May 8, 1934. W. C. KRESS 1,957,462

RATCHET WRENCH

Filed Jan. 25, 1933 2 Sheets-Sheet 1

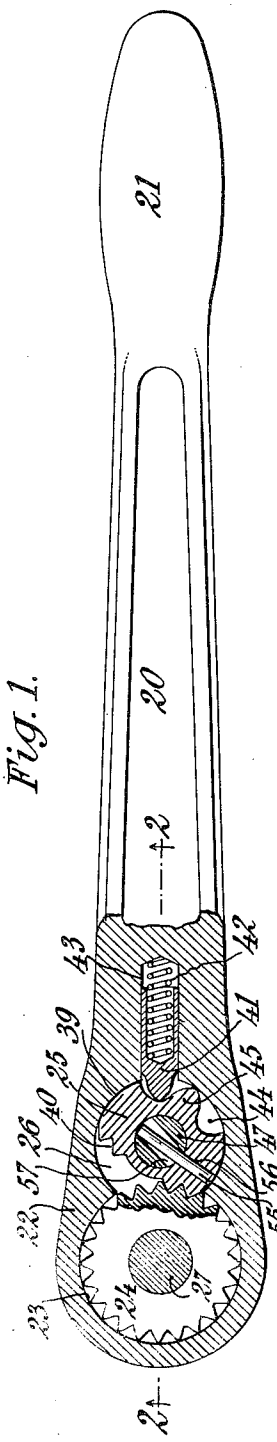


Fig. 1.

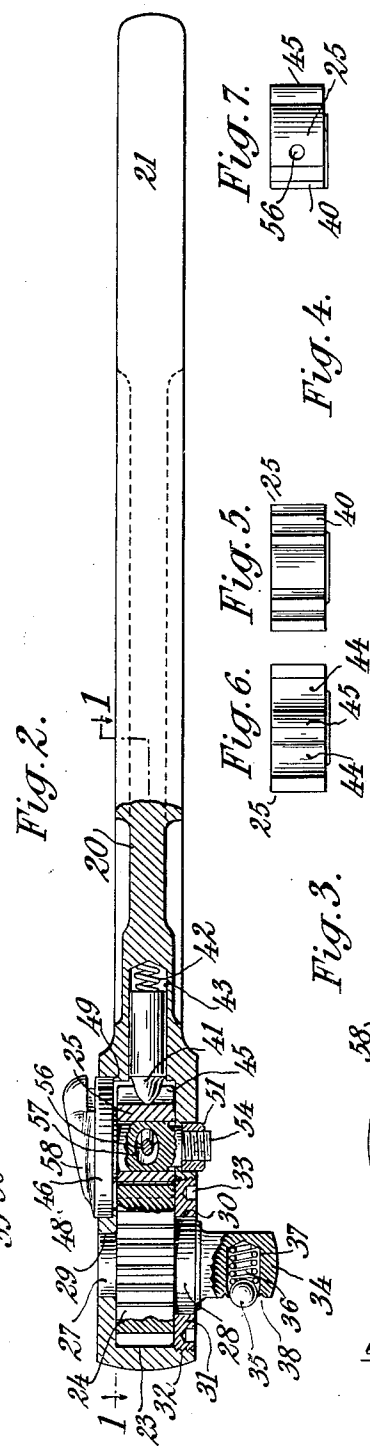


Fig. 2.

Fig. 7.

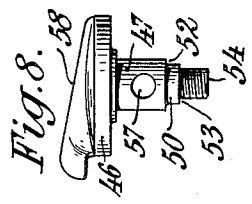


Fig. 8.

Fig. 5.

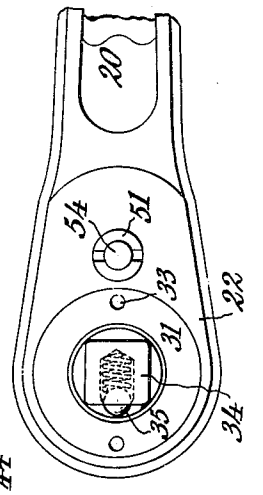


Fig. 4.

Fig. 6.

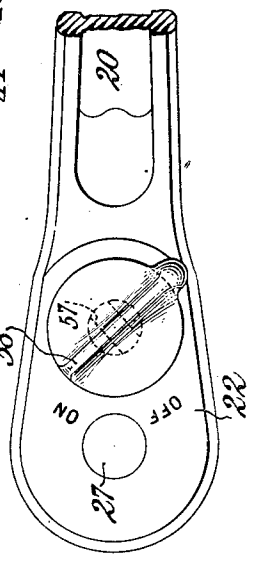


Fig. 3.

INVENTOR

Willard C. Kress,

BY Fraser, Myers & Manley

ATTORNEYS.

May 8, 1934. W. C. KRESS 1,957,462

RATCHET WRENCH

Filed Jan. 25, 1933 2 Sheets-Sheet 2

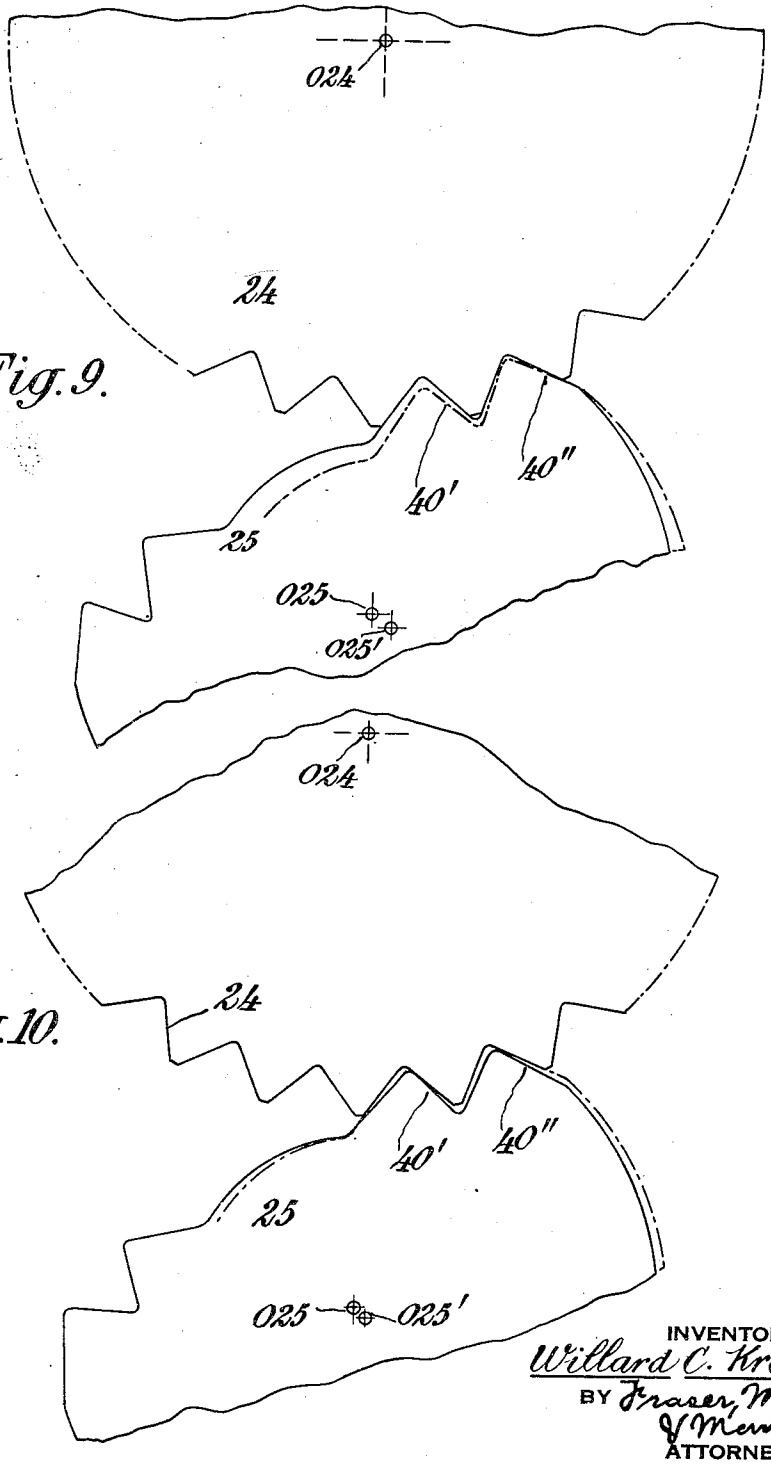


Fig. 9.

Fig. 10.

INVENTOR
Willard C. Kress,
BY Fraser, Myers & Mawley
ATTORNEYS.

Patented May 8, 1934 1,957,462

UNITED STATES PATENT OFFICE

1,957,462

RATCHET WRENCH

Willard C. Kress, Kenmore, N. Y., assignor to J. H. Williams & Co., Buffalo, N. Y., a corporation of New York

Application January 25, 1933, Serial No. 653,372

5 Claims. (Cl. 81—63)

This invention relates to an improved ratchet wrench. It is an object of the invention to provide a wrench having a ratchet wheel and a pawl with two teeth so arranged that forces transmitted from the body member of the wrench through the pawl to the ratchet wheel may be substantially equally divided when the parts of the wrench are being subjected to strains corresponding with a normal working load.

It is a further object of the invention to provide a reversible ratchet wrench having a pawl shiftable from one position to another to reverse the wrench, with a manipulator for shifting the pawl and a loose connection between the manipulator and the pawl whereby the pawl may be freely moved as the ratchet teeth are moved under the teeth of the pawl while the manipulator is at rest. One important element of this feature of the invention is a loose key by means of which limited rotational movement may be permitted between the pawl and the manipulator, the parts of the mechanism being so related and assembled that the key can not be accidentally separated from the pawl and the manipulator when mounted in the body member of the wrench but may be readily removed when the parts are disassembled.

In the accompanying drawings illustrating a preferred form of the invention,—

Figure 1 is a side view of a ratchet wrench embodying the invention, the head end of the body member and mechanism mounted therein being represented in cross-section along the line 1—1 of Fig. 2.

Fig. 2 is an edge view of the same wrench, parts thereof being shown in section along the line 2—2 of Fig. 1.

Fig. 3 is a side view of the head portion of the wrench illustrated in Fig. 1.

Fig. 4 is a view of the opposite side of the head portion of the wrench illustrated in Fig. 1.

Fig. 5 is a view of that face of the pawl illustrated in Fig. 1 which is directed toward the ratchet wheel when the parts are assembled.

Fig. 6 is a view of that face of the same pawl which is directed away from the ratchet wheel when the parts are assembled in the wrench.

Fig. 7 is a view of that face of the pawl which is disposed laterally as the parts are assembled in the wrench.

Fig. 8 is a side view of a manipulator for the pawl.

Fig. 9 is a diagram of portions of the ratchet wheel and pawl indicating the manner in which forces would be transmitted from the pawl to the ratchet wheel, when the wrench is used to rotate a work-piece, if so constructed that two teeth of the pawl would be in contact before the turning force is applied.

Fig. 10 is a similar diagram representing the manner in which forces are transmitted from the pawl to the ratchet wheel, when the wrench is used to rotate a work-piece, if the teeth are designed in accordance with the teachings of the invention hereinafter to be explained.

In Figs. 1 to 8, inclusive, the invention is indicated as being applied to a wrench comprising a body member 20 having a handle 21 and a head 22. Within a cylindrical recess 23 in the head is housed a ratchet wheel 24, which may preferably of a diameter such that there will be only a working clearance between the teeth and the inner wall of the cavity.

The movements of the ratchet wheel 24 may be controlled by a pawl 25 housed in a second cylindrical recess 26 in the head, the two recesses being so disposed as to intercept each other as shown.

The ratchet wheel 24 may have cylindrical bearing elements 27, 28, one mounted in a cylindrical opening 29 in one wall of the wrench head and the other in a cylindrical opening 30 in a cover-plate 31 having a threaded connection 32 with the surrounding portion of the wrench head and serving as an opposite wall. The cover-plate 31 may be provided with a plurality of recesses or sockets 33 to be engaged by a spanner wrench by which it may be rotated when it is desired to remove it and permit the ratchet wheel to be disassembled from the wrench head.

The ratchet wheel may be provided with any suitable means for engagement with a wrench socket or other work-piece, such means being herein disclosed as a portion 34 of non-circular cross-section extending in an axial direction from the bearing member 28 and provided with means by which it may be yieldingly held in engagement with the socket or work-piece, comprising a ball 35 and spring 36 held in a socket 37 by peening the surface of the material around the socket as at 38 after the ball and spring have been inserted. This spring-pressed ball as a means for yieldingly holding two elements of a tool in engagement is a well-known feature of the prior art constituting no part of the invention herein sought to be protected.

The pawl 25 will preferably be of substantially the form indicated in Fig. 1 having oppositely-disposed cylindrical surface portions 39 complemental to the cylindrical wall of the recess 26

and of dimensions such as to provide only a sufficient clearance to permit the pawl to rotate in the recess.

In the preferred form of the invention herein disclosed the pawl is provided with two pairs of teeth 40 so disposed that one pair may be brought into engagement with the teeth of the ratchet wheel when it is desired to prevent rotation of the ratchet wheel in one direction and the other pair brought into engaging relation with the teeth of the ratchet wheel when it is desired to prevent its rotation in the opposite direction.

Appropriate means may be provided for moving either pair of teeth into, and for yieldingly holding them in, engagement with the teeth of the ratchet wheel. In the form of the invention herein disclosed this pawl moving and yieldable holding means comprises a plunger 41 and spring 42 mounted in a recess 43 in the body member of the wrench and a pair of recesses 44 in the pawl into either of which the plunger 41 may be thrust by the spring 42 when moved into registration with the throat of the recess 43. The recesses 44 may be separated by a protuberance 45 having oppositely-disposed curved or cam-like surfaces which cooperate with the nose of the plunger 41 whenever the pawl is rocked out of its engagement with the teeth of the ratchet wheel to cause the plunger to be moved into the recess 43 against the opposing effort of the spring 42, which will, in turn, cause the plunger to restore the pawl to its engaging relation with the ratchet wheel as soon as the teeth of the pawl can again enter spaces between teeth of the ratchet wheel.

In the position in which the pawl is indicated in Fig. 1 the ratchet wheel may be rotated in a clockwise direction but is prevented from rotating in a counterclockwise direction. The pawl may, however, by the application of sufficient force be moved to a position such that the protuberance 45 will rest at the opposite side of the nose of the plunger 41, after which the plunger will be caused to enter the other of the two recesses 44. This will cause the teeth 40 of the pawl which are represented in Fig. 1 as being in engagement with the teeth of the ratchet wheel to be widely separated from said teeth and the other pair of teeth 40 of the pawl to be brought into engaging relation with the teeth of the ratchet wheel, after which the ratchet wheel may be rotated in a counterclockwise direction, the teeth of the pawl being thrust away from the teeth of the ratchet wheel during such rotation but immediately returned to and yieldingly held in engaging relation with the ratchet wheel teeth by the spring 42 and plunger 41 in cooperation with the cam surface on the protuberance 45.

As an appropriate means for shifting the pawl from the position indicated in Fig. 1 to its reverse position a manipulator 46 may be provided, one satisfactory form of which, as shown in the drawings, may comprise a cylindrical portion 47 extending through a cylindrical opening in the pawl concentric with its cylindrical surfaces 39. The cylindrical portion 47 may have at one end a head 48 adapted to serve as a cover-plate for the recess 26 in which the pawl is housed and thereby prevent the removal of the pawl without disassembling the manipulator from the body element of the wrench. The body element of the wrench may be provided with a shouldered recess 49 to receive the cover-plate, and the end of the cylindrical portion 47 of the manipulator may be provided with an extension 50 (Fig. 8) of reduced diameter to extend through a circular opening in the opposite wall of the body member and held in place by a suitable fastening device such, for example, as a threaded nut 51.

The shoulder 49 under the cover-plate 48, the shoulder 52 at one end of the extension 50, and the shoulder 53 at the base of the threaded portion 54 of the manipulator which receives the nut 51, should be so disposed with respect to the opening in the wall of the body member through which the extension 50 of the manipulator extends that the manipulator may be freely rotated after the nut 51 has been drawn up tightly against the seat 53. The engagement between the shoulder 49 and head 48, however, prevents axial movement of the manipulator in one direction and the engagement between the under surface of the nut 51 and the underlying portion of the wall of the body element will prevent axial movement in the opposite direction.

In order that the manipulator may serve its purpose as a means of shifting the pawl from one of its two positions to the other when it is desired to reverse the direction of rotation in which the wrench will be effective, it is necessary that there be some connecting means between the manipulator and the pawl. If, however, one of these parts be made fast to the other, the entire manipulator will be caused to rapidly vibrate or flutter whenever the wrench is rotated in the direction in which it is free to rotate, in order to get a new hold on a work-piece. As each tooth of the ratchet wheel passes the engaging teeth of the pawl, the pawl will be rotated slightly and will be subsequently returned before the next tooth engages the mating tooth of the pawl. This rapid vibration of the manipulator by the pawl is undesirable, and, should it take place when the thumb of the operator is in contact with the manipulator, might be decidedly displeasing and objectionable. It is one feature of the invention to dispense with this vibratory movement of the manipulator and yet permit the manipulator to perform its intended function of reversing the pawl when desired. One satisfactory means of accomplishing this end is clearly illustrated in Fig. 1, from which it will be seen that the manipulator and pawl are secured together by a loose key comprising a pin 55 disposed radially in an opening 56 in the pawl having its outlet in one of the cylindrical surfaces 39. One end of the key 55 extends into an opening 57 in the cylindrical portion 47 of the manipulator, but this opening is of a diameter such as to permit a relative rotational movement between the pawl and the manipulator which may be of an amplitude at least equal to the amount of angular movement of the pawl necessary to permit the teeth of the pawl to clear the teeth of the ratchet wheel when rotated. It will be apparent that the invention is not dependent upon the use of a key of the specific form of the one disclosed in the drawings, and it will also be apparent that the loose connection is not dependent upon the opening in the manipulator being selected as the one which should be larger than the key. What is of importance is that one or the other, or both, of the elements secured by the key shall be free to have a limited movement with respect to the key. The loose connection permits the pawl to vibrate rapidly while the manipulator remains at rest, yet when it is desired to reverse the wrench the manipulator may be rotated by its thumb-piece 58 (Fig. 3) through a sufficient angle to shift the pawl from one of its two operating

positions with respect to the ratchet wheel to the other.

As indicated in Figs. 1 and 3, the pawl is in a position such that the wrench might be used to screw a nut on a bolt having a right-hand thread. This, as shown by the marking on the head of the wrench (see Fig. 3), is regarded as the "on" position. If the position of the pawl is reversed by shifting the manipulator to its "off" position as indicated by the marking on Fig. 3, the wrench may be used to remove a nut from a bolt having a right-hand thread.

It is well known that the amount of swing which must be imparted to the handle of a ratchet wrench in order to obtain a new hold on one of the teeth of the ratchet wheel is dependent upon the size and number of teeth in the wheel. By increasing the number of teeth and proportionately decreasing their size, the minimum effective swing may be reduced, but the reduction in size of the teeth correspondingly reduces the strength of the tool. The obvious remedy would be to increase the number of teeth on the pawl to compensate for the reduction in the size of the teeth, and this remedy has been applied to devices of the prior art but the results have been unsatisfactory for reasons which were not obvious. It is an important feature of this invention to rely upon more than one tooth of the pawl as a means of transmitting forces through the pawl to the ratchet wheel in a manner which is not obvious but which, when the parts of the tool are properly correlated, will cause the transmitted forces to be divided approximately equally between the teeth when the wrench is being subjected to a normal working load.

According to the practice heretofore resorted to, when the pawl has been provided with two or more teeth to engage a corresponding number of teeth on the ratchet wheel, the parts have been so designed that the surfaces of all of the teeth on the pawl make actual contact with the mating teeth on the ratchet wheel before the working strains are effective. The result is that as the force to be transmitted through the pawl to the ratchet wheel is increased, the load on one of the teeth of the pawl is rapidly reduced and the load on the other tooth increased, and when the maximum load is being applied to the wrench the entire force is transmitted through one tooth of the pawl and the other tooth has been moved clear of contact with its mating tooth on the ratchet wheel. This operation of a wrench constructed in accordance with the practice heretofore followed, when using two teeth on the pawl, may be more clearly explained on reference to Fig. 9 of the drawings. In this figure a portion of the pawl 25 is represented in full lines with two of its teeth in snug engagement with two teeth of the ratchet wheel 24, a portion only of which is shown. This represents the relative position of the pawl and ratchet wheel before any force has been applied to rotate a work-piece. If it be assumed that a wrench embodying the pawl and ratchet wheel, portions of which are represented in Fig. 9, be applied to a work-piece and force be applied to rotate the wrench in a counterclockwise direction, parts of the ratchet wheel and pawl between their respective centers 024, 025, and their contacting teeth will act as a toggle tending to cause the centers to be spread and the pawl to roll or rotate a very slight amount with respect to the ratchet wheel about the effective zone of contact between the teeth of the pawl and the teeth of the ratchet wheel. Although through the parts of the wrench would appear to the layman to be rigid and incapable of a sufficient degree of distortion to materially alter their relative positions, it is known to the engineer and the expert mechanic that when the parts of the wrench are strained as they are when subjected to a normal working load, certain portions are subjected to compression and other portions to tension, as a result of which the compressed portions, as, for example, portions of the pawl and ratchet wheel in this case, have their dimensions reduced and other portions which are subjected to tension, such as portions of the body member of the wrench, are extended. Due to these changes of the dimensions of the parts of the wrench illustrated in Fig. 9 as the load is increased, if it be assumed that the ratchet wheel is held fast and that the body element of the wrench is being forced in a counterclockwise direction, the tendency to roll the pawl about its effective zone of contact with the ratchet wheel will gradually reduce the pressure between the tooth 40′ and the opposed tooth of the ratchet wheel and to increase the pressure between the tooth 40″ of the pawl and the opposed tooth of the ratchet wheel. As the load is increased, the approximate center of rotation of the pawl with respect to the ratchet wheel will become localized at a point near the base of the tooth 40″, after which all parts of the pawl may be regarded as being rotated about this center with respect to the ratchet wheel, causing the center of the pawl to shift to a new position 025′ and the driving surface of the tooth 40′ to be separated from the adjacent tooth of the ratchet wheel, as indicated by broken lines in the diagram. As this rolling movement takes place, more and more of the increments of the increase of the load must be transmitted through the tooth 40″ to the ratchet wheel, and after separation takes place between the driving surface of the tooth 40′ and the adjacent tooth of the ratchet wheel, the entire load will have to be transmitted through tooth 40″ and the pawl becomes in effect a one-toothed pawl at the time when it is most essential that the load be divided between the two teeth.

It will be appreciated that the change of position of the parts due to distortion as represented in Fig. 9 has been materially exaggerated for purposes of clearness of illustration.

In Fig. 10 is in like manner represented the effect of distortion of the parts of the ratchet wrench when subjected to load, if constructed in accordance with the invention to be protected by this application. In this diagram the normal centers 024 and 025 of the ratchet wheel 24 and pawl 25 and the dimensions of the pawl and ratchet wheel are so disposed that when no appreciable force is being transmitted through the pawl to the ratchet wheel the tooth 40′ will be in contact with the opposite tooth of the ratchet wheel and the tooth 40″ will be slightly separated from the surface of the adjacent tooth of the ratchet wheel, as indicated in full lines in the diagram. Under these conditions an increase in the force transmitted through the pawl to the ratchet wheel as an attempt is made to rotate the body portion of the wrench in a counterclockwise direction while the ratchet wheel is held in fixed engagement with the work-piece to be rotated, causes the pawl to be rotated with respect to the ratchet wheel about a center near the base of the tooth of the ratchet wheel which is in contact

with the tooth 40' of the pawl. As the strain to which the parts of the wrench are submitted increases due to the toggle-like action of the parts of the ratchet wheel and pawl between the centers 024 and 025, the intervening part of the body portion of the wrench will be stretched or extended and the intervening portions of the pawl and ratchet wheel will be compressed, thus resulting in an effective spreading of the centers 024, 025, as a consequence of which the center 025 will be shifted to a new position 025' and the tooth 40'' of the pawl will be forcibly pressed against the surface of the adjacent tooth of the ratchet wheel, thus causing the forces transmitted from the pawl to the ratchet wheel to be divided between the two teeth of the pawl and the teeth of the ratchet wheel with which they make contact. In this case, as in the diagram illustrated in Fig. 9, the amount of distortion which would actually occur in practice has been exaggerated.

For best results the normal locations of the centers 024 and 025 and the clearance between the tooth 40'' and the adjacent tooth of the ratchet wheel when the tip of the tooth 40' is in contact with the tooth of the ratchet wheel with which it is paired should be such that the force transmitted to the ratchet wheel by the tooth 40'' will equal the force transmitted to the ratchet wheel by the tooth 40' when the wrench is carrying the maximum load which it is designed to carry. As the turning moment is first applied to the workpiece by the wrench the force transmitted from the pawl to the ratchet wheel would be relatively small and would substantially all be carried by the tooth 40' which is initially in contact with the adjacent tooth of the ratchet wheel. As the load increases, the load on tooth 40' would increase, but at an early stage in the application of the forces a material portion would be thrown upon the tooth 40''. Further increases of the turning moment would cause increments to be added to the tooth 40'' more rapidly than to the tooth 40' until at some stage the forces transmitted by the two teeth would be equal. A still further increase of the load applied to the wrench might cause the force transmitted by the tooth 40'' to exceed the force transmitted by the tooth 40'. The distribution of forces, however, would even then be far more favorable than that which results from the usual construction represented by Fig. 9 where the entire load is carried by one tooth and the other tooth relieved altogether.

The exact spacing of the centers and disposition of parts of the pawl and ratchet wheel to produce the required results would doubtless be difficult of determination mathematically. It has been found, however, by experience that it is perfectly practical to construct a test model having two teeth substantially in contact as indicated in full lines in Fig. 9 and subject the model to its normal working load while making close measurements of the distortion of the parts. By noting this distortion, and particularly the amount of spread of the centers 024, 025, the desired conditions may be attained by giving the centers a normal position such that, when extended under the load, two teeth of the pawl will be in effective contact with the adjacent teeth of the ratchet wheel. Having carefully made such tests for a wrench of any given size and material, any number of wrenches might be manufactured without further experimental work. One set of experimental tests, however, would have to be made for each new type of wrench involving changes of size, form and materials. It has been found that a mechanic of average skill who has been fully informed as to the principle of the herein disclosed invention and the results desired to be attained can quite readily work out the proper placing of the centers of the pawl and ratchet wheel to cause the two teeth of the pawl to share the transmitted forces when the wrench is carrying its normal load, by a series of experiments and measurements, as herein explained, without rendering the application of the invention in the slightest degree burdensome or impractical.

To a mechanic not informed as to the principle of the herein-described invention a wrench constructed in accordance with its teachings would give the appearance of having been carelessly made. One would erroneously conclude that the centers 024 and 025, Fig. 10, had been carelessly located too close together, but on examination of the parts of the wrench when subjected to strain it would be found that the two teeth of the pawl make accurate engagement with their mating teeth on the ratchet wheel at just the time when such engagement is most effetcive. This would not be true of the carefully constructed tool of the prior art the teeth of which are caused to make accurate engagement before the parts of the tool are subjected to their normal working strains with their attendant distortion.

The invention is not intended to be limited to the specific form herein selected for purposes of illustration but should be regarded as including modifications and variations thereof within the scope of the appended claims.

What is claimed is:

1. A ratchet wrench comprising a body member, a ratchet wheel rotatably mounted in said body member and provided with means for connection with a machine element to be rotated, and a pawl movably mounted in said body member and having two teeth to cooperatively engage two of the teeth of said ratchet wheel, the effective centers of said wheel and pawl and the forms and relative dispositions of their engaging teeth being such that the initial force transmitting engagement will be most effective between the pair of engaged teeth located nearest the imaginary line joining the centers of the ratchet wheel and the pawl and such that the ratio of the respective forces transmitted betwen the two teeth of the pawl and the pawl-engaging teeth of the ratchet wheel will approach unity as the turning moment transmitted from the body member to the ratchet wheel through the pawl is increased from zero to a normal working load for the wrench.

2. A ratchet wrench comprising a body member, a ratchet wheel rotatably mounted in said body member and provided with means for connection with a machine element to be rotated, and a pawl movably mounted in said body member and having two teeth to cooperatively engage two of the teeth of said ratchet wheel, the effective centers of said wheel and pawl and the forms and relative dispositions of their engaging teeth being such that the tooth of the pawl nearest the imaginary line which would connect the center of the ratchet wheel with the effective center of rotation of the pawl will be brought into firm contact with the tooth of the ratchet wheel with which it is paired when a slight turning moment is being transmitted through the pawl from the body member of the wrench to the ratchet wheel while the other of the two teeth of the pawl is

separated from the tooth of the ratchet wheel with which it is paired by a slight clearance, whereby, on increasing the turning moment transmitted from the body member through the pawl to the ratchet wheel, the resulting distortion of the parts, as they are subjected to additional strain, will cause the second tooth of the pawl to make contact with and be gradually brought into an increasingly effective engaging relation with the opposed tooth on the ratchet wheel and thereby cause a gradually increasing proportion of the added load to be transmitted to the ratchet wheel by the second tooth of the pawl as compared with that transmitted by the first-mentioned tooth.

3. A reversible rachet wrench comprising a ratchet wheel, a pawl shiftable from one position to another to reverse its directional effectiveness with respect to the ratchet wheel, a manipulator by which the pawl may be shifted from one of its effective positions to the other, resilient means in addition to and independent of said manipulator to move the pawl into and yieldingly hold it in engagement with the ratchet wheel when in either of its two effective positions, and a loose connection between the manipulator and the pawl, the amplitude of free rotational movement between the pawl and the manipulator being not less than the angle through which the pawl must be rotated to move it from its effective tooth-engaging position to a position clear of the teeth of the ratchet wheel.

4. A reversible ratchet wrench, as defined by claim 3, of which the loose connection between the pawl and its manipulator comprises a cylindrical portion of the manipulator in a cylindrical opening in the pawl concentric with its effective center of rotation and of a diameter such as to provide for free rotational movement, and a key having portions extending into the pawl and manipulator respectively to limit the amplitude of their relative rotational movement, the opening for the key in at least one of said parts being greater than the portion of the key which extends into it to an extent dependent upon the amplitude of free relative rotational movement desired.

5. A reversible wrench comprising a body member, a ratchet wheel rotatably mounted in said body member, a reversible pawl mounted in a cylindrical opening in the body member and having oppositely-disposed cylindrical surfaces concentric with the walls of the opening in which it is housed and of a diameter such as to provide for free rotational movement, a manipulator for said pawl comprising a cylindrical portion extending through a cylindrical opening in the pawl concentric with its center of rotation with respect to the body member and of a diameter such as to provide for free rotational movement between the pawl and the manipulator, a manipulator fastening means providing for relative rotational movement between the manipulator and the body member and for preventing the separation of one from the other, a head on the manipulator to cover the pawl and hold it in place in the body member, and a loose key extending radially through openings in the cylindrical portion of the manipulator and an adjacent part of the pawl, the opening in the pawl having an outlet in one of its two opposed cylindrical surfaces through which the key may be inserted and withdrawn, only when the pawl and manipulator are removed from the body member, the opening for the key in at least one of the two parts in which it is mounted being sufficiently large to provide for a limited amount of relative movement between the pawl and the manipulator.

WILLARD C. KRESS.