July 25, 1967 H. S. CUMMINGS, JR., ETAL 3,332,295

RATCHET MECHANISM

Filed March 1, 1965

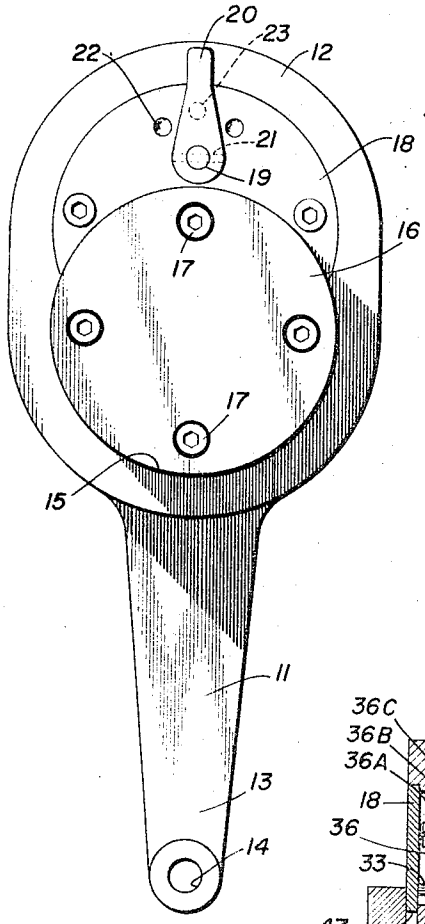


FIG. 1

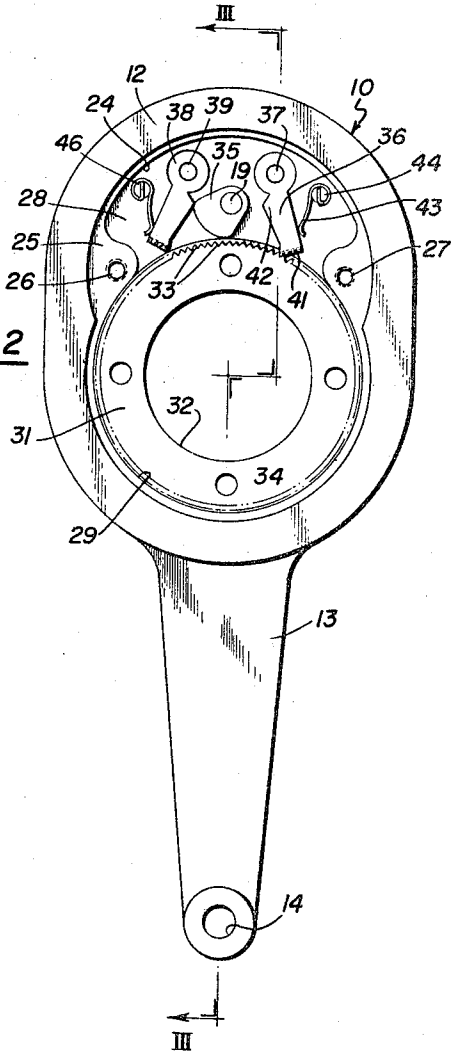


FIG. 2

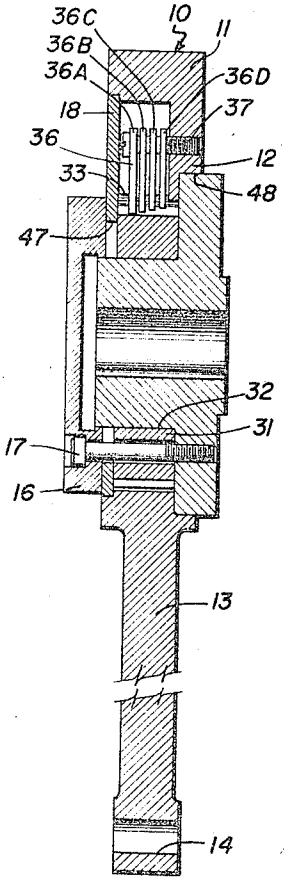


FIG. 3

HENRY S. CUMMINGS, JR.
DOMINIC CAMPANILE
PHILIP H. WILDER
INVENTORS.

BY

Henry S. Blackgat

United States Patent Office

3,332,295
Patented July 25, 1967

3,332,295

RATCHET MECHANISM

Henry S. Cummings, Jr., Holden, and Dominic Campanile and Philip H. Wilder, Worcester, Mass., assignors to Lowell Wrench Company, Worcester, Mass., a corporation of Massachusetts

Filed Mar. 1, 1965, Ser. No. 435,913
4 Claims. (Cl. 74—157)

This invention relates to a ratchet mechanism and, more particularly, to apparatus arranged to transmit power in small increments.

In the design of machine elements, it is often necessary or desirable to introduce the so-called "ratchet-and-pawl mechanism." This mechanism is used when it is desired to transform linear reciprocations into small powerful rotary uni-directional motions, the obvious application of such ratchet mechanism being to wrenches, although these mechanisms find use in many other types of machinery. One of the difficulties experienced with ratchet mechanisms of the past is that, when very small increments of rotation are used, it has been necessary to make the teeth on the ratchet very fine. Fine teeth have of necessity a small cross-sectional area and the force that can be transmitted is, of course, limited by the ultimate stress which such a small cross-section can withstand. In other words, in ratchet mechanisms it has been possible to transmit relatively large forces with large teeth and large increments of motion but, when small increments are desirable, small teeth must be used with the result that the forces which can be transmitted are also small. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a ratchet mechanism capable of transmitting relatively large forces with small increments of rotation.

Another object of this invention is the provision of a ratchet mechanism capable of dividing a single rotation of the output shaft into a large number of increments without providing fine incremental teeth on the ratchet.

A further object of the present invention is the provision of a ratchet mechanism capable of transmitting large forces without sacrifice of fine incremental motion.

It is another object of the instant invention to provide a ratchet mechanism capable of fine incremental motion without high cost.

It is a further object of the invention to provide a ratchet mechanism which is inexpensive to manufacture, which is simple and rugged in construction, and which is capable of a long life of useful service with a minimum of maintenance.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

The character of the invention, however, may be best understood by reference to one of its structural forms as illustrated by the accompanying drawings in which:

FIG. 1 is a front elevational view of a ratchet mechanism embodying the principles of the present invention;

FIG. 2 is a similar view of the invention with portions removed; and

FIG. 3 is a sectional view of the invention taken on the line III—III of FIG. 2.

In general, this invention has to do with a ratchet mechanism of the type used in a ratchet-type socket wrench having pawls which engage ratchet teeth formed on the outside of a socket. This permits a step-by-step actuation of the socket in the well-known manner. The invention herein lies in the concept that each pawl consists of a plurality of elements all on the same pivot, each

successive element being shorter than the one above, so that it is possible to obtain very fine ratchet adjustments. For instance, in a typical case, the teeth on the socket or ratchet can be located approximately once every 3° but, by having four pawl elements stacked together, it is possible to index the socket in a little less than 1° of rotation. In other words, in any given valley between two teeth, the top pawl will fall in first, followed a short time later by the second pawl, then by the third pawl, followed finally by the fourth pawl, because each successive pawl is slightly shorter than its predecessor.

Referring first to FIG. 1, wherein are best shown the general features of the invention, the ratchet mechanism, indicated generally by the reference numeral **10**, is shown as consisting of a main body **11** having a large head **12** at one end from which extends an arm **13**. The extreme end of the arm **13** is provided with an aperture **14** by which it may be connected to a reciprocating source of power. In the case of a socket wrench, this source of power would be the human arm but, in other mechanisms, it might be a linear actuator, such as a pneumatic cylinder or the like. The head **12** is of generally circular configuration and relatively small thickness to present a disc-like appearance. The head is provided on one side with a recess **15** having the configuration of two intersecting displaced circles. Covering a portion of the opening into this recess is a circular cover **16** held in place by socket head screws **17**. The entire recess is occupied by a flat cover **18** of generally "Figure 8" shape. Extending through this cover is a shaft **19** which is connected by a pin **21** to a selector finger **20**. The finger is provided with a ball detent (not shown) which engages dimples **22** and **23** formed on the outer surface of the cover **18**. These dimples lie on the periphery of a circle having the axis of the shaft **19** as its center and are spaced approximately 60° apart on that circle.

FIG. 2 shows clearly the interior mechanism of the apparatus. It can be seen that the head **12** is provided with another recess **24** smaller than the recess **15** but of the same general configuration. The recess **15** is relatively shallow to carry the thin cover **18** and a relatively narrow flat plateau **25** extends between the two recesses to hold the cover in place. Threaded holes **26** and **27** are provided in a relatively wide portion of the plateau **25** for use with screws to lock the cover **18** in place. The recess **24** is provided with an outer portion **28** of generally crescent-shaped form and an inner portion **29** to form an almost complete circle. In the inner portion **29** resides a ratchet wheel **31** of generally disc-like configuration having an inner or central bore **32** which is to be attached to the output portion of the mechanism. Apertures **34** located 90° apart are formed on the ratchet wheel **41**. On the outer periphery of the ratchet wheel **41** are provided a number of evenly-spaced teeth **33**; in the drawing these teeth are shown as being 3° apart, so that there are 120 of them in the complete periphery of the ratchet wheel **31**. In the upper portion **28** of the inner recess **24**, the shaft **19** is provided with a cam **35**. At the right side of the shaft **19** in the upper portion **28** is located a pawl **36** pivotally mounted at one end on a pin **37**, the pin being located upwardly and to the right of the shaft **19**. Another pawl **48** is arranged to the left of the shaft **19** and is pivotally mounted on a pin **39**. The pawls **36** and **38** are mirror images of one another. The pawl **36** is provided at its free end (away from the pin **37**) with a point **41** which exactly fits into valleys between the teeth. At an intermediate portion of the pawl **36** and on the edge facing toward the shaft **19** is a protuberance **42** which is on an exact level with the centerline of the shaft **19**. The pawl **38** is, of course, similarly provided with a point and protuberance. A series of wire springs **43** mounted on a post **44** press against the

pawl **36** and biases it toward engagement with the teeth **33** on the ratchet wheel, while similar wire springs **45** are mounted on a post **46** and press the pawl **38** toward engagement with the ratchet wheel.

The sectional view in FIG. 3 shows other details of the mechanism. The cover **18**, for instance, is shown as extending throughout the entire recess **15** and being provided with a circular aperture **47**. The cover **16** lies over the cover **18** concentrically of the aperture **47**. Mounted at the back side of the head **12** in a circular recess **48** is a disc-like plate **49** having a cylindrical hub **51** mounted in the bore **32** in the ratchet wheel **31**. The bolts **17** extend through the cover **16**, extend through the holes **34** in the ratchet wheel **41**, and are threaded into the plate **49**. The plate **49** is provided with a bore **52** to which is connected the output element. In the case of a socket wrench the socket would reside in this area and in the case of other mechanisms it would be keyed to a shaft or the like which is to be moved incrementally.

This figure of the drawing shows particularly well the details of the pawl **36** and its pivot pin **37**. As is evident in the drawing, the pawl **36** is made up of a number of independent pawl elements **36A**, **36B**, **36C**, and **36D**, the pawls being slightly shorter than one another in the order named and each having its own separate spring **43**. In each of the elements **36A**, **36B**, **36C**, and **36D**, the abutment **42** is provided in exactly the same place; that is to say, exactly beside the axis of the shaft **19**. It is the point **41** of each element which is in a slightly different location. All the points, of course, exactly fit into the valley between two teeth **33**; they are successively slightly closer to the pivot pin **37** as one goes from the pawl element **36A** to the pawl element **36D**. However, the difference in length between the longest and the shortest pawl element is never greater than the distance along the slope of a tooth **33**; otherwise, a short pawl element would fall into the next valley while the longest pawl element was engaging a tooth.

The operation of the apparatus will now be readily understood, in view of the above description. The input motion is provided to the ratchet mechanism **10** on the outer end of the handle **13**. As has been stated before, this would be the human hand in the case of a socket wrench or, in the case of a machine, it might be a reciprocating linear actuator. The output load is centered in the bore **52** and the entire mechanism rocks about that point in response to the reciprocation. Before beginning the motion, however, the selector finger **20** must be located over either the dimple **23** or the dimple **24** on the outer surface of the cover **18**. Let us suppose that it has been placed over the dimple **23**, so that the cam **35** has pressed against the abutment of the pawl **38** so that the pawl is maintained away from the ratchet wheel. In this condition, the spring **43** presses the pawl **36** against the teeth **33** of the ratchet wheel **31**. The cam **35** does not touch the pawl **36** at that time so the pawl is free to do so. When the arm **13** is reciprocated to the right in FIG. 2, it rotates the entire mechanism in a counter-clockwise direction. The point **41** of the pawl **36** slides up the forward slope of a given one of the teeth **33** and, eventually, falls into the valley between the given tooth and the next one. The ratchet wheel **31** is not moved, nor is the load rotated. When reciprocation takes place in the return direction, the lower end of the arm **13** is carried to the left and it rotates the entire body **12** in the clockwise direction, the point **41** of the pawl **36** presses against the back slope of the tooth **33** and moves the ratchet wheel **31** in the clockwise direction. If the reciprocations of the lower end of the arm **13** are selected properly, a pawl will engage one tooth at a time. Because of the difference in lever arm length between the end of the arm **13** and the point of contact of the pawl with the outer periphery of the ratchet wheel, a fairly large reciprocation of the arm **13** can be made without exceeding more than one tooth length in ratchet operation.

Referring now to FIG. 3, the description of the operation of the pawl **36** must be somewhat modified in view of the fact that it is made up of four independent elements **36A**, **36B**, **36C**, and **36D**. In response to small reciprocations at the outer end of the arm **13**, the pawl element **36** being shorter than the rest will pass over the top of the tooth **33** and fall into the next valley, while the remaining three are still sliding up the forward slope of the tooth **33**. The reciprocations, therefore, can be very small and, when the reverse reciprocation takes place, the pawl **36D** will engage the back slope of the tooth **33** and rotate the ratchet. This means that a very small reciprocation of the arm **13** can take place and still permit positive ratchet engagement with the teeth **33**. As a matter of fact, because there are four pawl elements making up the pawl **36**, it is possible to obtain 120×4 or 480 divisions of one rotation. In other words, with small reciprocations of the arm it is possible to obtain fine incremental rotations of the output shaft.

The advantages of the invention can be appreciated from the above description. To begin with, the teeth **33** can be made relatively coarse and still obtain the same action as would be obtained with 480 fine teeth on the periphery of the ratchet wheel **31** instead of 120 coarse strong teeth. Since the amount of force that can be transmitted from the pawl to the ratchet wheel is determined by the shear strength of the teeth **33** and since the shear strength is determined by the cross-sectional area of the tooth, the present invention gives the advantage of fine teeth with the strength of coarse teeth. Normally, the thickness of the pawl element can readily be made adequate to serve the purpose; it is the ratchet teeth which limit the force that can be transmitted. Another aspect of the invention, of course, is that machining 480 fine teeth on the periphery of the ratchet wheel is a much more difficult and costly operation than providing 120 coarse teeth. The result is that the present mechanism has the advantages of an expensive mechanism without the cost.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. A ratchet mechanism, comprising

(a) a ratchet wheel having relatively coarse teeth formed on its outer periphery, and

(b) a pawl consisting of a plurality of pawl elements mounted on a common pivot having different lengths whereby, during motion in one direction, the pawl elements move up the forward surface of a given tooth until the shortest pawl element passes over the top of the tooth into the valley beyond and, upon reverse relative rotation, the said shortest pawl, element presses against the back surface of the said given tooth and moves the ratchet wheel forward by an increment, and whereby, during the next relative rotation in the first direction a second pawl element passes over the top of the tooth to engage the back surface of the tooth during a subsequent relative rotation in the other direction, so that the ratchet wheel is moved in a plurality of small increments substantially smaller than the distance between successive teeth on the periphery of the ratchet wheel.

2. A ratchet mechanism, comprising

(a) a body adapted to be subjected to reciprocating rotation,

(b) a ratchet wheel pivotally mounted in the body and adapted to be connected to a load which is to be rotated in small uni-directional increments of rotation,

(c) a pawl pivotally mounted on a pivot pin in the body and having a free end adapted to engage the teeth of the ratchet wheel, the pawl being made up of a plurality of pawl elements all independently pivoted on the said pivot, the pawl elements being of differing lengths to pass over a given tooth of the ratchet wheel at different points in rotation of the body, the pawl elements forming a stack and being of relatively thin construction and the distance from the axis of the pivot to the outer end of each pawl element becoming shorter as one progresses from one side of the stack to the other, and

(d) another pawl similar to the said pawl being provided in the body but pivoted at a point spaced from the said pawl, both pawls being provided with springs which bias them toward engagement with the teeth of the ratchet wheel.

3. A ratchet mechanism as recited in claim 2, wherein a selector shaft is provided located between the two pawls,

a cam being fixed to the shaft and being rotatable from a first position in which one pawl is maintained out of engagement with the ratchet wheel to a second position in which the other pawl is maintained out of engagement with the ratchet wheel.

4. A ratchet mechanism as recited in claim 3, wherein each pawl element is provided with a protuberance at an intermediate point thereof for engagement with the said cam.

References Cited

UNITED STATES PATENTS

786,703	4/1905	Wilson	74—157
1,680,515	8/1928	Gormley	192—43.1
2,943,523	7/1960	Gray et al.	81—62

FRED C. MATTERN, JR., *Primary Examiner.*

W. S. RATLIFF, *Assistant Examiner.*