

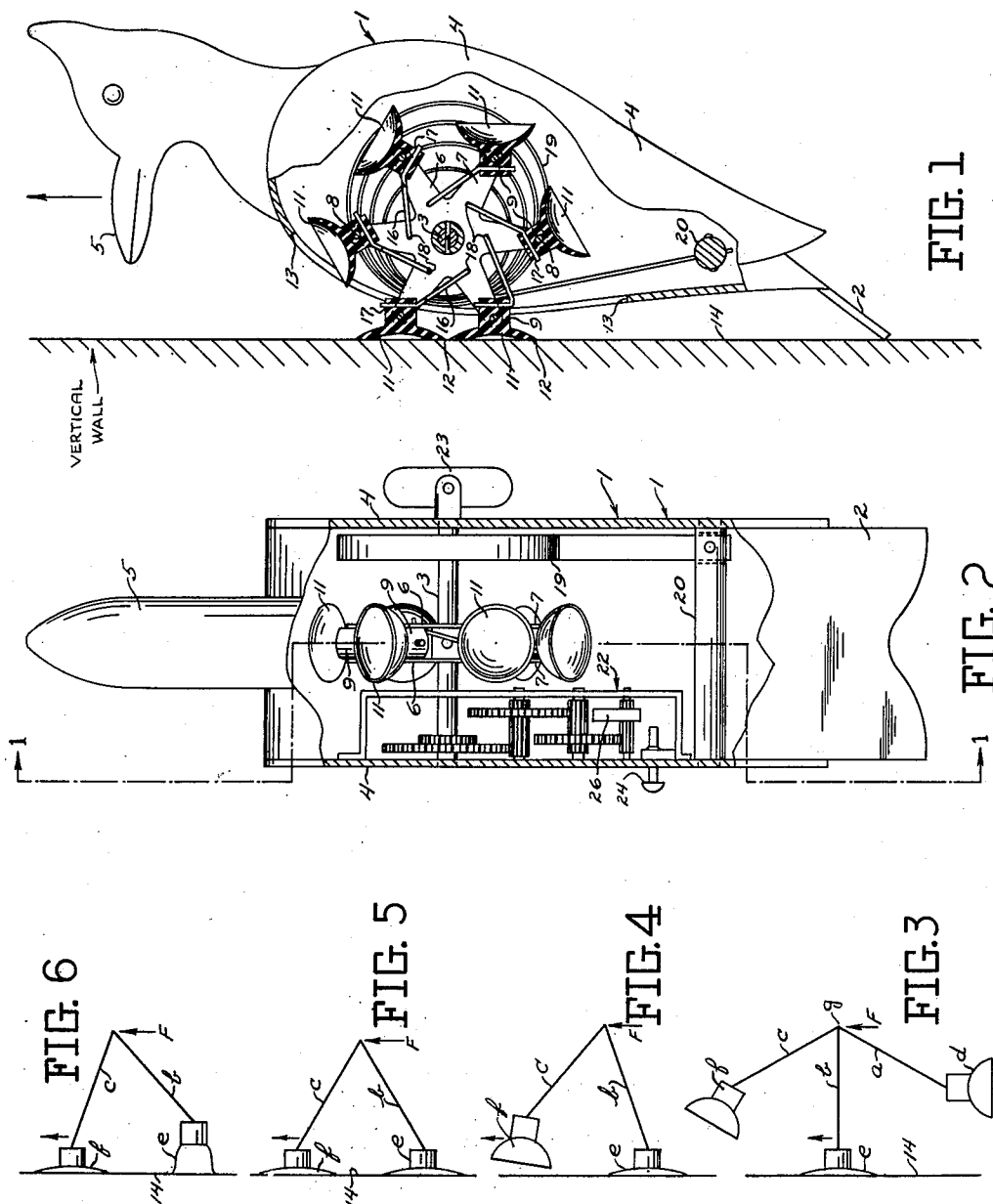
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CLIMBING TOY

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2 SHEETS—SHEET 1



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CLIMBING TOY

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This invention relates to a device adapted to adhere to a surface and to move along such surface through self-contained power means, irrespective of the inclination of the surface. The device is capable of moving up a vertical surface in direct opposition to the force of gravity and also of moving across a ceiling with its weight dependent therefrom.

In a preferred form, the invention comprises a toy formed in the simulation of a bird or other climbing animal, but is to be carefully distinguished from devices which are enabled to climb through the expedient of a definite interlock of some kind and which can only climb along a track specially constructed or adapted for the purpose. This invention depends only upon an intersurface attraction and an arrangement which makes and breaks the engagement with a surface in successive steps to effect a continuous progress of the object.

It is, therefore, an object of the invention to provide a vehicle which will support itself against the action of gravity while propelling itself along a smooth surface. Otherwise stated, it is an object to provide a vehicle which will support itself against the action of gravity while propelling itself along a surface of any inclination whatever, and without any positive interlock with the surface.

More particularly, it is an object to provide a self-propelling device adapted to make and break, successively, a holding contact with a surface while progressively moving along the surface.

These and other ends, which it is believed have never been achieved heretofore except by a living agency, are attained by the present invention, certain preferred and proven forms of which are described in the following specification and illustrated in the drawings, in which:

Fig. 1 is a side elevation of a mechanical bird attached to a vertical wall, and partly broken away to show the interior mechanism.

Fig. 2 is a top view of the bird of Fig. 1 with a portion of the upper shell broken away.

Figs. 3 to 6 are schematic views showing the action of the vacuum cup foot members in successive stages.

Figs. 7 and 8 are views similar to Fig. 1 showing modified forms of traction units.

Fig. 9 is an enlarged detail of a modified foot member of the type shown in Fig. 7.

Fig. 10 is a fragmentary view showing a modified foot member.

Figs. 11 and 12 are reduced views similar to

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Fig. 1 illustrating the employment of alternative power means.

Referring to the drawings by characters of reference, there is shown in Figs. 1 and 2 an ambulatory mechanism in the semblance of a bird, namely a woodpecker, having a torso 1 within which the power mechanism and associated elements are contained, and having a tail 2 and a head with a beak 5. Keyed to a main shaft 3, which is journaled in the sides 4 of the torso, are a pair of star wheels 6, each pair of spokes 7 of the wheels bearing near their outer ends a small shaft 8 on which is mounted the shank 9 of a suction cup 11. This arrangement permits variation of the angular relation of the suction cup to a radius of the wheel 6 passing through the shaft 8. Obviously, the cup may be rotatable on the shaft 8, but preferably it will have a tight fit thereon and the shaft will be rotatable in the spokes 7. The cups 11 are flared and have feathered peripheral edges as shown at 12 so that they may be applied with a light force, provide a close, tight seal, and respond favorably to withdrawal forces.

The cup members 11, in the region of their circular path at the lower side of the torso 1, pass out through a suitable opening 13 so as to extend somewhat from the torso for engagement with a surface 14 over which the bird is to travel.

It will be noted that each cup 11 in its normal position when out of engagement with the surface 14 is arranged at an angle to the radius of the wheel 6 passing through its shaft 8. This is to ensure that as each cup approaches engagement with the surface 14 it will be substantially parallel thereto and effect, almost instantly, complete peripheral contact therewith. The most favorable angle at which the cups are set is a matter dependent upon the number of cups. If the cups are numerous, the angle may approach actual perpendicularity with the radius while, if they are few in number (and it is possible to operate the device with as few as two), the angle will be increasingly varied from perpendicularity.

The cups are yieldingly held at their normal angular position, and this may be accomplished in a variety of ways. As shown in Fig. 1, a rubber strand 16 is anchored, as at 17, in a portion of the shank 9 of each cup, inwardly of shaft 8, and has its other end anchored at an inner portion of the wheel, as at 18. The position of equilibrium of cup 11 will be that position in which the line of force of the strand 16 passes through the shaft 8. Thus, turning of the shank 9 about shaft 8 in either direction will move the line of action of strand 16 so that it no longer passes

through shaft 8, and thus give rise to a moment about the axis of shaft 3. The shank will thus return to equilibrium position when the cup is free of the surface.

The wheels 6 may be turned by any convenient form of power means. For purposes of illustration, there is shown a spiral spring 19 anchored at one end to the main shaft 3 and at its other end to a cross member 20 extending between the sides 4 of the body of the bird. While the latter mentioned end of the spring is fixed in the region of the tail 2 of the bird, its particular location on the body is immaterial since the only requisite in this respect is a system providing reaction between the shaft 3 and the body of the bird as a whole, the ultimate reaction being on surface 14 through tail 2, whereby there is a tendency to turn the body clockwise about shaft 3 when the spring is wound.

It is, of course, desirable to properly time the release of energy and therefore a gear train indicated generally at 22 is connected to the main shaft 3 to slow down the unwinding of the spring. Some form of escapement may also be included and this will provide a clicking sound which will render the representation of a woodpecker or other birds or animals more realistic. The usual winding key 23 is attached to an end of shaft 3, and a detent 24, slidable through a side of the body of the bird, serves to intercept a vane 26 on the end wheel of the gear train to lock the motor as during winding or whenever desirable. The vane 26, through air resistance or through its inertia, or both, will further function to slow down the rate of unwinding and reduce the number of pinions required in the gear train.

The action of the device of Fig. 1 will now be described. The suction cups are so designed that any single one, when in firm engagement with a satisfactorily smooth surface, will sustain the weight of the bird against the action of gravity for the inclination of climb intended, the operation, of course, being most spectacular in the extreme cases where the bird is adapted to climb a strictly vertical wall or move across a ceiling. In the operation, at least one cup is in complete holding engagement with the surface at all times. With the motor wound, the bird is merely pressed against the wall surface. At least one, and possibly two cups will be in position to adhere to the wall. The spring reacts against surface 14 through tail 2 and the wheels 6 will turn, with the bird as a whole progressing in the direction of its head but with the engaged cup continuing to hold fast to the surface 14 and its shank 9 turning on its shaft 8 against the pull of strand 16. With the originally applied cup continuing to hold while swinging about the shaft 8, the next succeeding cup is brought gradually into close proximity with the surface 14 and in substantial parallelism thereto, and finally into holding contact therewith, only a very slight pressure being necessary to effect such holding engagement. Prior to engagement of the second cup, there is no force available to disengage the first-engaged cup, the only action possible on the cup during this interim being the turning of the same on shaft 8. However, after the next cup is firmly planted on the surface 14, it not only makes sealing contact with the surface 14 sufficient to hold the bird but also acts as a fulcrum or reaction point whereby the torque on the shaft 3 acts to forcibly remove the preceding cup from the surface. As a simple explanation of the forces involved, the torque at shaft 3 pulls up on

the cup while reacting against the surface 14 through the newly engaged cup and also through the tail 2. The action may also be likened to that of a claw hammer with a force applied on a lever arm against a fulcrum point and overcoming a force at another point.

Following separation of a cup, the same cycle is repeated, with the bird progressing, supported on one cup until the next succeeding cup is pressed onto the surface.

The foregoing operation is demonstrated in a simple manner in the schematic representation in Figs. 3 to 6. In Fig. 3 is shown a portion only of a star wheel such as the wheel 6, with the respective spokes designated *a*, *b* and *c* having cups *d*, *e* and *f* at their extremities and revolving about a common center *g*. In this view the entire sustaining force is furnished by the adherence of cup *e* to surface 14. The motive force causing progress of the bird may be represented simply by a vector *F* applied at the center *g*. As the center *g* moves upward, from the position shown in Fig. 3, both it and cup *f* will approach surface 14 as shown in Fig. 4, the cup *e* continuing to adhere to the surface and the spoke *b* changing in its angular relation to the cup *e*. In Fig. 5 cup *f* has been pressed into adhering contact with the surface 14 and the total weight is sustained by cups *e* and *f* together. Any progress beyond the situation shown in Fig. 5 results in increased pressure on cup *f* and a withdrawal action on cup *e* in the "claw hammer" action referred to above. This results in the condition shown in Fig. 6 where cup *e* is shown reluctantly yielding to the withdrawal force by first contracting at its periphery to an extent where the reduced effective area under the influence of atmospheric pressure is overcome by the force *F*, whereupon the cup *e* separates from the surface 14 and resumes its normal angular relation to the spoke *b*. The cycle is then repeated, starting with the condition shown in Fig. 3.

As above stated, the present invention distinguishes over known devices in that it involves locomotion of a vehicle in which the action of gravity is counteracted by means involving adherence to a surface without interlocking means. Broadly speaking, this sort of adherence can be effected by various means other than the atmospheric pressure utilized in the case of a suction cup. The adherence, for instance, could be effected by a magnetic force. In fact, magnets will perform in a manner strikingly similar to suction cups in that they are easily applied and difficult of removal. Magnets, of course, require an appropriate metallic surface, but it need not be as smooth as required when suction cups are employed.

In Fig. 7 is shown a modification generally similar to the one just described, except that magnets 27 have been substituted for the vacuum cups 11. The operation is the same in both cases since the mechanics of applying and separating the foot members is not dependent on the nature of the force uniting the feet to the surface. Magnets, in at least one respect, may be more desirable than the vacuum cups since they need not be aligned in close parallelism to the surface as they approach it, but will naturally assume such a position due to the magnetic field.

In order to delay removal of the magnets and secure the mechanical advantage of the situation shown in Fig. 6, they may be mounted on the spokes to provide a lost motion. In Fig. 9, the shaft 8, on which the magnet turns, is mounted

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in an elongated slot 21 in the spoke 7 and an elastic member 16, having one end secured to the magnet and the other end to the spoke, serves to hold the shaft normally at the radially inward end of the slot as well as to keep it at a definite angular position. When the engaged magnets are in the position of cups *e* and *f* of Fig. 5, the magnet equivalent to cup *e* will not immediately leave the surface as the spokes revolve but will slide and the member 16 will begin to elongate, and positive removal of the magnet will only take place when shaft 8 reaches the outer end of slot 21 or when the adhering force is overcome by the spring, depending upon design of the spring and slot.

While the magnets are shown in Fig. 7 as having one pole on the surface-engaging face, they may be magnetized on side faces. Such a device is shown in Fig. 10 where the magnet 27' has the form of a cylinder. This eliminates any need for parallel alignment with the surface. Only the bottom need be rounded. The magnet, of course, need not be mounted for rotation in this case.

In cases where the magnets are applied to a smooth metallic surface there may be a tendency for them to slide downward on the surface. For such a case it is advisable to apply to the working face of the magnet a layer of friction material. A thin layer of rubber composition thus applied has been found adequate to defeat sliding tendencies, and the rubber may include a fibrous component at least at its outer surface.

To further emphasize the possible latitude in the selection of the means of adherence to the surface 14, it is possible to effect similar results by the mere expedient of employing a substance of sufficient stickiness on the feet of the bird or on the surface to be travelled.

In Fig. 8 is shown a modification in the manner of resiliently positioning the cups. Instead of employing the rubber strand 16 as in Fig. 1, the shanks 28, which are pivoted on shafts 29, are extended and further pivoted at their ends on shafts 31. As the bird progresses over the adhered suction cup, the latter will tend to remain in flat engagement with the surface and its shank will deform into an arc between shafts 29 and 31, as shown at 32. After release of the cup, the arc will straighten out and return the cup to a position in readiness for parallel approach to the surface at the time of its next engagement therewith. The shafts 29 and 31 are, in this figure, shown as mounted on wheel components 33 of modified form.

The four-legged form has a very realistic effect in action since only two feet are visible at one time and it gives the illusion that the foot coming into engaging position is the rearward foot which has just been pulled from the surface.

It is not strictly necessary to pivot the cups or other foot members to the wheels or spokes, since they could be rigidly attached for the desired normal positioning and depend upon deformation of the shank entirely for permitting adhered engagement of the cups as the body advances and for restoring the cup to normal position after withdrawal. In the pivoted form the orientation of the cups for vertical wall operation may be accomplished by a small pendulum hanging from the cups so as to keep their faces vertical at all times.

Whereas, throughout, the invention has been illustrated as employing foot members fixed at

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equally spaced radial distances from the main drive shaft, obviously they could be otherwise arranged without departing from the inventive concept. For instance, they could as well be arranged on an endless track or chain, in which case their path of motion would not necessarily be limited to a circular one. In such alternative use, more cups could be in engagement at one time and, therefore, these would each require less holding capacity. Also, in the prior art of ambulatory devices in general, various devices have been proposed which employ a single pair of legs simulating the walking action of a biped and it is possible for these to be adapted to provide the successive engagement of surface-adhering feet according to the present invention instead of the peripherally arranged feet, although the construction of the latter is simpler, and therefore to be preferred.

Obviously, many forms of prime mover could be employed. In any case, the motive means will react through a part of the body against the surface traversed to produce the necessary torque. If an electric motor be employed, it can be arranged for reversal so that the bird will creep back down a wall. In the latter case, the nose of the bird will furnish the contact for torque reaction instead of the tail.

It is even possible to effect a descent of the bird, forwards or backwards without the aid of a motor of any sort, since the weight of the bird may be made sufficient for the purpose. Or the weight of the bird may be supplemented by a weight suspended from a pulley wound on the main shaft.

The foregoing described actions are illustrated in Figs. 11 and 12 in more or less schematic form. In Fig. 11, the spokes 7' carrying the cups 11' are attached to a drum 36, on which a cord 37, carrying a weight *W* is adapted to be wound. In this case the weight which each cup must be able to sustain is the total weight of the bird and the weight *W*. In the position shown in Fig. 11, the first action of the weight is not to remove the adhered cup but to turn its spoke downward about the cup. When the beak 5 of the bird contacts the surface 14 the action is seen to be the same as previously described except that motion is downward as shown by the arrow, with the weight *W* acting to produce a torque in the same manner as the spring motor, and with one cup being torn from the surface by the torque acting about another cup as a fulcrum.

In Fig. 12 the bird is caused to climb by the falling weight, the cord 37 in this case being trained over a pulley 38 journaled in a bracket 39 attached to the wall by any convenient means, the cord being attached to a shaft 41 on which the hub 42 is journaled. This is the only arrangement shown in which the power means is not entirely contained in the bird.

Other changes and modifications will be apparent to those skilled in the art and the invention should not, therefore, be considered as limited except as shall appear from the spirit and scope of the appended claims.

What is claimed is:

1. A self-propelled device capable of vertical ascent along a plane surface comprising a plurality of foot means adapted to adhere to said surface and arranged for revolution about an axis in said device whereby to be brought successively into contact with said surface and successively out of contact therewith, and means normally holding said foot means in a position which is

parallel with the surface at the approach of contact therewith, said holding means being yieldable to permit continuance of said parallelism for duration of such contact.

2. A self-propelled device capable of vertical ascent along a plane surface comprising a plurality of foot means adapted to adhere to said surface and mounted on a rotatable means so as to revolve in a circle about an axis in said device whereby to be brought successively into contact with said surface and successively out of contact therewith, said foot means being individually pivoted to said rotatable means at points radially outwardly of said axis, so as to remain in parallelism with said surface for the duration of contact therewith in the progress of the device.

3. A self-propelled device capable of vertical ascent along a plane surface comprising a body, a plurality of foot means rotatable about an axis in the body and adapted to adhere to said surface to a degree to sustain the weight of the body against the force of gravity in vertical ascent and arranged for successive contact with said surface, and power means in the body connected therewith to provide a torque thrust of the body about said axis against the said surface, in opposition to said foot means to move the latter into said successive contact, and to remove said foot means successively from said surface between the point of said thrust and a newly engaged foot member.

4. A self-propelled device capable of vertical ascent along a plane surface comprising a body, a plurality of foot means rotatable about an axis in the body and each adapted to adhere to said surface, and power means in the body connected therewith to provide a torque thrust of the body about said axis against said surface, in opposition to said foot means to revolve the same about said axis to bring them successively into contact with the said surface, and to remove them successively from said surface by reaction against the point of said thrust and against a newly engaged foot member.

5. A self-propelled device capable of vertical ascent along a plane surface comprising a body, a plurality of foot means adapted to adhere to said surface and arranged for cyclic motion in a closed path and successive contact with said surface, said foot means each being pivotally mounted to maintain parallelism with said surface during contact therewith in the progress of the device, and power means in the body connected therewith and to said foot means in a manner to provide a torque therebetween by a thrust of an extending portion of the body against said surface, to move the foot means into said successive contact, and to remove said foot means successively from said surface between the point of said thrust and a newly engaged foot member.

6. A device as in claim 3, said foot means comprising discrete vacuum cups.

7. A device as in claim 3, said foot means comprising discrete magnets.

8. A self-propelled device capable of moving along a surface while adhering thereto against the force of gravity, said device comprising a series of feet mounted in supporting relation to said device for cyclic movement in a closed, curved path and adapted to adhere to said surface successively, said feet comprising vacuum cups having shank portions adapted to deform whereby the angular disposition of the cups may

be varied to increase the duration of adherence to the said surface as the device progresses thereover.

9. A self-propelled device capable of vertical ascent along a plane surface comprising a power means, a shaft driven by said power means, and circumferentially spaced means adapted to adhere to said surface and connected to and radially spaced from said shaft, a plurality of said circumferentially spaced means being engageable with said surface simultaneously, and the number of said means so engageable, less one, embodying a total force of surface attraction at least sufficient in magnitude to sustain the total weight of the device against the pull of gravity.

10. A device as is claim 9 in which said spaced means comprise magnets.

11. A gravity-powered device capable of vertical descent along a plane surface comprising a plurality of foot means adapted to adhere to said surface and arranged for revolution about an axis in said device whereby to be brought successively into contact with said surface and successively out of contact therewith, and means normally holding said foot means in a position which is parallel with the surface at the approach of contact therewith, said holding means being yieldable to permit continuance of said parallelism for duration of such contact.

12. A gravity-powered device capable of moving along a surface while adhering thereto against the force of gravity, said device comprising a series of feet mounted in supporting relation to said device for cyclic movement in a closed, curved path and adapted to adhere to said surface successively, said feet comprising vacuum cups having shank portions adapted to deform whereby the angular disposition of the cups may be varied to increase the duration of adherence to the said surface as the device progresses thereover.

13. A gravity-powered device capable of movement along a plane surface, comprising a shaft, defining an axis of rotation of said device, and circumferentially spaced means adapted to adhere to said surface and connected to and radially spaced from said shaft, a plurality of said circumferentially spaced means being engageable with said surface simultaneously, and the number of said means so engageable, less one, embodying a total force of surface attraction at least sufficient in magnitude to sustain the total weight of the device against the pull of gravity.

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