No. 675,020. Patented May 28, 1901.

H. J. SCHMICK.

CAM FOR OPERATING MACHINERY.

(Application filed Mar. 12, 1900.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

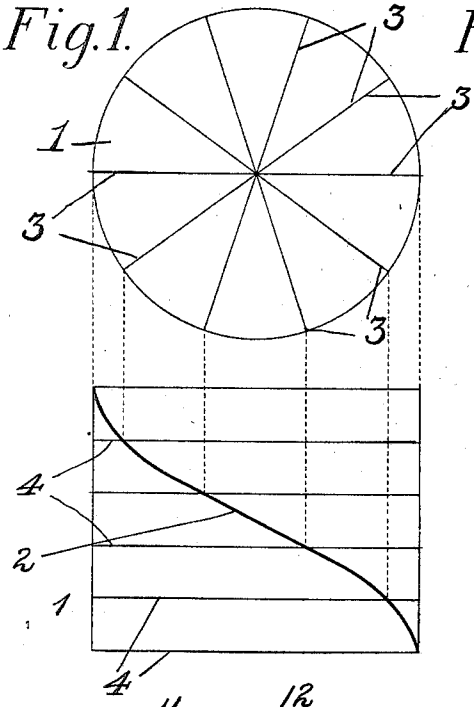



Fig. 2.

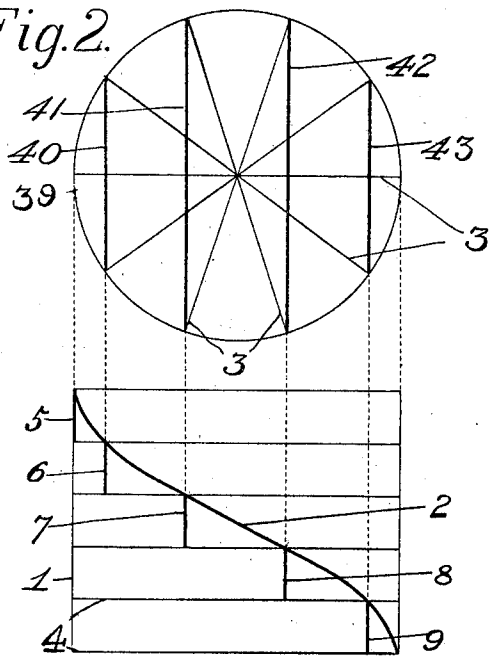



Fig. 3.

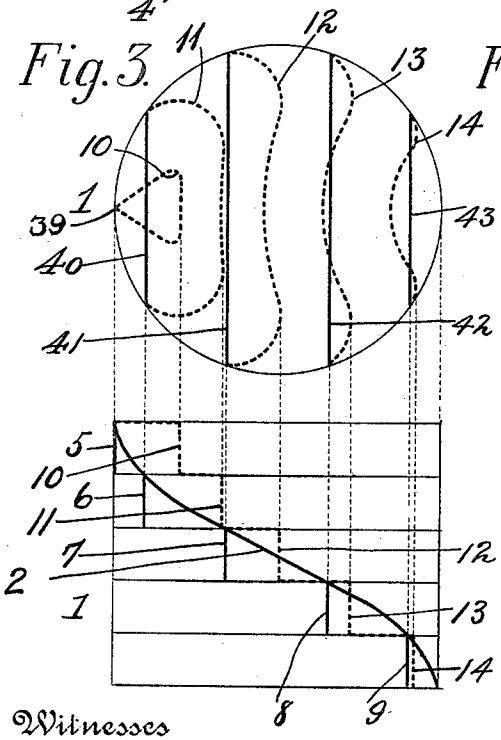
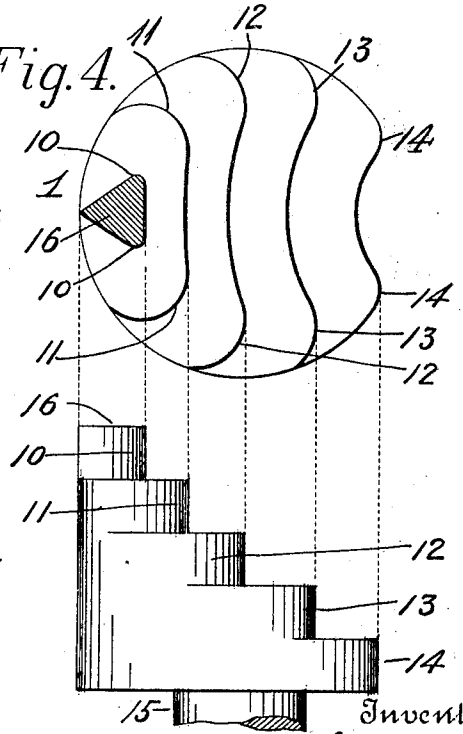



Fig. 4.




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Fig. 5.

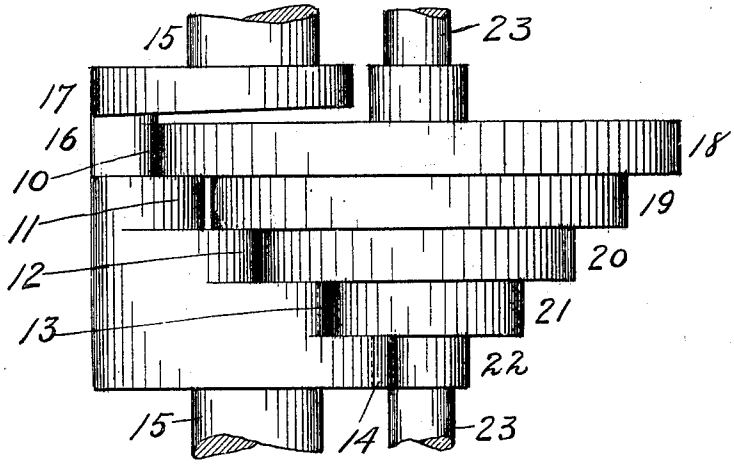
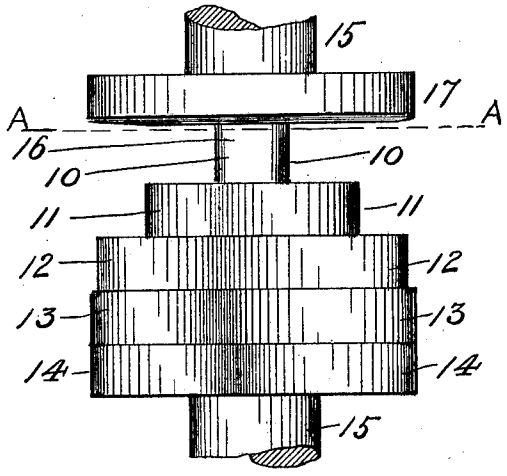



Fig. 6.




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Fig. 7.

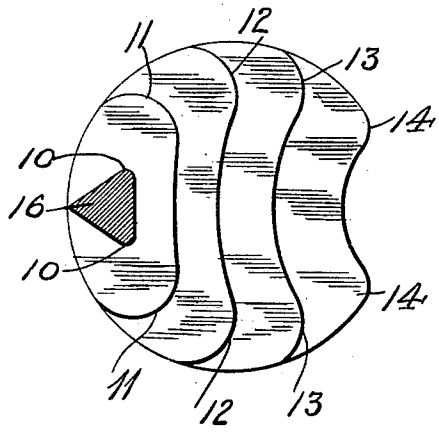



Fig. 8.

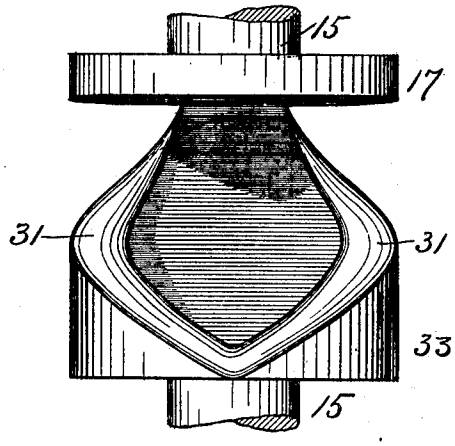
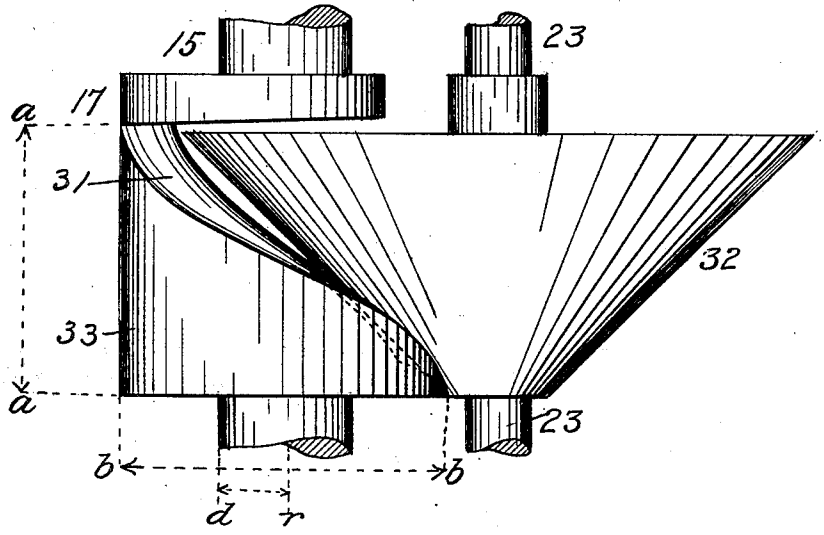



Fig. 9.




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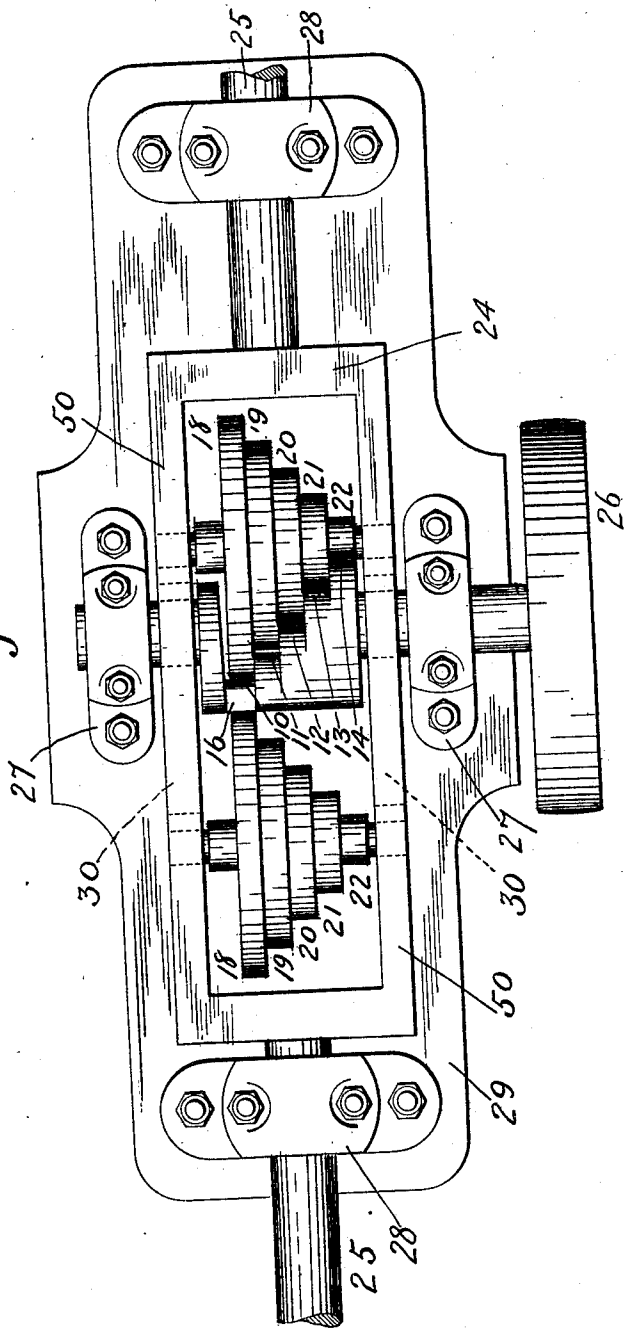
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Fig. 10.




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# UNITED STATES PATENT OFFICE.

HENRY J. SCHMICK, OF HAMBURG, PENNSYLVANIA.

## CAM FOR OPERATING MACHINERY.

SPECIFICATION forming part of Letters Patent No. 675,020, dated May 28, 1901.

Application filed March 12, 1900. Serial No. 8,307. (No model.)

*To all whom it may concern:*

Be it known that I, HENRY J. SCHMICK, a citizen of the United States, residing at Hamburg, in the county of Berks and State of Pennsylvania, have invented certain new and useful Improvements in Cams for Operating Machinery; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to machine elements, has especial reference to cams for operating machinery, and has for its object a cam mechanism constructed to produce a stroke in excess of the radius of the cam in the revolution thereof with the minimum frictional contact practicable; and the invention consists in certain improvements in construction, which will be fully disclosed in the following specification and claims.

For the purpose of distinguishing the construction of my cam it has been designated as a "radio-helical cam," since a helix usually acts coaxially; but the helix defined by the motion of this cam acts radially or transaxially or at a right angle to the axis of the cam.

In the accompanying drawings, which form part of this specification, Figure 1 represents a diagrammatic view showing a top plan and side elevation of a cam-cylinder with pitch-lines of helix formed by ordinates; Fig. 2, a like view showing contact-lines projected by ordinates; Fig. 3, a like view showing relation of contact-lines to contact-faces; Fig. 4, a like view of the cam, showing its stepped approximately helical dwell developed; Fig. 5, a top plan view showing the cam in engagement with one of the revoluble bearings; Fig. 6, a like view of the cam, taken in a plane at a right angle to Fig. 5, showing a stepped approximately helical dwell on each side of the axis of the cam; Fig. 7, a plan view of the cam, taken on line A A, Fig. 6, looking toward the shaft at the opposite end of the cam; Fig. 8, a top plan of a modified construction of the cam, showing a continuous helical dwell on each side of the axis of the cam; Fig. 9, a like view of the modified cam and a plain conical bearing engaging the cam; and Fig. 10, a top plan view showing the cam, its power-shaft, a reciprocatory head, and revoluble bearings engaging the cam on both sides of its axis and supported upon a suitable frame.

This cam may be a longitudinally-recessed cylindric ungula, (the term "ungula" being used throughout the specification to represent an approximate ungula,) whose sides are cut to reverse helical contours, or a continuous helical contour, half-pitch of each of which helices is angularly coincident with half a revolution of such modified or approximate ungula and is lineally equal to the altitude of such ungula. Its function is to impart lineal motion in a direction transaxial or at a right angle to the axis of the cam to a member whose throw equals for every half-revolution of the cam the diameter of the cylinder of the ungula minus the thickness of the neck of the said modified or approximate ungula.

Reference being had to the drawings and the designating characters thereon, 1 in Figs. 1, 2, and 3 indicates the cylinder on which several diagrams are laid, and 2 the curve of one-half pitch of the helical ungula to which the side of the cylinder is to be cut as formed by the intersection of the radial ordinates 3 and the horizontal ordinates 4. It will be seen from these diagrams that the whole cam length is accurately divided longitudinally into five transaxial steps, contacts, or working surfaces, which will be called "dwells," and is accurately divided peripherally into five ordinates of advance for each side running in reverse direction for the opposite sides of the approximate ungula. The effect of this is plain in the theoretic cam shown in Fig. 2, where each of the radial ordinates 3 projected intersects the helical path 2 and has dropped from said point of intersection the contact-lines 5, 6, 7, 8, and 9 in a direction perpendicular to said radial ordinates, parallel to the cam-axle, and of a length defined by the distance between two horizontal ordinates of advance 4. However, as it is undesirable to allow wear to be solely distributed on knife-edge lines, such as those of the contact-lines just developed, curves 10, 11, 12, 13, and 14 are very properly employed to increase the durability and smoothness of the cam, sustaining the relation to the mathematical contact-lines 5, 6, 7, 8, and 9, which is conveniently demonstrated by Fig. 3, being

a superposition of the theoretic cam of Fig. 2 upon the actual cam of Fig. 4, in which the full lines 39, 40, 41, 42, and 43 in Fig. 3 represent the theoretic cam of Fig. 2, the line 39 necessarily showing as a mere point in plan as representing a face superficially coincident with the cylinder, and the dotted lines 10, 11, 12, 13, and 14 of same figure represent the structural lines of actual cam shown in Fig. 4. Nevertheless, as the actual helix determining the cam action must be superficial to the cam-cylinder it is clear that no included helices which might be considered as being formed upon the introducing faces could in any manner effect the action; but the kinematic contact-lines 5, 6, 7, 8, and 9 are the only lines which meet or intersect said superficial helix 2.

The practically-constructed cam, showing its points of attachment to shaft 15, respectively, directly at one end of the cam and by neck 16 of ungula at the other end, is shown in Fig. 4, and in Fig. 5 the connection 17 between the neck 16 and the shaft 15 is shown. In Fig. 5 is also shown a revoluble and interrupted or stepped conical bearing or follower in the axial plane of the cam and whose altitude is equal to the altitudinal length of the cam and having faces 18, 19, 20, 21, and 22, which engage the curves or dwells 10, 11, 12, 13, and 14, whose points of departure from surface contact describe an approximately helical path on one side of the axis of the cam, the cone being applied in reverse to the ungula or cam, so that the greatest diameter of the cone-bearing engages the least diameter or neck 16 of the ungula. This conical bearing or follower is provided with a shaft 23, as shown in Fig. 5, and is supported in a movable member or head 24 in the plane of the cam, one bearing or follower being placed on each side of the axis of the cam, as shown in Fig. 10.

In the application of my invention herein shown the movable member 24 is supported by rods 25 at each end of the member 24, and the shaft 15 is provided with pulley 26, through which power is communicated to the shaft from any suitable motor, so that the member 24 may have a linear motion transaxial to the cam, imparted thereto by the radio-helical cam, in either or in both directions during each half-revolution of the cam, and the throw of the movable member is in excess of the radius of the cam in each half-revolution thereof.

The preferred form of my cam and of its conical bearing or follower is interrupted or stepped, and in this form there is synchronous action upon the revoluble bearing or follower by each two adjacent dwells at the instant of exchange of actuation between them, thus forming the approximate helical line of the cam in their normal order of progression, as shown in Fig. 10, in which it will be observed that the neck 16 of the ungula or dwell 10 is just going out of engagement with the face 18 on the left-hand bearing, and the dwell 14 is just in engagement with the face 22 of the bearing on the right hand of the cam, so that the interchange from one approximately helical line of action to the opposite approximately helical line of action is continuous and uninterrupted, and, as also indicated in Fig. 10, the dwell 13 of the cam is ready to engage with the face 21 of the cone synchronously with the disengagement of the dwell 14 of the cam from the face 22 of the cone, whereby the leverage of the cam is continuous along the line of the helix of the cam.

The shaft 15 is supported in journal-bearings 27, and the rods 25 are supported in bearings 28 on a frame 29, and the sides 50 of the head 24 are provided with longitudinal slots, (shown in dotted lines in Fig. 10,) and through which slots the shaft 15 projects on each side of the head. The cam may, however, be modified by constructing the helices 31 continuous, as shown in Figs. 8 and 9, where the revoluble bearing is a plain cone 32, whose altitude is also equal to the length along the axis of the helical bearing portion of the cam and is supported upon a shaft 23, identical with shaft 23 of the revoluble bearings or followers of the preferred form of the cam, as shown in Figs. 5 and 10, and the cam is also provided with a shaft 15, like the shaft in the same figures.

It will be clear by reference to Fig. 9 that the kinetic efficiency and kinematic ratio of the cam (to wit, the relative degree of pressure and quantity of motion respectively transmitted by it to its actuated member in proportion to the pressure and quantity of motion received by it from its actuating-shaft 15) can be determinably varied by definite changes in the cam structure, as follows: The radius $r$ $d$ of shaft 15 may manifestly be of any desired length necessary to support the cam without affecting the action of the latter. Assuming a diameter, as $b$ $b$, of the cam-cylinder 33, I may increase or decrease the said diameter $b$ $b$, and by correspondingly changing the form of the bearing or follower 32 will increase or decrease the kinetic efficiency and decrease or increase the kinematic ratio above explained.

The frictional conditions adapting the cam to variations in the angular velocities developed in its application, respectively, to high and low speed machinery may be determinably controlled by similar variations of structure, as follows: If the helical advance $a$ $a$ be extended or the number of dwells increased by lengthening the cam, the surface of engagement is increased. To illustrate, if a new or additional dwell is introduced to give the first half of the throw of a dwell, the surface of the new dwell, which is used to cause the throw, will be nearer the surface of the original cylinder than that inner portion of the engaging surface of the former dwell thus disengaged, and will therefore be longer for the same angle of advance. The converse is also true. The practical out-

come of these modes of varying the cam structure to control the surface and pressure of frictional contact seems to me to afford a readier means of adapting it to all dynamic conditions of speed variation, whose higher speeds require greater and lower speeds less approximation to uniform throw than has been practicable with the cams ordinarily in use.

It will be observed that the member or head 24 is lineally movable transaxially to the cam in either or in both directions, and it is therefore obvious that the radio-helical cam may be applied to various kinds of machines for transmitting power. By the construction shown and described the frictional contact-surfaces of the dwells of the cam are reduced to the minimum practicable extent, and the leverage of the cam is, as attained upon its working surface, practically or substantially constant and uninterrupted throughout the stroke of the cam.

Having thus fully described my invention, what I claim is—

1. A cam having a dwell on one edge thereof in an approximately helical path; in combination with a member in the same axial plane having linear motion, transaxial to the cam, imparted thereto directly by said cam.

2. A cam having a dwell extending longitudinally of the shaft and in an approximately helical path; in combination with a member in the same axial plane having linear motion, transaxial to the cam, imparted thereto directly by said cam.

3. A cam having a dwell in an approximately helical path on one edge thereof; in combination with a member having linear motion, transaxial to the cam, and a bearing, in the same axial plane with, and of equal altitudinal length to said cam.

4. A cam having a dwell in an approximately helical path on one edge thereof; in combination with a member having linear motion, transaxial to the cam, and a revoluble bearing, in the same axial plane with, and of equal altitudinal length to said cam.

5. A cam having a helical dwell; in combination with a member having linear motion, transaxial to the cam, and a conical bearing, in the same axial plane with, and of an altitude equal to the altitudinal length of the cam.

6. A cam having a helical dwell; in combination with a member having linear motion, transaxial to the cam, and a revoluble conical bearing, in the same axial plane with, and of an altitude equal to the altitudinal length of the cam.

7. A cam having parallel dwells in approximately helical paths on opposite sides of the axis of the cam; in combination with a movable member in the same axial plane, and bearings on opposite sides of the cam.

8. A cam having dwells in approximately helical paths on opposite sides of the axis of the cam; in combination with a movable member in the same axial plane, and a revoluble bearing on each side of the cam and supported by said member.

9. A cam having parallel dwells in approximately helical paths on opposite sides of the axis of the cam; in combination with a detached member having linear motion, transaxial to the cam, in either or both directions, and bearing-faces of equal altitudinal length to said cam.

10. A cam having parallel dwells in approximately helical paths on opposite sides of the axis of the cam; in combination with a detached member having linear motion, transaxial to the cam, in either or both directions, and revoluble bearing-surfaces, in the same axial plane with, and of equal altitudinal length to said cam.

11. A cam having dwells in approximately helical paths on opposite sides of the axis of the cam and extending longitudinally of the shaft; in combination with a movable member, and revoluble bearing-surfaces, in the same axial plane with, of equal altitudinal length to, and located on opposite sides of the cam.

12. A cam having a plurality of dwells in different vertical planes parallel with and on opposite sides of the axis of the cam and in an approximately helical path; in combination with a lineally-movable member in the same axial plane and provided with bearing-surfaces coincident with the dwells on the cam.

13. A cam having a plurality of dwells in different vertical planes longitudinally of the shaft, and in an approximately helical path and on opposite sides of the axis of the cam, in the same axial plane therewith; in combination with a lineally-movable member, and revoluble bearing-surfaces coincident with the dwells on the cam and on opposite sides thereof.

14. The combination with a movable member, of a cam in the same axial plane for moving said member, said cam being composed of elements in parallel planes and in an approximately helical path and the working surfaces of said elements being arranged to act consecutively and gradually advance the member, as set forth.

15. The combination with a movable member, of a cam in the same axial plane for reciprocating said member, said cam being composed of a series of elements in parallel planes, and in an approximately helical path and the working surfaces of said elements being arranged to act consecutively on the member in moving it in each of the two opposite directions, as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

HENRY J. SCHMICK.

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