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Published

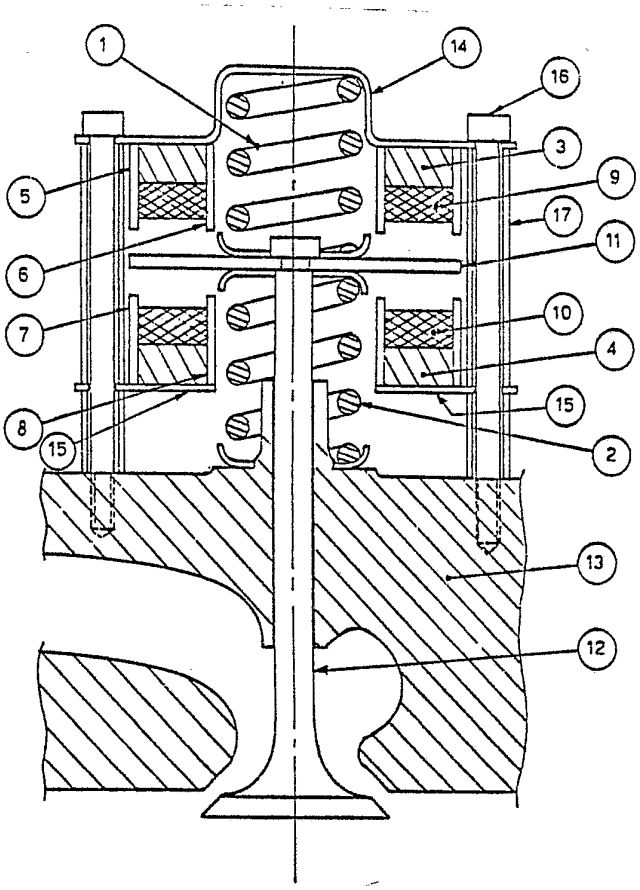
With international search report

With amended claims

(54) Title: A TWO POSITION MECHANISM

(57) Abstract

Mechanisms in which one member may occupy one of two fixed positions and can be caused to change over from one position to the other at will. In order to accomplish rapid change-over with minimum energy input and minimum impact, an elastic suspension of this member is provided and so arranged that the change-over process is substantially a half cycle of oscillation in which the moving members starts and ends with no or little speed of motion. The moving member is captured in the vicinity of, and held at the fixed positions, against the force exerted by the said elastic suspension by mechanisms exerting short range forces upon it. When a change-over is to be initiated, the corresponding short range force is temporarily removed by an appropriate means. This then releases the said moving member, which executes substantially a half cycle of oscillation and is captured again at the opposite fixed position.



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A TWO POSITION MECHANISM

This invention relates to mechanisms and specifically those mechanisms which have only two defined rest positions, but do not exercise rigid control over the motion of the member which is moved from one rest position to the other. For convenience, such mechanisms will hereafter be referred to as binary mechanisms.

Some examples of binary mechanisms are: electric relays, solenoid actuators, manually operated electric switches, and thermally actuated electric switches utilising differential expansion of metals. In each case, there has to be provided a means for applying a force or forces to the said moving member, hereafter referred to as the oscillator, and for removing this force or forces. This force or forces may be generated mechanically or electromagnetically, by the action of fluid pressure or vacuum, manually or inertially.

The great variety of modes of operation of binary mechanisms is also reflected in the great diversity of their application and for this reason, a functional rather than operational definition is found convenient.

It is a feature of binary mechanisms that, as the motion of the oscillator is not under rigid control, there is a degree of impact as the oscillator changes over from one rest position to the other. The combination of short change-over time and substantial oscillator mass leads to excessive impacts and an excessive requirement of energy for generating the said force or forces.

It is the object of this invention to minimize the severity of the said impacts and also to minimize the said energy requirement.

In the present invention, the oscillator is suspended from a spring or spring system so arranged that, during the early part of the change-over, spring forces act to accelerate the oscillator, while during the latter part of the change-over, they act to decelerate the oscillator. By this means, the greater part of the energy associated with the change-over is released and stored again in the spring or spring system, and only energy losses incurred during the change-over need to be supplied.

To hold the oscillator at either of the said fixed positions, against the pull of the spring or spring system, capture/release mechanisms are provided at each of the fixed positions, able to exert short range forces exceeding the spring forces; by means of which the oscillator, when approaching the fixed positions, is attracted to and held at the fixed positions. To release the oscillator from the fixed positions at any time, the short range force is temporarily suppressed, whereupon the spring force sets the oscillator into motion, causing it to execute a half cycle of oscillation which brings it into the vicinity of the opposite fixed position, where it is again captured and held until released in the aforesaid manner.

In various embodiments of this invention, the said spring or spring systems may comprise elastic solids or suitabl- contained fluids. The said capture/release mechanisms may exert mechanical forces; forces due to pressure or vacuum; or forces due to magnetic fields. The best method of performing this invention known to me embodies springs of suitably formed elastic solids, and capture/release mechanisms exerting forces

due to permanent magnets which are neutralised and amplified by means of suitable electric current carrying coils to effect release and capture respectively.

Figure 1 illustrates a particular embodiment of the invention in which a binary mechanism is used to switch a poppet type valve between the full on and full off positions, which correspond to the rest positions of the oscillator which, in the present instance includes the valve. In Figure 1, the valve is shown in the half-open position at which the oscillator exhibits its greatest speed of motion.

With reference to Figure 1, two helical coil springs, 1 and 2, contained between valve body 13, and upper mounting plate 14, act on the ferromagnetic capture disk 11, tending to hold it in the position shown, so that a force is required to displace capture disk 11 and with it valve 12 either up or down.

Also attached to mounting plate 14 is the upper capture release mechanism comprising permanent magnet ring 3 preferably of non-conductive composition, and magnetised radially; ferromagnetic pole pieces 5 and 6, and power coil 9.

In like fashion mounting plate 15 supports the lower capture/release mechanism comprising permanent magnet ring 4; ferromagnetic pole pieces 7 and 8; and power coil 10; the mounting plates 14 and 15 being supported by a multiplicity of bolts 16 with tubular spacers 17 engaging with and held firmly upon the upper surface of valve body 13.

If, by means of an external agency, valve 12 is now pushed upwards, it will encounter an increasing spring force due to springs 1 and 2 as the capture disk 11 approaches pole

pieces 5 and 6. However, in the vicinity of the pole pieces 5 and 6, the magnetic force will equal the spring force, and as it is acting in the opposite direction, balance it. Further upward displacement will cause capture disk 11 to snap onto the pole pieces 5 and 6 and be held there indefinitely.

By means of power coil 9, the effect of permanent magnet 3 may be amplified with electric current of suitable polarity, and by this means the said balance of forces may be achieved at a greater distance from pole pieces 5 and 6. Conversely, by reversing the polarity of the electric current in power coil 9, the effect of permanent magnet 3 may be partially or wholly cancelled, thereby effecting the release of capture disk 11 from the upper capture/release mechanism.

At the instant that capture disk 11 is released by the upper capture/release mechanism, the oscillator, comprising in this instance capture disk 11 and valve 12 , proceeds to execute a half cycle of oscillation beginning from rest at the upper pole pieces 5 and 6 and ending again at rest in the vicinity of the lower pole pieces 7 and 8, except that the magnetic force due to pole pieces 7 and 8, imposes an additional displacement causing capture disk 11 to snap against the lower pole pieces 7 and 8 and remain there.

Power coils 9 and 10 may be connected in series or parallel, to form a single electric circuit, but in opposed sense, so that the effect of the one magnet is amplified when that of the other is diminished. When this is done, current effecting release from one capture/release mechanism needs only to be sustained until the oscillator is re-captured by the opposite capture/release mechanism to amplify the action of the capturing magnetic force during re-capture.

The neutral position of the said oscillator is that where there is no nett spring force and lies between the fixed positions. Where the oscillator encounters a greater resistance in one direction of motion than the other, the fixed positions are unequally disposed about the neutral position. Now the said oscillator, after encountering the greater resistance, is captured at the fixed position closer to the neutral point, and after encountering the lesser resistance, the oscillator is captured at the fixed position further from the neutral point.

So far the capture/release mechanisms have been presented as the sole source of external energy to the oscillator. However, instances are envisaged, where it is desirable to supply a portion of the external energy by means other than the capture/release mechanisms, and at different points in the motion of the oscillator, to best compensate for the resistance to the motion of the oscillator in special cases.

The disadvantages of binary mechanisms in the present state of the art, to which this invention is directed, become most significant for oscillators of substantial mass and short change-over times.

It is envisaged that the present invention could be used to great advantage in high voltage, high power switching equipment; in internal combustion engines where total control of valve timing permits substantial improvement in part load efficiency, as well as increased maximum power; in gas and vapour expanders with variable inlet valve cut-off, for which the present invention is ideally suited; in mechanical indexing where random timing is necessary; as well as many of the applications for which solenoid type actuators are presently used.

The claims defining the invention are as follows:

Claim 1. A mechanism comprising an oscillator free to move between two fixed positions, but suspended from a spring or spring system in such a manner that its motion is substantially a half cycle of oscillation starting from rest at the one fixed position and ending at rest again at the other fixed position, and two capture/release mechanisms by means of which the oscillator is captured when in the vicinity of either of these fixed positions, and from which it may be released at will to be subsequently captured by the opposite capture/release mechanism. ~~(3rd December, 1979).~~

Claim 2. A mechanism as claimed in claim 1 in which the capture/release mechanisms each comprise a permanent magnet (preferably with little or no electrical conductivity), an electric coil able to neutralise or amplify the effect of the permanent magnet, ferromagnetic pole pieces by which magnetic forces are exerted and a ferromagnetic armature integral with the said oscillator, upon which the magnetic forces act. The electric coils of each of the two capture/release mechanisms may be energized independently or connected to form a single circuit, but in opposite sense so that when the effect of one magnet is amplified by flow of current in a given direction in this circuit, the effect of the second magnet is neutralised. ~~(3rd December, 1979)~~.

Claim 3. A mechanism as claimed in claims 1 and 2 in which the capture/release mechanisms are positioned unequally with respect to the oscillatory motion to compensate for unequal resistance to the motion of the oscillator in the two directions of motion. ~~(3rd December, 1980)~~

Claim 4. A mechanism as claimed in claim 1 in which the said spring or spring system may be a suitably confined gas or liquid. ~~(3rd December, 1979).~~

Claim 5. A mechanism as claimed in claim 1 in which the said capture/release mechanisms utilize fluid pressure or vacuum to capture the oscillator. (3rd December, 1979).

Claim 6. A mechanism as claimed in claim 1 in which the said capture/release mechanism comprises levers, links and other necessary parts to enable it to act on the oscillator mechanically. ~~(3rd December, 1979).~~

Claim 7. A mechanism as claimed in claim 1 in which a further means is provided to impart additional energy to the said oscillator in one or both directions of motion. (3rd December, 1979).

Claim 8. A mechanism as claimed in claim 1 in which the said oscillator is a valve which may be switched between two states corresponding to the two fixed positions of the oscillator. ~~(3rd December, 1979).~~

AMENDED CLAIMS

(received by the International Bureau on 27 April 1981 (27.04.81))

CLAIM 1

(Amended)

A mechanism comprising an oscillator, free to move between two fixed positions, but suspended from a spring or spring system in such a manner that its motion is substantially a half cycle of oscillation starting from rest at the one fixed position and ending at rest again at the other fixed position, and two capture/release mechanisms by means of which the oscillator is captured when in the vicinity of either of these fixed positions and brought to the fixed position, from which it may be released at will to be subsequently captured by the opposite capture/release mechanism ~~(3rd December, 1979)~~.

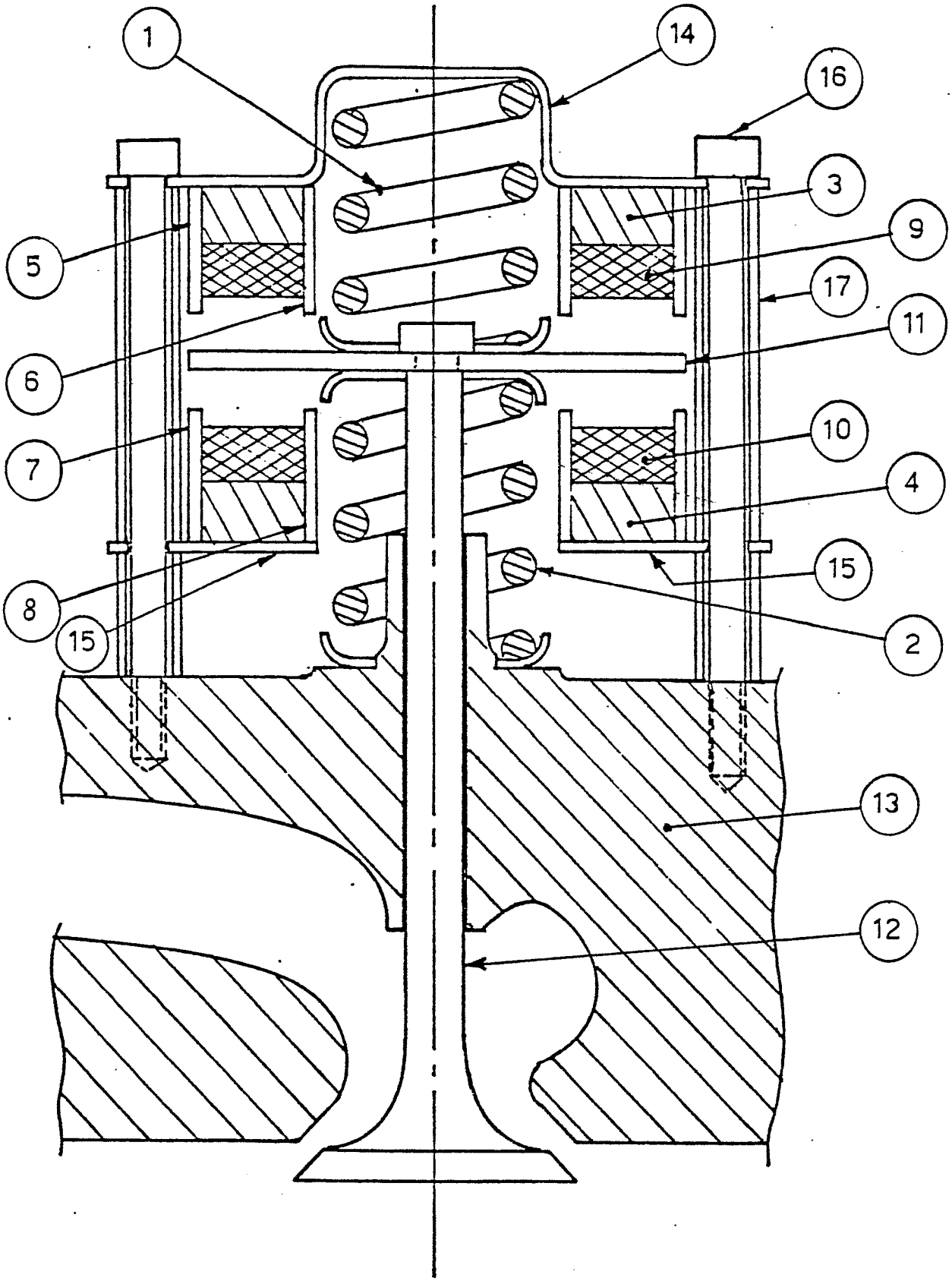

FIGURE 1

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 80/00105

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl.[3] H01H 51/01, 51/06, 5/06, 3/60, H02K 33/12

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	H01H 51/00, 51/01, 51/06, H02K 33/12
US Cl.	335/170, 335/171, 335/192, 335/233, 335/257

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

AU:IPC as above; Australian Classification 02(S), 04.22

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	FR, A, 1428611, published 1966, Jan. 10, see fig. 3, Les Modeles Francais, Anciens Establissements R. Gaume, Societe Anonyme.	1, 2, 6
X	AU, B, 47843/68 (427851), published 1970, Jun. 18, see fig. 1, Allis-Chalmers Manufacturing Company.	1, 2
X	AU, B, 67283/65, published 1967, Jun. 1, see fig. 1, Jennings Radio Manufacturing Corporation.	1, 6
X	US, A, 3569878, published 1971, Mar. 9, see fig. 2, William E. Grass, Robert D. Boley	1, 2
X	US, A, 3444490, published 1969, May 13, see figs. 1,2,7-11, Donald E. Krummel and David L. Bowles.	1, 2
X	US, A, 1971199, published 1934, Aug. 21, see figs. 1,3, Joseph W. Owens.	1, 6
X	US, A, 3629746, published 1971, Dec. 21, see fig. 1, Victor E. DeLucia.	1, 2
X	AU, B, 36650/50 (154940), published 1950, Nov. 2, see fig. 1, Thomas Kim Hodgkinson.	1
X	FR, A, 1043703, published 1953, Nov. 10, see fig. 1, Societe D'Etudes Et Recherches Commerciales Et De Courtage.	1

* Special categories of cited documents: [15]

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
23 January 1981 (23.01.81)	27 January 1981 (27.01.81)
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Australian Patent Office	A.S. Moore

Form PCT/ISA/210 (second sheet) (October 1977)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

X	DE, C, 883173, published 1953, Jul. 16, see Fig. 2, Folke Bruno Soderstrom	1
X	US, A, 3569890, published 1971, Mar. 9, see fig. 1, Ezio Baratelli	1
X	US, A, 3484629, published 1969, Dec. 16, see fig. 1, Paul-Albert Kunz.	1
X	AU, B, 87475/75 (503085), published 1977, Jun. 16, see figs. 1,3,10,17, Matsushita Electric Works Ltd., and Hans Sauer.	
X	AU, B, 83375/75(504993), published 1977, Jan. 27, see figs. 2, 9, 12, SDS-Elektro GMBH and Matsushita Electric Works Ltd.	1,2

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers....., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.