

June 28, 1960

H. SPODIG

2,943,216

POWER TOOL AND MAGNETIC MOTION CONVERTER FOR USE THEREWITH

Filed Feb. 5, 1957

2 Sheets-Sheet 1

Fig 1

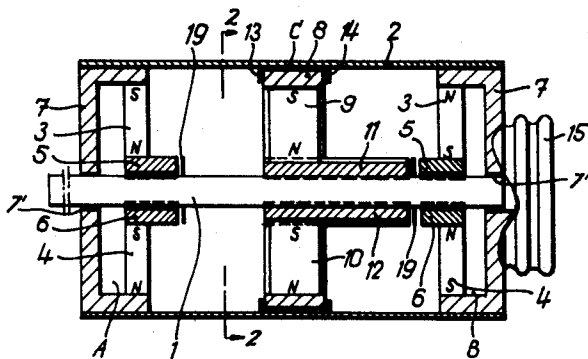


Fig 2

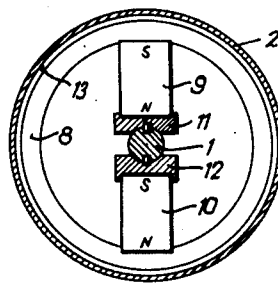


Fig 3

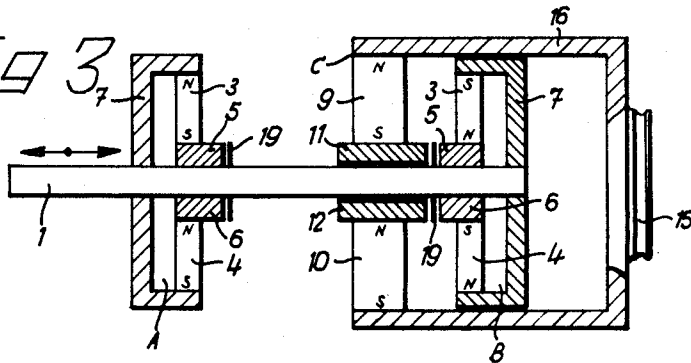
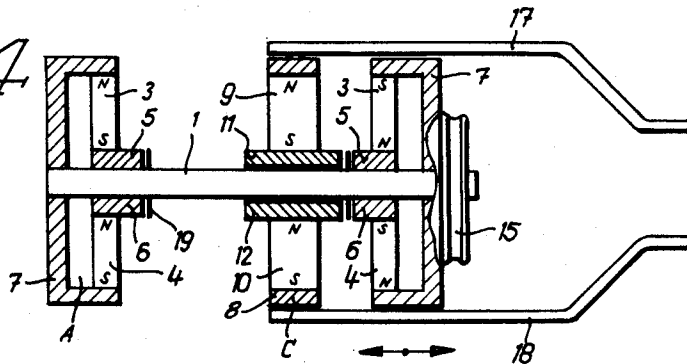


Fig 4



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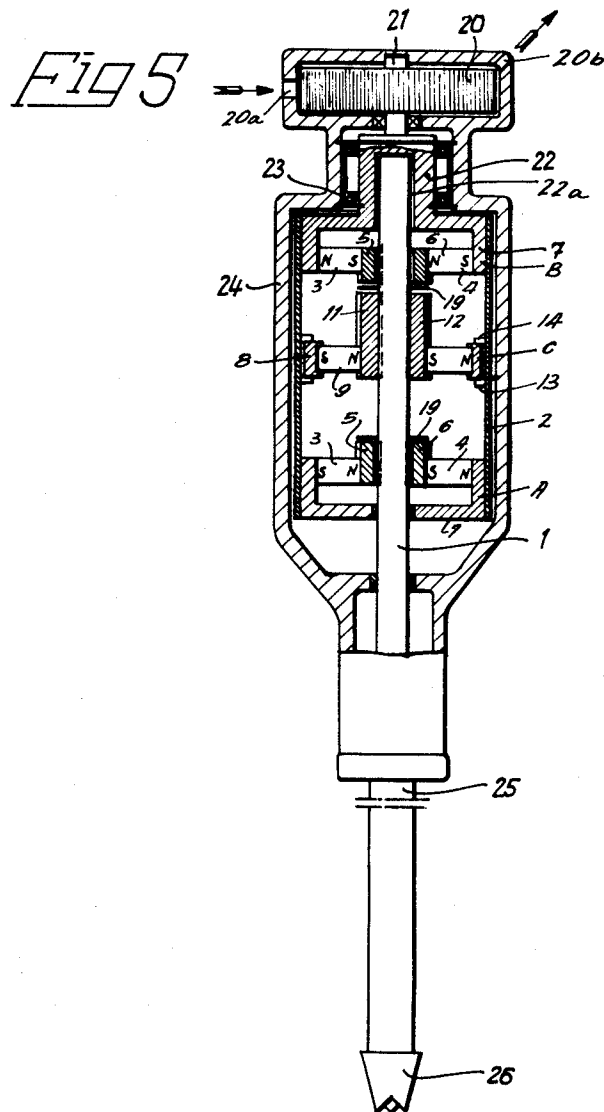
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POWER TOOL AND MAGNETIC MOTION CONVERTER FOR USE THEREWITH

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18 Claims. (Cl. 310—103)

The present invention relates to a power tool as well as to a magnetic motion converter for use therewith.

More particularly, the present invention relates to a power tool of the type in which the tool itself is continuously reciprocated with great force, such as a power hammer or drill or the like.

There exist power tools in which compressed air is used to reciprocate a piston with which the tool moves. Such an arrangement requires the use of complicated valves and other control devices which are expensive to construct and maintain. Also, known power tools are inherently rather inefficient so that large compressors, which consume considerable power, must be provided in order to operate the tool.

It is therefore an object of the present invention to provide a power tool which overcomes the above disadvantages.

It is another object of the present invention to provide a power tool which comprises a minimum of parts each of which may be mass-produced at low cost, so that the power tool may be built and sold at low cost.

The objects of the present invention also include the provision of a power tool which will give long periods of trouble-free service.

It is yet another object of the present invention to provide a power tool which may readily be operated by any available suitable source of power.

It is a still further object of the present invention to provide a power tool in which the power input can be in the form of rotary motion, which rotary motion is transformed by the power tool into reciprocation for driving the tool proper.

With the above objects in view, the present invention mainly consists in that improvement in power tools which comprises a tool and means operatively associated with the tool for reciprocating the same, these means being in the form of a magnetic motion converter for converting rotary motion into reciprocation. More particularly, the means include a rotatable component, a reciprocable component connected to the tool and movable therewith, and magnetic motion converting means interconnecting the components for converting rotation of the rotatable component into reciprocation of the reciprocable component.

It is still another object of the present invention to provide an efficient magnetic motion converter capable of converting rotation into reciprocating movement.

The present invention has a further object the provision of a magnetic motion converter which incorporates permanent magnets the magnetization of which is retained for long periods of time.

With these objects in view, the present invention further resides in a magnetic motion converter which includes rotatable and reciprocable components. One of the components includes a pair of similarly constructed axially spaced magnet members each of which incorporates at least a pair of opposite pole shoes and magnet

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means for imparting opposite polarities thereto, respectively, each of the magnet members being so constructed and arranged that each pole shoe of each magnet member is opposite a pole shoe of the other magnet member which has an opposite polarity. The other component includes a magnet member which incorporates at least one pole shoe and magnet means for imparting a predetermined polarity thereto. The last-mentioned magnet member is arranged between the other two magnet members in such a manner that the components are rotatable as well as axially movable relative to each other, the above-mentioned other component being so constructed and arranged that its pole shoe is capable of being simultaneously in the magnetic field emanating from two opposite pole shoes of the pair of magnet members.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a sectional view of one embodiment of a magnetic motion converter according to the present invention, which motion converter is adapted to be used in a power tool or the like;

Fig. 2 is a sectional view taken substantially along line 2—2 of Fig. 1;

Fig. 3 is a sectional view of another embodiment of a magnetic motion converter according to the present invention;

Fig. 4 is a sectional view of yet another embodiment of a magnetic motion converter according to the present invention; and

Fig. 5 is a sectional view of a power tool incorporating a magnetic motion converter according to Fig. 1.

Referring now to the drawings, and to Figs. 1 and 2 thereof in particular, there is shown a magnetic motion converter which is adapted to be used in a power tool. The motion converter comprises a rotatable component as well as a reciprocable component, the former of which includes a pair of spaced magnet members A and B which are firmly connected to each other by way of a housing or shell 2. Each magnet member is composed of a yoke or cup-shaped element 7 made of magnetic material, i.e. a material capable of transmitting magnetic flux, at least one pair of radially extending permanent bar magnets 3, 4 and axially extending pole shoes 5, 6 associated with the bar magnets 3 and 4, respectively. The magnet members A and B are similar in construction and are so placed that the pole shoes of each magnet member are opposite the pole shoes of the other magnet member. However, the polarities of the bar magnets are such that each pole shoe of each magnet member is opposite a pole shoe of the other magnet member which is of opposite polarity. Thus, the pole shoe 5 of the magnet member A is of N polarity whereas the opposite pole shoe 5 of the magnet member B is of S polarity, and the pole shoe 6 of the magnet member A is of S polarity whereas the pole shoe 6 of the magnet member B is of N polarity, as may readily be seen from Fig. 1.

The reciprocable component includes a central axle 1 made of non-magnetic material which passes between the pole shoes 5, 6 of each of the magnet members A and B, as well as through central openings 7' formed in the elements 7, so that the axle 1 and the magnet members A and B are freely rotatable as well as axially movable relative to each other. The reciprocable component further includes a magnet member C which incorporates an annular yoke 8 made of magnetic material, a pair of radially extending permanent bar magnets 9, 10

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and a pair of axially extending pole shoes 11, 12 associated with the bar magnets 9 and 10, respectively. The magnets are so arranged as to impart opposite polarities to the pole shoes 11 and 12, and in the embodiment illustrated in Fig. 1, the pole shoe 11 has an N polarity whereas the pole shoe 12 has an S polarity. The magnet member C is so constructed that when one of its pole shoes as, for example, the pole shoe 11, is between the pole shoes 5 of the magnet members A and B and therefore in the magnetic fields emanating from both of these pole shoes 5, the other pole shoe 12 is between the pole shoes 6 of the magnet members A and B and therefore in the magnetic fields emanating from both of these pole shoes 6.

A pair of retaining rings 13 and 14 are provided for securing the annular yoke 8 together with the bar magnets 9 and 10 against axial displacement relative to the housing 2, whereas the pole shoes 11 and 12 which are firmly connected to the axle 1 for movement therewith are freely slidable relative to the magnets 11 and 12 which impart the N and S polarities to the pole shoes 11 and 12, respectively.

The rotatable component is mounted for rotation in any suitable manner (not shown in Figs. 1 and 2), so that the rotatable component may rotate freely relative to the reciprocable component incorporating the axle 1 and the magnet member C. Suitable driving means are provided for rotating this rotatable component. This may be accomplished by attaching a driving motor directly to the rotatable component, or by attaching thereto a driving wheel 15 which, in turn, is driven by a suitable power source. The driving wheel 15 may be attached directly to the yoke 7 of one of the magnet members A or B.

By virtue of the above arrangement, the reciprocable component will not be rotated upon rotation of the rotatable component, but will only be reciprocated relative thereto. This is accomplished as a result of the changing angular position of the pole shoes 5, 6. For instance, it will be seen that when the parts occupy the position shown in Fig. 1, the pole shoes 11 and 12, together with the axle 1, will be attracted by the magnet member B and repelled by the magnet member A. However, after the magnet members A and B have been rotated 180°, the pole shoes 5 will be in alignment with the pole shoes 12 and the pole shoes 6 will be in alignment with the pole shoe 11, so that the pole shoes 11 and 12, together with the axle 1, will be attracted by the magnet member A and be repelled by the magnet member B. The pole shoes 11, 12 and axle 1 will therefore move leftwardly, as viewed in the drawings.

Similarly, further rotation of the magnet members A and B throughout an angular distance of 180° will restore the parts to their positions shown in Fig. 1, so that continuous rotation of the rotatable component will be seen to produce reciprocation of the reciprocable element. Such reciprocation may be imparted to a hammer or other tool connected to or carried by the reciprocable element, as, for example, at the free end of the axle 1.

The above-described magnetic motion converter has been found to be particularly efficient inasmuch as the mass of the reciprocable component is quite small, and includes only the axle 1 and the pole shoes 11 and 12. Consequently, relatively little driving power is necessary for rotating the rotatable component so as to produce reciprocation of the tool.

As may readily be seen from the drawing, the magnets of each magnet member are arranged diametrically opposite each other, and the pole shoes associated with the magnets partly encompass the axle 1, suitable spacing being maintained so as to avoid mutual attraction between the pole shoes of each magnet. Moreover, the pole shoes 5, 6 are so constructed as to cause the lines of magnetic flux generated by each of the magnets 3, 4 to be directed toward the pole shoes 11, 12 associated with the magnets 9, 10 of the magnet member C. In this

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way, strong attraction as well as repulsion is obtained between each of the pair of magnet members A and B and the magnet member C, thereby causing rapid shifting of position of the reciprocable component whenever the rotatable component changes its angular position relative thereto. This, in turn, produces smooth and steady reciprocation of the pole shoes 11, 12 and the axle 1 during rotation of the magnetic members A and B.

Moreover, the provision of the yokes 7 and 8 practically eliminates all stray fields, so that the entire magnetic fields generated by the bar magnets are concentrated in the gap between the pole shoes. This serves to preserve the magnetization and consequently the useful life of the permanent magnets.

Additionally, the housing 2 may be made of magnetic material and be in contact with the yokes 7 for providing a low-reluctance return path for the lines of magnetic flux traversing the spaces between the pole shoes of the rotatable and reciprocable components, thereby further reducing any stray fields.

If desired, suitable shock-absorbing means may be arranged between the magnet members A, B and the magnet member C so as to prevent excessively abrupt impacts. Such shock-absorbing means may be in the form of hard rubber disks 19.

The embodiment illustrated in Fig. 3 differs from the above-described one in that it is the reciprocable, rather than the rotatable component, which includes the pair of magnet members A and B, whereas the rotatable component includes the magnet member C, the latter incorporating a yoke or deep cup-shaped element 16 to take the place of the annular yoke 8, which element carries the driving wheel 15. In this embodiment, the axle 1 is firmly secured to the magnet members A and B and is freely slidable relative to the pole shoes 11 and 12 which are firmly secured to the bar magnets 9 and 10. Inasmuch as rotation of the rotatable component, which includes the magnet member C, will not cause rotation of the axle 1 or of the magnet members A and B, these elements will be reciprocated for the reasons set forth above in connection with the previously described embodiment.

If desired, the embodiment shown in Fig. 3 may be so constructed that only the pole shoes 5 and 6 are reciprocated with the axle 1, in which case these pole shoes are suitably mounted for sliding movement relative to their respective bar magnets. In this way, the mass of the reciprocable parts is reduced.

The embodiment illustrated in Fig. 4 is similar to that shown in Fig. 1 in that the rotatable component incorporates the two magnet members A and B and the reciprocable component includes the magnet member C. In this embodiment, however, the magnet members A and B are connected to each other by the axle 1 which is firmly attached to these magnet members, whereas the pole shoes 11 and 12, which are firmly attached to the magnets 9 and 10, respectively, are freely movable relative to the axle 1. Thus, when the rotatable component is rotated, the magnet member C together with arms 17 and 18 attached to the annular yoke 8 is reciprocated in the manner described above. In this way, a tool connected to the arms 17 and 18 is reciprocated.

Fig. 5 illustrates a power tool which incorporates a magnetic motion converter possessing substantially the characteristic features of the embodiment shown in Fig. 1, it being understood, however, that the structural details of the motion converter may be different, and may, for example, resemble the embodiments shown in Figs. 3 and 4. In the arrangement shown in Fig. 5, the rotatable component of the motion converter is driven by a compressed air operated rotor 20 which is mounted upon a shaft 21 connected to a cylindrical boss portion 22 forming part of the yoke 7 of the magnet member B, the

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compressed air being supplied to the rotor 20 by way of an inlet 20a and leaving the chamber housing this rotor through an outlet 20b.

The boss portion 22 is rotatably mounted in the power tool housing 24, suitable roller bearings 23 or the like being provided for this purpose. The uppermost end of the axle 1, as viewed in Fig. 5, is freely rotatable and slidable within a bore 22a of the boss portion 22, so that when compressed air is supplied to the rotor 20, the axle 1 is reciprocated. The latter carries at its lower end an attaching rod 25 which, in turn, carries the tool 26 which is illustrated as a drill. If desired, the lowermost end of the axle 1 may be hardened or be provided with a hardened connecting piece.

If desired, other means than the one shown in Fig. 5 may be provided for rotating the rotatable component of the magnetic motion converter. For example, the rotatable component may carry a wheel 15 which is rotated by an external drive. Alternatively, a suitable electric motor may be substituted for the compressed air operated rotor 20.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of power tools and magnetic motion converters differing from the types described above.

While the invention has been illustrated and described as embodied in a power tool incorporating a magnetic motion converter, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a power hammer or the like, in combination, an axle for a tool mounted movably in axial direction but not rotatable about its axis; and means operatively associated with said tool for reciprocating the same, said means including a magnetic motion converter for converting rotary motion into reciprocation, said motion converter including a rotatable component being rotatable about its axis but axially confined and a reciprocatable component mounted on said axle and movable therewith only in axial direction of said axle, one of said components including a pair of similarly constructed axially spaced magnet members each of which incorporates at least a pair of opposite pole shoes and magnet means for imparting opposite polarities thereto, respectively, each of said magnet members being so constructed and arranged that each pole shoe of each magnet member is opposite a pole shoe of the other magnet member which has an opposite polarity, the other of said components including a magnet member which incorporates at least one pole shoe and magnet means for imparting a predetermined polarity thereto, said magnet member of said other component being arranged between said pair of magnet members of said one component in such a manner that said components are rotatable as well as axially movable relative to each other, said other component being so constructed and arranged that its pole shoe is capable of being simultaneously in the magnetic fields emanating from two opposite pole shoes of said pair of magnet members so that when said one pole shoe is between one set of opposite pole shoes of said pair of magnet members, said one pole shoe is attracted by the pole shoe of one of said pair of magnet members and

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is repelled by the pole shoe of the other of said pair of magnet members, whereas when said one pole shoe is between the other set of pole shoes of said pair of magnet members, said one pole shoe is repelled by the pole shoe of said one of said pair of magnet members and is attracted by the pole shoe of said other of said pair of magnet members, whereby when said rotatable component is rotated, said reciprocatable component together with said tool is reciprocated; and means independent of said axle for rotating said rotatable component without shifting it in axial direction.

2. In a power hammer or the like, in combination, an axle for a tool mounted movably in axial direction but not rotatable about its axis; and means operatively associated with said tool for reciprocating the same, said means including a magnetic motion converter for converting rotary motion into reciprocation, said motion converter including a rotatable component being rotatable about its axis but axially confined and a reciprocatable component mounted on said axle and movable therewith only in axial direction of said axle, one of said components including a pair of similarly constructed axially spaced magnet members each of which incorporates at least a pair of diametrically opposite pole shoes and magnet means for imparting opposite polarities thereto, respectively, each of said magnet members being so constructed and arranged that each pole shoe of each magnet member is opposite a pole shoe of the other magnet member which has an opposite polarity, the other of said components including a magnet member which incorporates a pair of diametrically opposite pole shoes, and magnet means for imparting opposite polarities thereto, respectively, said magnet member of said other component being arranged between said pair of magnet members of said one component in such a manner that said components are rotatable as well as axially movable relative to each other, said other component being so constructed and arranged that one of its pole shoes is simultaneously in the magnetic fields emanating from one set of two opposite pole shoes of said pair of magnet members while the other of the pole shoes of said other component is simultaneously in the magnetic fields emanating from the other set of two opposite pole shoes of said pair of magnet members, whereby when said rotatable component is rotated, said reciprocatable component together with said tool is reciprocated; and means independent of said axle for rotating said rotatable component without shifting it in axial direction.

3. The combination defined in claim 2 wherein said one component including the pair of spaced magnet members in said rotatable component and said other component including said axle is said reciprocatable component.

4. The combination defined in claim 2 wherein said one component including said pair of spaced magnet members and said axle is said reciprocatable component and said other component is said rotatable component.

5. The combination defined in claim 3 wherein said rotatable component further includes housing means interconnecting said pair of magnet members and encompassing said magnet member of said reciprocatable component.

6. The combination defined in claim 2, and means operatively associated with said rotatable component for rotating the same.

7. The combination defined in claim 3 wherein only said pole shoes of said reciprocatable component are movable with said tool and are reciprocatable relative to the remainder of said reciprocatable element; and means for preventing reciprocation of said remainder of said reciprocatable component.

8. The combination defined in claim 5, wherein the magnet means of each magnet member includes at least two permanent magnets one pole of each magnet being in contact with the pole shoes of the responsive magnet member, respectively, and an element made of magnetic

material and contacting the other pole of each magnet thereby placing said magnets in series with each other.

9. The combination defined in claim 8 wherein said housing means are made of magnetic material and are in contact with said elements of said magnet members for providing a low-reluctance return path for the lines of magnetic flux traversing the spaces between the pole shoes of said rotatable and reciprocable components.

10. The combination defined in claim 3 wherein said pair of magnet members of said rotatable component are mounted on said axle element for concomitant rotation relative thereto.

11. The combination defined in claim 10 wherein each of said pole shoes at least partly encompass said axle element.

12. The combination defined in claim 3 wherein said rotatable component includes said axle arranged connecting said pair of magnet members to each other for concomitant rotation, and wherein said magnet member of said reciprocable element is mounted on said axle for rotation and axial movement relative thereto.

13. The combination defined in claim 4 wherein said reciprocable component includes said axle arranged connecting said pair of magnet members to each other for concomitant reciprocation, and wherein said magnet member of said rotatable element is mounted on said axle for rotation and axial movement relative thereto.

14. The combination defined in claim 13 wherein said rotatable component further includes housing means encompassing at least one of said pair of magnet members of said reciprocable component; and means operatively associated with said housing for rotating said rotatable component.

15. The combination defined in claim 2, and shock-absorbing means interposed between the magnet member of said other component and each of said pair of magnet members of said one component.

16. A magnetic motion converter for converting rotary motion into reciprocation, comprising, in combination, an axle mounted movably in axial direction but not rotatable about its axis, a rotatable component being rotatable about its axis but axially confined and a reciprocable component mounted on said axle and movable therewith only in axial direction of said axle, one of said components including a pair of similarly constructed axially spaced magnet members each of which incorporates at least a pair of opposite pole shoes and magnet means for imparting opposite polarities thereto, respectively, each of said magnet members being so constructed and arranged that each pole shoe of each magnet member is opposite a pole shoe of the other magnet member which has an opposite polarity, the other of said components including a magnet member which incorporates at least one pole shoe and magnet means for imparting a predetermined polarity thereto, said magnet member of said other component being arranged between said pair of magnet members of said one component in such a manner that said components are rotatable as well as axially movable relative to each other, said other component being so constructed and arranged that its pole shoe is capable of being simultaneously in the magnetic fields emanating from two opposite pole shoes of said pair of magnet members so that when said one pole shoe

is between one set of opposite pole shoes of said pair of magnet members, said one pole shoe is attracted by the pole shoe of one of said pair of magnet members and is repelled by the pole shoe of the other of said pair of magnet members, whereas when said one pole shoe is between the other set of pole shoes of said pair of magnet members, said one pole shoe is repelled by the pole shoe of said one of said pair of magnet members and is attracted by the pole shoe of said other of said pair of magnet members, whereby when said rotatable component is rotated, said reciprocable component is reciprocated; and means independent of said axle for rotating said rotatable component without shifting it in axial direction.

17. A magnetic motion converter for converting rotary motion into reciprocation, comprising, in combination, an axle mounted movably in axial direction but not rotatable about its axis, a rotatable component being rotatable about its axis but axially confined and a reciprocable component mounted on said axle and movable therewith only in axial direction of said axle, one of said components including a pair of similarly constructed axially spaced magnet members each of which incorporates at least a pair of diametrically opposite pole shoes and magnet means for imparting opposite polarities thereto, respectively, each of said magnet members being so constructed and arranged that each pole shoe of each magnet member is opposite a pole shoe of the other magnet member which has an opposite polarity, the other of said components including a magnet member which incorporates a pair of diametrically opposite pole shoes and magnet means for imparting opposite polarities thereto, respectively, said magnet member of said other component being arranged between said pair of magnet members of said one component in such a manner that said components are rotatable as well as axially movable relative to each other, said other component being so constructed and arranged that one of its pole shoes is simultaneously in the magnetic fields emanating from one set of two opposite pole shoes of said pair of magnet members while the other of the pole shoes of said other component is simultaneously in the magnetic fields emanating from the other set of two opposite pole shoes of said pair of magnet members, whereby when said rotatable component is rotated, said reciprocable component is reciprocated; and means independent of said axle for rotating said rotatable component without shifting it in axial direction.

18. A magnetic motion converter as defined in claim 17 wherein the magnet means of each magnet member includes at least two permanent magnets one pole of each magnet being in contact with the pole shoes of the respective magnet member, respectively, and an element made of magnetic material and contacting the other pole of each magnet thereby placing said magnets in series with each other.

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