein a recess is formed in said retaining member for receiving therein said permanent magnet.

* * * * *