Socket ratchet wrenches and socket combinations using a magnetic ratchet/clutch-type apparatus are disclosed, one of which defines a "through hole" for allowing bolts to pass entirely through the socket and the wrench's head so that a nut can be threaded on a bolt of any length. The wrench's head defines a chamber in which a ratchet wheel is received for rotation relative to the wrench head. The chamber also has pockets for receiving and positioning floating pawls adjacent the wheel to facilitate their movement between a drive position and a release position. A permanent ring magnet is mounted to one side of the wheel for socket retention and magnetically attracting the floating pawls to facilitate the movement of at least one pawl into the drive position in which it is sandwiched between the ratchet wheel and a wall of the pocket to lock the wrench head and the wheel together so that a drive stroke can be made with the wrench.
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MAGNETIC RATCHET/CLUTCH TYPE APPARATUS

Technical Field of the Invention

The invention relates generally to ratchets and clutches, and more particularly to socket ratchet wrenches and sockets for use with such wrenches.

Background of the Invention

The prior art is replete with ratchets and ratcheting mechanisms which are employed in a variety of uses. For example, U.S. Patent Nos. 4,063,626; 5,386,747; and 4,404,773 disclose ratcheting mechanisms for socket wrenches and other types of tools using ratchets, or ratcheting mechanisms. In addition, U.S. Patent No. 5,301,893 discloses a ratcheting mechanism for a seat belt retractor and U.S. Patent No. 4,480,802 discloses a ratcheting mechanism for a fishing reel, the latter also being indicated to provide a silencer for the clicking sound typically associated with ratchets which occurs during the ratchet's release state and is caused by the ratchet's pawl clicking against the teeth of the ratchet wheel as the wheel rotates. U.S. Patent No. 5,325,790 also discloses a silent ratchet-like apparatus for preventing rollback in a rail vehicle, which also provides a mechanism for reducing or eliminating the clicking noise associated with pawls moving over a tooth rack or ratchet.

While all of the above ratcheting apparatus undoubtedly work as indicated, none is believed to disclose or suggest the socket ratchet wrench of the present invention which uses a magnet in its operation which makes possible socket ratchet wrenches having
any or all of the following advantages or features:

(1) Less resistance between the pawl and ratchet wheel during the ratchet wrench's return stroke. This means that a nut or other member being driven or threaded by the wrench is less likely to be unthreaded during the wrench's return stroke. Such unthreading is typically not a problem when the nut or other member is actually being tightened or untightened but it is a problem when the nut is being threaded on or off a bolt before or after actual tightening or untightening of the nut.

(2) Stronger and able to withstand and transmit more force than a conventional ratchet wrench due to the use of components, particularly pawls, which are much stronger than those used in conventional ratcheting mechanisms.

(3) Longer life due to the use of no springs for pushing a pawl into engagement with the ratchet wheel. The magnet of the present invention can be used to replace the springs found in many conventional ratchets which typically break or wear out over a period of time.

(4) Less expensive to manufacture.

(5) The magnetic force of the magnet can also be utilized to magnetically hold a wrench socket on the wrench's ratchet wheel, i.e. on the male drive of the ratchet wheel of a conventional socket wrench or in the cut-out of a ratchet wheel of the present invention. As such, the need for complicated and expensive spring loaded pin-like mechanisms for holding the socket which often jam or fail in one way or another is eliminated.

(6) In addition, if a ring magnet (or similar type
magnet(s)) is employed as the permanent magnet in the aforementioned ratchet wrench and axially aligned with and mounted about the rotational axis of the wrench's ratchet wheel to one side thereof, a novel ratchet socket and ratchet wrench combination can be designed with a unique "through hole" which allows bolts to pass entirely through the socket and the wrench so that a nut can be threaded on a bolt (not shown) of any length. Such a socket and wrench combination would in all likelihood eliminate the need for deep well sockets which are typically used to thread nuts on and off bolts having long threaded shafts.

Summary of the Invention

As known to those skilled in the ratchet and clutch art, a ratchet (or a clutch) transmits force from a first force transmitting member such as a socket wrench handle (or body) to a second force transmitting member such as the ratchet wheel of a socket wrench (or vice versa) when it is in its drive position and it is driven in a specific direction. For example, in a socket wrench such force is transmitted when the wrench handle is turned or rotated in a clockwise direction if the socket wrench's ratcheting apparatus is in its drive position when it is rotated in a clockwise direction. When it is turned or rotated in the opposite, i.e. counterclockwise direction, the ratcheting apparatus of the wrench releases, i.e. moves into its release state or position in which force is no longer transmitted from the wrench handle to the socket drive. The release position, however, permits relative movement between the wrench
handle and the socket drive which enables one to make a return stroke with the handle so that it can be returned to a position which enables one to make another drive stroke with the handle.

As also known to those skilled in the ratchet art, when the ratchet is in its drive position, it is the ratchet's pawl (or pawl means) which locks the first and second force transmitting members together to prevent relative movement therebetween when a force is applied to the first transmitting member in a specific first direction or when a force is applied to the second transmitting member in a specific second direction (which is generally opposite the first direction).

Finally, as also known, when the ratchet is in its release position it is the ratchet's pawl which releases or moves out of engagement with the second force transmitting member (typically the ratchet wheel or rack), which enables relative movement between the first and second force transmitting members when a force is applied to the first transmitting member in a specific first direction or when a force is applied to the second transmitting member in a specific second direction (which is generally opposite the first direction).

The ratchet/clutch-type apparatus of the present invention fundamentally operates in a manner very similar to that of a conventional ratchet or roller clutch. However, it does so with magnetic force and with components which cooperate in a unique way to provide the aforementioned advantages.

In its broadest sense, the ratchet/clutch-type apparatus of the present invention includes a first force transmitting member, a second force transmitting member, pawl means generally
positioned between the first and second force transmitting member for being moved into and out of a drive position, offset means for cooperating with the pawl means so that they are magnetically attracted to each other to facilitate movement of the pawl means into the drive position, and means for facilitating the release or movement of the pawl means out of the drive position. When the first transmitting member is moved in a first direction, the pawl means of the present invention is moved into its drive position in which it engages both the first and second force transmitting member to prevent relative movement therebetween and thereby transmit force from the first transmitting member to the second transmitting member. When the first transmitting member is moved in a second direction which is opposite the first direction, the pawl means releases or moves out of engagement with the second force transmitting member which permits relative movement between the first and second force transmitting member, thereby enabling one to make a return stroke with the first force transmitting member.

The offset means and the pawl means are preferably positioned or oriented relative to each other such that the lines of magnetic force therebetween are at an angle relative to the direction in which force is transmitted between the first and the second force transmitting members. In a particularly preferred embodiment of the invention, the offset means provides the magnetic force with a permanent magnet. The permanent magnet is positioned relative to the other components so that most, preferably all, of the force transmitted between the first and second force transmitting members bypasses the magnet. In most
situations, this will mean that the magnet is positioned out of the plane and thus offset or isolated from the plane in which force is transmitted between the first and second force transmitting members. As those skilled in the art of permanent magnets will appreciate, it is important that the magnet pass little, preferably none, of the force being transmitted between the first and second transmitting members due to the brittle nature of permanent magnets.

In yet another embodiment of the present invention, the offset means includes permanent magnet means which magnetizes the second force transmitting member so that the pawl means and the second force transmitting member are attracted to each other which in turn facilitates movement of the pawl means into the drive position. In yet another embodiment of the present invention wherein the offset means is fixed relative to the second force transmitting member, the magnet means holds the pawl means, i.e. it restrains movement of the pawl means relative to the second force transmitting member so that said first force transmitting member facilitates movement of the pawl means into the drive position by preferably pushing the pawl means into the drive position.

In one embodiment of the socket ratchet wrench of the present invention, the pawl means includes a generally cylindrical or spherically shaped pawl which is not mechanically attached to anything or physically mounted upon anything within the wrench and is thus referred to herein sometimes as a floating pawl. The second force transmitting member includes a ratchet wheel, and the first force transmitting member includes an
elongated wrench body (or frame) defining a chamber in which the ratchet wheel is received for rotation relative to the wrench body. The wrench body (or frame) also defines a pocket for each pawl which opens into the chamber or is part of the chamber defined by the wrench body. Each pocket receives and positions a pawl adjacent the ratchet wheel to facilitate the pawl's movement into a drive position in which it is sandwiched between and engaging the ratchet wheel and the wrench body, and the pawl’s release from or movement out of the drive position in which it is not engaging the ratchet wheel. Thus, when the pawl is released from its engaged drive position, the wrench body and ratchet wheel are capable of rotating relative to each other, whereas in the drive position, the wrench body and ratchet wheel are prevented from rotating relative to each other.

The magnet means of this embodiment includes a ring magnet which is coaxially aligned with the ratchet wheel to one side thereof for attracting the pawl(s) to the ratchet wheel to facilitate the pawl(s) movement into the drive position when the wrench body/head is rotated in a first direction. The means for facilitating movement of the pawl means out of the drive position includes abutments or posts positioned adjacent each pocket, and between the ratchet wheel and the wrench body which push the pawl(s) out of the drive position when the wrench body is rotated in an opposite second direction. The wrench also preferably includes reversing means for reversing the direction in which the wrench operates so that the pawl(s) are moved into their drive position (actually attracted to the ratchet wheel) when the wrench body is rotated in the second direction and are released
therefrom when the wrench body is moved in the first direction.

In one embodiment, to prevent rotation of the wrench body relative to the ratchet wheel, the cylindrical pawls become sandwiched between rounded detents provided in the rim of the ratchet wheel and the pocket wall of the wrench body when the wrench is rotated in its first or driving direction.

In another embodiment which is more in the nature of a clutch, particularly a roller clutch, the ratchet wheel has a smooth cylindrical surface, i.e. no rounded detents or teeth. Despite the use of a smooth cylindrical wheel, the friction between the wheel and the pawl means (which includes at least three preferably more pawls) is sufficient to prevent the wheel from rotating relative to the wrench body/head, i.e. when each pawl is in its drive position in which it is sandwiched or wedged between the ratchet wheel and the wall of the pocket in which it is received.

Yet another embodiment of the present invention provides a novel ratchet wrench and socket combination which defines a unique "through hole" for allowing the shank of a bolt to pass entirely through the socket and the wrench's head so that a nut can be threaded on the bolt's shank no matter what its length. Those skilled in the art will appreciate that such a socket and wrench head combination will eliminate the need for deep well sockets in most situations which are typically used to thread nuts on and off bolts having long threaded shanks.

Moreover, all disclosed embodiments of the present invention use the magnetic force of a permanent magnet, preferably a permanent ring magnet, to magnetically hold or retain a socket
on the ratchet wheel, i.e. on either the male drive of the disclosed ratchet wheels or in the cut-outs of the disclosed ratchet wheels. Those skilled in the art will appreciate that such use of a magnet eliminates the need for complicated and expensive spring loaded socket holding mechanisms which often jam or fail in one way or another.

In addition, while all disclosed embodiments use a permanent magnet for two purposes, i.e. to control pawl movement in a ratchet and to hold a socket on the wrench, the scope of the present invention is not intended to be limited to such dual purpose apparatus and it is specifically considered to be within the scope of the present invention to use a permanent magnet(s) to hold or retain a socket on any ratchet wrench including those employing conventional spring loaded pawl ratchet mechanisms.

**Brief Description of the Drawings**

The invention will be more readily understood by reference to the accompanying drawings wherein like reference numerals indicate like elements, and wherein reference numerals sharing the same last two digits identify similar corresponding elements throughout the various disclosed embodiments, and in which:

Figure 1 is a top plan view of a magnetic socket wrench of the present invention.

Figure 2 is a top plan view of the wrench of Figure 1 showing, however, the inner components of the wrench's ratcheting apparatus as they appear after removing the wrench's top end cap 64 and tear drop shaped reversing mechanism 38.

Figure 3 is a cross sectional view taken along lines 3-3 of
Figure 2.

Figure 4 is a cross sectional view taken along lines 4-4 of Figure 1.

Figure 5 is a top plan view of the inner components of the ratcheting mechanism of the wrench of Figure 1 showing the position of the components in the mechanism's forward position, and when the wrench is rotated in its driving clockwise direction.

Figure 6 is a view similar to Figure 5 showing, however, the position of the ratcheting mechanism's components as they would appear when the mechanism is switched to its reverse direction by moving tear drop shape mechanism 38 to its reverse position.

Figure 7 is an exploded perspective view showing the components of the wrench of Figure 1.

Figure 8 is a view of the apparatus which is similar to that illustrated in Figure 5 which shows the position of the wrench's ratcheting components as they would appear when one begins to make a drive stroke with the wrench.

Figure 9 shows the position of the wrench's components after having turned the wrench of Figure 8 approximately 90 degrees.

Figure 10 shows the position of the wrench's ratcheting components as they appear after the wrench has been rotated another 90 degrees from its position in Figure 9.

Figure 11 shows the position of the wrench's ratcheting components as they would appear as one begins to make a counterclockwise return stroke with the wrench after completing the drive stroke as shown in Figure 10.

Figure 12 illustrates the position of the wrench's
ratcheting components about halfway through the wrench's return stroke which as illustrated is roughly how they would appear after rotating the wrench in a counterclockwise direction another 90 degrees from its position in Figure 11.

Figure 13 shows the position of the wrench's ratcheting components at about the end of the return stroke which as shown is how they would appear after having rotated the wrench body/head approximately another 90 degrees in the counterclockwise direction.

Figure 14 is a top plan view of another socket wrench embodiment of the present invention which in dotted lines additionally shows some of the inner components of the wrench's ratcheting apparatus. The detents of the ratchet wheel are, however, not shown in this view.

Figure 15 is a cross sectional view taken along lines 15-15 of Figure 14.

Figure 16 is a top plan view of the wrench of Figure 14 showing the wrench with its end cap removed to illustrate the position of the wrench's inner ratcheting components (and its reversing member in dotted lines) as they appear when making a drive stroke with the wrench in its forward position.

Figure 17 is a top plan view of the wrench of Figure 14 showing the wrench with its end cap removed to illustrate the position of the wrench's inner ratcheting components (and its reversing member in dotted lines) as they appear when making a drive stroke with the wrench in its reverse position.

Figure 18 is an exploded perspective view showing the components of the wrench of Figure 14.
Figure 19 is a perspective view of the reversing member of the wrench of Figure 14 illustrating the components thereof located on its underside.

Figure 20 is a top plan view of a third socket wrench embodiment of the present invention showing the wrench with its end cap removed to illustrate the position of the wrench's inner ratcheting components (and its reversing member in dotted lines) as they appear when making a drive stroke with the wrench.

Figure 21 is a perspective view of a fourth magnetic socket-type wrench embodiment of the present invention.

Figure 22 is an exploded perspective view showing the components of the wrench of Figure 21.

Figure 23 is a top plan view of the wrench of Figure 21 showing the wrench with an end cap removed to illustrate the position of the wrench's inner ratcheting components as they appear when making a drive stroke with the wrench in the clockwise direction.

Figure 24 is a cross sectional view taken along lines 24-24 of Figure 23 showing, however, the view as it would appear if the end cap and a removable drive were respectively in place and received by said wrench.

Figure 25 is a top plan view of the wrench of Figure 21 showing the wrench with an end cap removed to illustrate the position of the wrench's inner ratcheting components as they appear when making a return stroke with the wrench in the counterclockwise direction.

Figure 26 is a top plan view of an alternative ratchet wheel having sawtooth-like teeth for use in the wrench of Figure 21.
Figure 27 is a perspective view of a fifth magnetic socket-
type wrench of the present invention.

Figure 28 is an exploded perspective view showing the
components of the wrench of Figure 27.

Figure 29 is a top plan view of the wrench of Figure 27
showing the wrench with an end cap removed to illustrate the
position of the wrench's inner ratcheting components as they
appear when making a drive stroke with the wrench in the
clockwise direction.

Figure 30 is a cross sectional view taken along lines 30-30
of Figure 29 showing, however, the view as it would appear if the
end cap and a removable drive were respectively in place and
received by said wrench.

Figure 31 is a top plan view of the wrench of Figure 27
showing the wrench with an end cap removed to illustrate the
position of the wrench's inner ratcheting components as they
appear when making a return stroke with the wrench in the
counterclockwise direction.

Figure 32 is a perspective view of a sixth embodiment of the
present invention which is a socket/wrench combination featuring
a unique "through hole" for allowing the shank of a bolt (not
shown) to pass entirely through the socket and the wrench's head
so that a nut can be threaded on the bolt's shank no matter what
its length.

Figure 33 is an exploded perspective view showing the
components of the wrench/socket combination of Figure 32.

Figure 34 is a cross sectional view taken along lines 34-34
of Figure 35.
Figure 35 is a cross sectional view taken along lines 35-35 of Figure 36.

Figure 36 is a partial top plan view of the wrench/socket combination of Figure 32. The wrench's reversing member 538 is shown in solid line in one position and shown in dotted line in its opposite reverse position.

**Detailed Description of Preferred Embodiments**

Figures 1 through 13 illustrate a socket wrench 10 of the present invention which utilizes the unique magnetic ratchet of the present invention. As illustrated, socket wrench 10 has four basic parts, the first of which is an elongated body referred to herein as wrench body 12 having a head 13 which defines a chamber 14 as shown in Figure 2, in which a ratchet wheel 16 (the second main part) is received for rotation relative to the wrench body.

As also illustrated, the third main part or element of wrench 10 is a pawl means which, as shown in the figures, consists of four cylindrically shaped pawls 18, which are received in pockets 20 of the wrench body. As shown, the pockets open into chamber 14 of the wrench body.

The fourth and last main element of wrench 10 is a ring magnet 22, also referred to and more generically covered in the claims attached hereto as the offset or magnetic means, which as shown, is mounted about the base (not numbered) of the ratchet wheel in a manner so that it is coaxially aligned with the wheel to one side thereof. As explained in more detail below, ring magnet 22 provides magnetic force which is transmitted to the ratchet wheel which attracts the pawls to the ratchet wheel,
thereby facilitating the pawls' movement into their drive position in which they are locked into engagement between the wheel and the wrench head and therefore in the position enabling the wrench to be used to drive or torque a nut, bolt head and the like. Those skilled in the relevant art will appreciate that the magnet in essence replaces the spring of a conventional ratchet which forces the pawl of a conventional ratchet into engagement with the teeth of a conventional ratchet wheel.

Referring now to Figs. 3 and 7, ratchet wheel 16 is provided with a plurality, in this particular instance, twenty detents 24 which function in a manner similar to the teeth of a normal ratchet wheel. However, because the radius of curvature of detents 24 is much less than that of a conventional tooth, it will be appreciated that the ratcheting apparatus of the present invention will not click, or make a clicking noise, as loudly as a conventional ratchet. As also illustrated, the radius of curvature of the detents is such that they complement the shape of the cylindrical pawls.

As also illustrated in Figs. 3 and 7, ratchet wheel 16 has an axially aligned, integral square socket drive 26 projecting outwardly to one side of the wheel. The square socket drive is similar to that of a conventional square drive for receiving a conventional socket. However, it will be appreciated that square drive 26 requires no mechanical means for holding a socket. As discussed in more detail below, ring magnet 22 provides enough magnetic attraction through drive 26 to securely hold a socket, and yet still enable an individual to pull the socket off the drive with relative ease.
As also shown in Figures 3 and 7, ratchet wheel 16 has a shoulder 28 located between its drive 26 and detents 24 for receiving a washer like end cap 30. The inner diameter of end cap 30 is dimensioned so that it is press fitted onto shoulder 28 of the ratchet wheel, and therefore securely attached thereto. Ring magnet 22 rests against end cap 30, and is held in place thereby. End cap 30 is preferably made out of steel to further enhance the magnetic attraction of a socket to the drive post. However, it is not absolutely necessary to make end cap 30 out of steel since ring magnet 22 will generally provide drive 26 will enough magnetic attraction to hold a socket in place, regardless of the material end cap 30 is made out of. The other end 32 of ratchet wheel 16 is, as illustrated, provided with a pair threaded bores, or holes 34, for receiving screws 36 to secure the assembly together.

As also shown, ring magnet 22 is provided with a cover 52 which is sized and configured to receive ring magnet 22, as well as ratchet wheel 16, through its axially positioned circular cut-out section 40. Cover 52 is preferably made from a plastic material, such as Delrin. Delrin provides a relatively friction free surface for pawls 18, the ends of which rest against the surface of cover 52, as illustrated in Figure 3. The friction reducing Delrin surface facilitates the movement of the pawls into and out of engagement with detents 24 of the ratchet wheel, as explained in more detail below.

As previously mentioned, pawls 18 are received in pockets 20 of the chamber 14 of the wrench head 13 as best illustrated in Figure 2. As perhaps best illustrated in Figure 7, chamber
14 and its pockets 20 are defined by an inner surface, or wall 42, of the wrench head 13. As also shown, wrench 10 has a handle or handle portion 47 extending from its head 13.

As also illustrated in Figure 3, Delrin cover 52 is received in a cylindrical cut-out 44 which is provided in a side 46 of the wrench head 13. The other oppositely facing side of the wrench head 13 identified herein as side 48 is also provided with a cut-out section 50. However, cut-out section 50 has a tear drop shape instead of the circular shape provided for cut-out section 44. As also best illustrated in Fig. 7, tear drop shaped cut-out 50 receives a tear drop shaped Delrin reversing member 38. As illustrated in Figure 1, however, tear drop shaped reversing member 38 has a more tapered tear drop shape than cut-out 50. This enables the reversing member 38 to be pivoted between forward and reverse positions, which reverse the direction in which the wrench operates so that, for example, in the forward direction, the wrench would drive in a clockwise direction, whereas in the reverse direction, the wrench would drive in a counterclockwise direction. The importance of this and details of this are described in more detail below.

As best visualized in Figures 5-7, reversing member 38 is provided with four abutments or posts 54, which are equidistantly spaced from each other, roughly 90 degrees apart from each other, and which project outwardly from the underside surface of reversing member 38. Only one abutment post 54 is visible in Figure 7. It will be appreciated, however, as shown in Figures 5 and 6, that four posts 54 are provided, each of which is adjacent a pocket, and positioned between the ratchet wheel and
the wall 42 of the wrench body, which defines chamber 14. As such, it will be appreciated that there is a post for each pawl 18 and as explained in more detail below, the posts serve to push the pawls 18 out of engagement with the ratchet wheel when the socket wrench is rotated in the direction which enables such, as is explained in more detail below.

Returning to Figure 7, it will be appreciated that reversing member 38 is also provided with a bore 56 near the tip of its tear drop. Bore 56 receives a cylindrical magnet 58 which, as explained in more detail below, is attracted to the inner surface 60 of the tear drop cut-out 50 in wrench body 12. Magnet 58 is provided with sufficient magnetic strength to maintain the position of reversing member 38 within tear drop shape cut-out 50 when the wrench is being used in its normal intended manner. As explained in more detail below, this enables the wrench to maintain either its forward or its reverse direction.

As further illustrated, magnet 58 is provided with a steel cap 62 which is held in place by the magnetic force of magnet 58. Steel cap 62 enables one to push cap 62 with his or her thumb quite easily and thereby move reversing member 38 to either its forward or reverse positions as explained below, or its locked position, which is located between the forward and reverse position, as illustrated in Figure 1.

Figures 1 and 7 also illustrate that apparatus 10 is provided with an end cap 64 which, when assembled, abuts against reversing member 38. End cap 64 is provided with a pair of bores 66 for receiving screws 36 which, when threaded into bores 34 of ratchet wheel 16, secure all elements of the assembly together.
The operation of the wrench will now be described with reference to Figures 8 through 13, which depict the position of the main components of the wrench, or ratcheting apparatus, during both a drive stroke and a return stroke. As explained in more detail below, when a drive stroke is made with the wrench, two of the four pawls shown are pulled into detents of the ratchet wheel by the magnetic attraction of the ratchet wheel which is provided by ring magnet 22. The pulled pawls are then immediately sandwiched between the wrench body 12 (actually wrench head 13) and ratchet wheel 16 so that they engage both the wrench head and the wheel to prevent relative rotation therebetween. That is, the wrench head and ratchet wheel are both fixed or locked relative to each other during the drive stroke so that turning or rotation of the wrench turns the ratchet wheel and its square drive 26, and thus a socket (not shown) held on the drive of the ratchet which, of course, in turn drives a bolt or nut positioned in the socket's cavity (also not shown). When the pawls are engaging the wheel and wrench head as described they are in their drive position as such term is used herein.

During the return stroke of the apparatus, the wrench is turned or rotated in the opposite direction which causes it rotate relative to the ratchet wheel, as those skilled in the ratchet art will appreciate. The pawls which engage the ratchet wheel during the drive stroke are pushed out of engagement therewith by the posts 54 which permits the ratchet wheel to rotate relative to the wrench body.

Figure 8 illustrates the position of the ratcheting
assembly's components at the beginning of a drive stroke. In this position, it will be appreciated that pawls 18a and 18c are engaging detents 24 of the ratchet wheel 16 (as well as the pocket wall 42 of the wrench head 13) and therefore in their drive position. Pawls 18b and 18d, however, are not engaged at this point because the pockets holding the pawls are not spaced 90 degrees equally from each other. A close inspection of the figures will reveal that pocket 20a is closer to pocket 20d than it is to pocket 20b. The actual included angle of the arc between pockets 20a and 20d is 85.5 degrees, whereas the included angle of the arc between pockets 20a and 20b is 94.5 degrees. Similarly, the included angle of the arc for pockets 20b and 20c is 85.5 degrees, whereas the included angle of the arc for pockets 20c and 20d is 94.5 degrees. Pockets 20a and 20c are, however, 180 degrees apart from each other and thus are in phase with each other which causes their respective pawls 18a and 18c to move in unison. Similarly, pockets 20b and 20d are 180 degrees apart from each other and are thus in phase with each other which causes their respective pawls 18b and 18d to move in unison. Since ratchet wheel 16 is provided with twenty detents 24, each detent has a ratcheting arc of 9 degrees. Accordingly, half a ratcheting arc is 4.5 degrees. By positioning pockets 20a and 20d as well as pockets 20b and 20c 4.5 degrees less than 90 degrees apart from each other, or half a detent ratcheting arc distance, the two pairs of oppositely facing pockets, i.e. pocket pair 20a,c and pocket pair 20b,d are out of phase with respect to each other. This out of phase arrangement keeps their respective pairs also out of phase with respect to each other so
that pawls 20a,c will not engage when pawls 20b,d engage and vice versa. This out of phase arrangement effectively provides the ratcheting wheel with forty teeth, or detents 24. Thus, by simply putting one pair of the pawls out of phase with respect to the other pair of pawls, one effectively reduces the ratcheting arc from 9 degrees to 4.5 degrees, thereby doubling the precision of the wrench, as those skilled in the art will appreciate. In other words, the wrench will engage every four-and-a-half degrees instead of every 9 degrees, thereby reducing the amount of play in the wrench before its pawls engage the ratchet wheel.

As mentioned, in Figure 8 the wall of pockets 20a,c (wall 42 as shown in Figure 7) for pawls 18a,c is also engaging pawls 18a,c. Accordingly, it will be appreciated that the pawls 18a,c are, in effect, being squeezed by the wrench between wall 42, and the respective detents of the ratchet wheel. This squeezing action prevents the wrench body from slipping on the ratchet wheel when the wrench body (actually handle 47) is driven, or rotated in a clockwise direction, as viewed in Figure 8. Thus, the force generated by one turning the wrench in a clockwise direction is transmitted through pawls 18a,c to the ratchet wheel which in turn causes the ratchet wheel to rotate in a clockwise direction, and thereby drive the socket (not shown) held on the ratchet wheel's drive 26 which turns a bolt, or other fastener (also not shown) held in the socket's cavity.

As will be appreciated, the longitudinal axis of the wrench handle in Figure 8 is positioned in about a 3:30 o'clock position. In Figure 9, it will be appreciated that the wrench
has been turned to approximately a six o'clock position. It will be appreciated that pawls 18a,c are still engaged and sandwiched between the inner wall 42 of the wrench head, and the same detents 24 shown in Figure 8.

Figure 10 illustrates the position of the wrench at approximately a nine o'clock position. It will be appreciated that pawls 18a,c are still engaged and in position to transmit force via the wrench to the ratchet wheel.

Figure 11 illustrates the position of the wrench with its handle 47 at about an 8:30 o'clock position, just after one begins making a return stroke with the wrench body. It can be seen in Figure 11 that pawls 18a,c have moved out of their respective detents. It can also be seen that pawls 18a,c are being contacted respectively by abutment posts 54a,c which serve to push the pawls out of engagement with the detents of the ratchet wheel. As also shown, abutment posts 54b,d are similarly pushing pawls 18b,d to prevent them from engaging a detent of the ratchet wheel.

Figure 12 illustrates continued movement of the wrench during the return stroke. Again, it will be seen that none of the pawls 18a-d are engaging a detent of the ratchet wheel. Thus, it will be appreciated that the position of the ratchet wheel is unchanged in Figures 11 and 12. However, the wrench has rotated approximately almost 90 degrees relative to the ratchet wheel in the counterclockwise direction.

Figure 13 illustrates continued counterclockwise movement of the wrench another 90 degrees from its position in Figure 12 so that it now has approximately a three o'clock position.
Again, it will be appreciated that none of the pawls 18a-d is engaging a detent of the ratchet wheel. It will also be appreciated that abutment posts 54a-d are pushing their respective pawls to prevent them from engaging a detent of the ratchet wheel. Due to the magnetic attraction of the ratchet wheel provided by ring magnet 22, the pawls will roll into and out of each detent (and make a slight clicking sound) as the wrench body is rotated but they will not engage the ratchet wheel and/or sandwich themselves between the wrench body wall 42 and the ratchet wheel as long as rotation continues in the counterclockwise direction. However, if one now begins to make a clockwise drive stroke with the wrench, and move the wrench to the position illustrated in Figure 8, pawls 18a,c will again engage detents of the ratchet wheel, thereby enabling one to drive the ratchet wheel. It is to be understood that pawls 18b,d could also engage the wheel. Which pair of pawls actually engages the wheel depends on their positioning at the beginning of a drive stroke. Generally, the pair which is closest to engagement at the beginning of a drive stroke will be the pair which actually engages the detents of the wheel.

The pockets are shaped to facilitate movement of the pawls into and out of engagement with the detents 24 of the ratchet wheel and wall 42 of the wrench head. Wall 42, of course, also defines the pockets' shape. Thus, it will be appreciated that in addition to the magnetic force provided by ring magnet 22, the wrench head/body defining the pocketed chamber, the ratchet wheel and the pawls all cooperate to move the pawls into (and out of) their locking drive position.
While ratchet 10 is provided with a ring magnet 22, it is to be understood that ring magnet 22 could be dispensed with by making the pawls (or the ratchet wheel 16 itself) out of magnetic material themselves. Such a magnetic pawl could also be cylindrical and, in fact, could be very similar to magnet 58 shown in the figures which is preferably made from a rare earth magnetic material such as neodymium-iron-boron (NdFeB). However, magnetic pawls made out of conventional ceramic material or NdFeB would not be as strong as the illustrated steel pawls 18 which are preferably made from a tempered or cold worked steel. Conventional ceramic and NdFeB magnets are also much more brittle than steel, and thus might not be able to withstand the forces being transmitted through them in a typical socket wrench application. In some applications, however, they may work fine.

For example, in some applications, it may be desirable to make the ratchet wheel and wrench body out of a non-magnetic material such as aluminum. In this case, the ring magnet could be replaced with a steel washer affixed to the ratchet wheel which would attract the magnetic pawls and generally restrain their movement but allow them to be pushed into and out engagement between the ratchet wheel and the wall of the wrench body, or other force transmitting body. The wall could be designed so that it would move or push the pawls into engagement with the ratchet wheel. Abutment posts could also be designed perhaps out of the wall itself to push the pawls out of engagement with the ratchet wheel. This type of ratcheting mechanism would also offer the advantage of being almost completely silent, since there would be no magnetic force pulling the pawls into the
ratchet wheel during a return stroke which is what causes the clicking noise associated with most conventional ratchets. In other words, once the pawls are pushed into the release position, they will remain in position until they are pushed back into engagement with the ratchet wheel. Such a silent ratchet may appeal to the military and may be of particular use in submarines where it is extremely important to avoid detection by an enemy.

Figures 5 and 6, as well as 7, illustrate the reversing mechanism or means of wrench 10 which reverses the direction in which the wrench operates. Figure 5 illustrates the position of the wrench's components in its forward position, which those skilled in the art will appreciate is the position the wrench is in as shown in Figures 8 through 13. In this position, it will be appreciated that a drive stroke is made with the wrench by rotating it in a clockwise direction as indicated by the arrow in Figure 5. In Figure 6, it will be appreciated that the drive stroke is made by rotating the wrench in the counterclockwise direction as indicated by the arrow in Figure 6.

A review of Figures 5 and 6 also illustrates that the reversing means of the wrench is provided by the tear drop shaped reversing member 38 which, when pushed to the right as shown in Figure 5, puts the wrench in its forward position. In this position, it will be appreciated that abutment posts 54 are moved in a slight clockwise direction so that the right ends of the posts project slightly into the left sides, or ends, of pockets 20. Similarly, when reversing member 38 is moved to the left to its reverse position shown in Figure 6, the left ends of posts 54 project into the right side of pockets 20. This repositioning
of the posts is what causes the mechanism to reverse the wrench's direction of operation since it is the protruding ends of posts 54 which push the pawls out of engagement with the ratchet wheel when a return stroke is made with the wrench. Thus, it will be appreciated that when the wrench is in its forward position illustrated in Figure 5, the right ends of the abutment posts push the pawls out of engagement when the wrench is rotated in a counterclockwise direction, which is the direction the wrench makes when one is making a return stroke with the wrench.

Similarly, in Figure 6, it will be appreciated that it is the left end of the abutment posts which push the pawls out of engagement with the ratchet wheel when a clockwise return stroke is made with the wrench.

As also shown in Figure 5, each pawl 18a and c is engaging a detent of the ratchet wheel, and the trailing side wall of its pocket (which sidewall is part of wall 42). It will be appreciated that the pawl actually engages the trailing sidewall of the pocket (which as viewed in Figure 5, is the right side of the pocket when looking at the pocket from the outside of the ratchet wheel) since the wrench is being moved in a clockwise direction. Thus, it will be appreciated and is believed that as one rotates the wrench in a clockwise direction, the trailing sidewall of the pocket impacts up against the pawl as the pawl is pulled into a detent 24 of the ratchet wheel by the magnetic attraction of the wheel as previously described. At this point, it is believed that the pawl becomes sandwiched between the pocket's trailing sidewall and a ratchet wheel detent to thereby engage both the wrench body (or head) and the ratchet wheel which
locks the wrench body (or head) into engagement with the ratchet wheel, thereby enabling one to make a drive stroke with the wrench. As previously mentioned, in this position, the driving forces are transmitted from the wrench body through the engaged pawl to the ratchet wheel. The same engagement operation is believed to take place in Figure 6, but in the opposite direction.

Reversing member 38 is also preferably made out of a friction reducing material, such as Delrin, because the ends of the cylindrically shaped pawls also slide on this surface as they move into and out of engagement as one makes drive and return strokes with the wrench. Delrin also facilitates movement of reversing member 38 between its forward and reverse positions as illustrated in Figures 5 and 6.

Magnet 58 received in bore 56 of reversing member 38 serves to hold or maintain reversing member 38 in the desired forward or reverse position after it is moved to the desired position. Magnet 58 holds member 58 in position due to its magnetic attraction to the underlying metallic surface 60 of tear drop shaped cut-out 50. As mentioned above, magnet 58 is preferably a neodymium-iron-boron (NdFeB) magnet because of its high magnetic strength but it could be a ceramic, or a samarium type magnet or any other type of magnetic material as long as the material is magnetically strong enough and sufficiently heat resistant and shock resistant. Ring magnet 22 of this embodiment is preferably a ceramic magnet having the industry designation of C5 or C8 due to the low cost of ceramic magnetic material. However, rare earth magnets such as NdFeB and samarium would also
work, perhaps even better than a ceramic due to the significantly higher magnetic strength provided by these magnets.

The wrench body 12, and the ratchet wheel 16 were made from 01 tool steel, and then heat treated to provide them with the desired temper, as is well known to those skilled in the art. However, they may be made in any commercially viable way known to those skilled in the art. Pawls 18 are preferably made from steel rod stock by simply cutting each pawl from the rod stock at its desired length. It has also been found that spherically shaped pawls such as steel ball bearings can also be used in this embodiment of the present invention as well as the other embodiments described herein and indeed can be substituted for the illustrated cylindrically shaped pawls. In addition, it has been found that the ratcheting apparatus of wrench 10 will work with just one pawl in one of the illustrated pockets 20 as well as two pawls which may be in two of the out of phase pockets such as pockets 20a and 20b or in two of the in phase pockets such as pockets 20a and 20c. The foregoing components may

As the foregoing discussion illustrates, pawls 18 are not mechanically attached to any part of the wrench such as the ratchet wheel or pocket nor are they physically mounted upon anything such as a spring. Thus, if it were not for the magnetic force exerted upon them by the ring magnet, each pawl 18 would be freely moveable in its respective pocket 20. As such, pawls 18 and all other such "unattached or free" pawls described herein shall be and are hereinafter sometimes referred to as "floating pawls" or "floating pawl means" as that term is used in the claims attached hereto.
In addition, it should be understood that while the disclosed preferred embodiment and those disclosed below use a ring magnet for socket retention and to facilitate the pawls movement into the ratchet wheel, the magnet need not be provided in the form of a ring magnet. Indeed, a magnet of any shape providing the requisite magnetic force for socket retention and/or moving the pawl(s) is considered to be within the scope of the present invention and the claims appended hereto.

Figures 14 through 19 illustrate another embodiment of the present invention for a socket wrench 110. Socket wrench 110 is quite similar to socket wrench 10 in that it is provided with a wrench body 112 having a head 113 defining a chamber 114 for housing a ratchet wheel 116. As will be appreciated, however, chamber 114 has a triangular shape since its pockets or corners 120a-c hold only three pawls 118a-c instead of the four pawls 18a-d provided in the first embodiment. Pockets 120a-c are also much less defined than the four pockets 20a-d of the first embodiment. They are, however, large enough to receive pawls 118a-c, and permit movement of the pawls into and out of engagement with the detents 124 of ratchet wheel 116 in a manner similar to that which takes place in the first embodiment. As will be appreciated, the simple triangular shape of chamber 114 of this embodiment enables the chamber to be easily machined or otherwise provided since it is a simple equilateral triangle provided with filleted or rounded corners having a radius of curvature of 0.25 inches. As will be appreciated, the filleted corners define the walls of pockets 120a-c.

Pawls 118a-c illustrated in solid lines in Figure 16 are
shown in their drive position in which one of the pawls, i.e. pawl 118b, is engaging the ratchet wheel. The pawls shown in dotted lines are in their disengaged, or release position, which is the position they would be in when one is making a return stroke with the socket wrench. The reason only one pawl, i.e. pawl 118b, is engaging the ratchet wheel is because the pawls are out of phase with respect to each other such that only one of the three pawls will engage a detent 124 of the ratchet wheel at any given time. This out of phase engagement occurs even though the pawls are spaced equally from each other by the equilateral triangularly shaped chamber 114 because the ratchet wheel is provided with twenty detents which is a number not evenly divisible by three. If the ratchet wheel were provided with 24 detents, all three pawls 118a-c would engage detents of the ratchet wheel simultaneously, since with 3 pawls there would be effectively one pawl for every eight detents. Those skilled in the art will appreciate that this out of phase arrangement effectively provides this embodiment with three times the number of detents, or 60 detents which provides the socket wrench with a ratcheting arc of only 6 degrees. Thus, the ratchet of this embodiment is a very precise ratchet which will engage its ratchet wheel with just a slight turn of the socket wrench.

Referring now to Figures 15 and 18, it will be appreciated that ratchet wheel 116 is received in an end cap 130 and secured thereto by a ledge 131 of the ratchet wheel's square drive 126. Figures 15 and 18 further illustrate that a ring magnet 122 is also provided which rests against end cap 130 as best shown in Figure 15. Ring magnet 122 functions in a manner similar to ring
magnet 22 of the first embodiment to magnetize ratchet wheel 116 so that its drive 126 magnetically holds a socket and its wheel portion with detents 124 attracts pawls 118a-c into engagement therewith. Figures 15 and 18 also illustrate that this embodiment is provided with a reversing member 138 which has a cylindrically shaped cut-out portion 139 for receiving ring magnet 122. Reversing member 138 functions similarly to that of the previous embodiment and is preferably made from a friction reducing material such as Delrin since pawls 118a-c move on the surface of its circular raised portion 140, as will be appreciated from viewing Figures 15 and 19. As explained below, however, reversing member 138 also incorporates the functions of reversing member 38 of the first embodiment.

As shown in Figure 19, reversing member 138 is also provided with a trio of abutment posts 154a-c on its circular raised portion 140 which function similarly to posts 54a-d of the first embodiment, by moving or pushing pawls 118a-c into their release position when a return stroke is made with the socket wrench. As previously mentioned, the release or disengaged position of pawls 118a-c is illustrated in dotted lines in the figures.

Returning to Figures 15 and 18, it will be appreciated that raised circular portion 140 of reversing member 138 is received in a circular cut-out section 144 of wrench head 113. Wrench head 113 also defines a cut-out area 162 which opens into cut-out section 144. As shown, cut-out section 162 has a sidewall, the right side of which is referred to herein as right sidewall 163a and the left side of which is referred to as left sidewall 163b.

As shown in Figures 15 and 19, the underside (not numbered)
of reversing member 138, is also provided with a cut-out area 157 for receiving approximately half of a magnet 158. The other half of magnet 158 is received in the cut-out section 162 of the wrench head as best shown in Figure 15. Magnet 158 functions in a manner similar to that of magnet 58 of the previous embodiment by locking or maintaining reversing member 138 in its forward or reverse position, as respectively illustrated in Figures 16 and 17. However, it has been found that it works significantly better than magnet 58, since instead of attracting itself to the bottom surface of the cut-out (which in the first embodiment is surface 60) magnet 158 is positioned on its side against the bottom of cut-out section 162 so that the exposed halves of the magnet's ends 159, 161 are attracted respectively to the right and left sidewall 163a,b of cut-out section 162. As will be appreciated, this arrangement of the magnet enables its magnetic force to literally snap or pull reversing member 138 into its forward and reverse positions as the magnet approaches right or left sidewall 163a or 163b. Accordingly, it is not necessary to push the reversing member all the way to its forward or reverse position. Once one moves the reversing member near the forward or reverse position, the magnetic force of magnet 158 takes over to pull the reversing member into the forward or reverse position. This magnetic switching arrangement is believed to be another novel feature of the present invention and may be of use in many applications besides its illustrated use in a ratchet. For example, it is believed that it would work extremely well in a conventional electrical wall switch in that it is unlikely to wear out, which is in complete contrast to conventional
electrical wall switches which often wear out quickly.

Figure 16 illustrates wrench 110 in its forward position in which end 159 of magnet 158 is in contact with right sidewall 163a. As illustrated by the arrow, a drive stroke is made in this position by rotating or turning the wrench in a clockwise direction. Figure 17 illustrates socket wrench 110 in its reverse position in which the magnet's other end 160 is attracted to and in contact with sidewall 163b. As illustrated by the arrow, in this position a drive stroke is made by turning the wrench in the counterclockwise direction.

Returning now to Figures 15 and 18, it will be appreciated that the entire assembly is held together by an end cap 164 with a screw 136 received therein and threaded into a threaded bore 134 provided in the end (not numbered) of ratchet wheel 116. As also shown, end cap 164 is received in a cut-out section 165 located on side 148 of the wrench head. End cap 164 is also preferably made out of a friction reducing material such as Delrin to facilitate movement of the pawls into and out of engagement with the ratchet wheel which are positioned against the inner facing side 166 of the end cap as illustrated.

Figure 20 illustrates yet another embodiment of the present invention, which is identical to that illustrated in Figures 14 through 19, with the exception that ratchet wheel 116, referred to herein as wheel 216, has a smooth cylindrical surface 217 which is not provided with any detents. It will thus be appreciated that this embodiment is more like a clutch, particularly a roller clutch, since this embodiment relies on friction to prevent movement between the wheel and the wrench.
head.

By providing the ratchet wheel with a smooth detent-free surface, it will be appreciated that all three pawls 218a-c engage surface 217 simultaneously and therefore prevent ratchet wheel 216 from rotating relative to wrench the head during a drive stroke by in essence squeezing the wheel. It will be appreciated that the friction which is generated during a drive stroke between the wheel's surface 217 and the surfaces of the three pawls 218a-c should be sufficient to prevent such rotation. It will further be appreciated that the force of a drive stroke is transmitted through all three pawls in this embodiment which means that wrench 210 will be able to withstand significant forces.

The simultaneous engagement of surface 217 by pawls 218a-c is shown in Figure 20 by the pawls drawn in solid lines. The pawls drawn in dotted lines show the pawls in their disengaged release position. As will be appreciated, there will be no clicking noise during a return stroke with this embodiment since there are no detents for the pawls to click against as the pawls travel over surface 217 during the return stroke.

The remainder of the components of socket wrench 210 are identical to those of socket wrench 110, and accordingly are numbered similarly such that reference numerals sharing the same last two digits identify similar corresponding elements.

Figures 21-26 illustrate a fourth embodiment of the present invention which is a one-way ratchet wrench 310. As those skilled in the art will appreciate, wrench 310 is provided with a drive hole 398 which extends all the way through the wrench
(See Figure 24) so that a square driving or drive cut-out 317 provided in wheel 316 can receive the square drive 390 of a male socket 388. As shown, the square drive 390 of the male socket is removably received a pre-set distance within the drive cut-out 317. Male socket 388 is also provided with a flat collar surface 391 for controlling the distance to which the drive 390 is received in the cut-out. Flat collar surface 391 also serves to enhance magnetic attraction between the socket and the wrench head.

As also shown, cut-out 317 is accessible from both sides 346, 348 of the wrench and therefore is capable of receiving drive 390 of the socket from either side of the wrench. The advantage of this embodiment is that it eliminates the need for a reversing member and locking magnet such as magnet 158 which in the previous embodiments locks the reversing member in its forward and reverse positions. These members are no longer necessary since use of the wrench in the opposite (or reverse) direction is accomplished by simply inserting the tool into the other side of the wrench. That is, to reverse the direction of the wrench's operation one simply removes a socket 388 from its position shown i.e. against side 346 of the wrench and inserts it into the opening for drive hole 398 located on the opposite side 348 of the wrench as such is shown in phantom in Figure 22.

While this embodiment eliminates the need for the reversing member such as reversing member 138 and the locking magnet 158, to magnetically attract and securely hold a socket (or other tool) on the opposite side of the wrench, i.e on side 348, an additional ring magnet 322 will be necessary in most situations.
As such, this means that it will also be necessary in most situations to position a Delrin friction reducing member 375 between the magnet and the pawls 318 to facilitate the pawls movement thereon. A Delrin member 375 may also be necessary for the magnet 322 located on side 346 of the wrench since there is no Delrin reversing member in this embodiment. It will also be appreciated that the end cap 364 for side 348 of the wrench is identical to end cap 364 for side 346 of the wrench and is therefore identified with the same number in this embodiment.

Friction reducing members 375 also serve to prevent direct magnetizable metal to metal contact between the caps 364 and the wrench head 313 which might prevent the pawls from being attracted to wheel 316.

It will further be appreciated that instead of three pawls as provided in the previous embodiment this embodiment is provided with five pawls 318a-e which are received in corresponding pockets 320a-e of the wrench head 313. It will also be appreciated that wheel 316 is only provided with nine detents 324. Nonetheless, since the pawls of this embodiment also engage in an out of phase arrangement, i.e. only one at any given time, this embodiment still has a rather high effective number of detents, i.e. forty-five which is determined by simply multiplying the number of actual detents, i.e. ne, by the number of pawls, i.e. five.

It will also be appreciated that detents 324 of wheel 314 are connected to each other by rounded surfaces 325 such that the detents are more rounded than those of the previous embodiments. That is, a rounded surface 325 defined by the wheel's rim
connects each detent 325 with an adjoining detent. The provision of the rounded detents should reduce the clicking noise which is typically associated with ratchets. As such, the ratchet of this embodiment should find acceptance in applications where the clicking sound of a ratchet is objectionable such as in a submarine.

Figure 23 shows the position the wrench's components are in when the wrench is in its drive position. As shown, pawl 314a is engaging a detent 324 of the wrench. Figure 23 shows the position of the wrench's components during a return stroke. As shown, it will be appreciated that the pawls roll into and out of each successive detent during the return stroke. It will also be appreciated that the backside 321 of each pocket pushes against its associated pawl during the return stroke. In this embodiment, both the pawls and the wheel are made out of magnetizable material such as steel so that they are magnetized by ring magnets 322 and so that they attract each other which is why they roll into and out of each successive detent during the return stroke.

In accordance with an important aspect of the invention, Figure 24 illustrates that ring magnet 322 and pawls 318 are positioned or oriented relative to each other such that the lines of magnetic force or attraction therebetween (not shown but will be appreciated to extend between ring magnet 322 and pawls 318) at an angle, actually perpendicular, to the direction in which force is transmitted via pawls 318 between wrench head 313 and wheel 316 when a drive stroke is made with the wrench. This direction of force transmission will be appreciated to lie in the
plane identified by the letter F (also referred to herein as force transmission plane F). It will also be appreciated that the lines of magnetic force or attraction are provided at this angle or perpendicular orientation by positioning ring magnet 322 to the side of wheel 316. It will further be appreciated that this positioning of the ring magnet to the side of wheel 316 means that the magnet is positioned out of plane F or isolated therefrom which is important since it insures that most, if not all, of the force being transmitted between the wrench body and wheel via the pawls bypasses the magnet. This is important because permanent magnets are quite brittle and often unable to withstand the forces being transmitted during the making of a drive stroke with the wrench.

Figure 26 illustrates an alternative ratchet wheel 316' for use in wrench 310. The sawtooth nature of these teeth or detents 324' should work well in the ratchet of wrench 310 since it is a one way ratchet. The sawtooth teeth should provide more positive engagement with the pawls and be less likely to roll out of engagement therewith.

Figures 27-31 illustrate a fifth embodiment of the present invention which is directed to a silent one-way ratchet wrench 410. Wrench 410 is identical to one-way wrench 310 except in two respects. One, the wheel is made out of a non-magnetic material such as stainless steel. Two, the friction reducing members 375 of the previous embodiment are replaced with steel or magnetizable washers 475 having a square cut-out 477. There is no need to make the washer out of a friction reducing material such as Delrin since it apparently does not matter if the wrench
head becomes magnetized. This is because in this embodiment it is not necessary for the wheel and pawls to magnetically attract each other for the pawls to engage the wheel. It is necessary, however, in this embodiment for the magnet to turn with the drive which is why washer 475 is provided with square cut-out 477. The square cut-out insures that the magnet turns with the drive since the magnet is attracted to the washer which with the square cut-out turns as the drive is turned.

In view thereof, it will be appreciated that pawls 418 (which are made out of magnetizable material such as steel) are held in place or restrained by the magnetic force of the ring magnets 422 which do not move at the beginning of a drive stroke and do not begin to move until a pawl engages the wheel. The pawls are held in place or restrained because the magnets are magnetically affixed to the drive. Thus, as one begins to make a drive stroke with the wrench, the pawls fundamentally stay where they are until the pawls' pockets 420 actually begin to envelope them. This happens because the pockets are moving relative to the magnets. This movement of the pockets and magnetic holding or restraining of the pawls by the magnets should cause the pawls to roll as they are enveloped, one of which will roll completely into engagement as shown by pawl 418a in Figure 29. Again, only one of the five pawls will engage the wheel at any given time since the pawls are out of phase with respect to each other as dictated by the fact that there are only nine detents 424 as previously described.

When a return stroke is made as shown in Figure 31, the backsides 421 of the pockets 420 simply push the pawls out of
engagement into the deep part of each pocket. The pawls will not roll in and out of each successive detent 424 as a return stroke is made since the pawls are not magnetically attracted to the wheel. They simply stay in the deep part of each pocket as shown. However, when one begins to make a drive stroke with the wrench the pawls will be held in place by the magnets as previously mentioned where they are enveloped by the pockets and roll until one of the pawls such as pawl 418a rolls into engagement with the wheel. It is believed that this embodiment of the ratchet will be completely silent i.e. there will be no clicking noise typically associated with ratchets since the pawls do not roll into and out of each successive detent as a return stroke is made with the wrench.

It should also be noted that in this embodiment, pawls 418 could be made out of permanent magnet material and magnets 422 could be replaced with ring-like washers made out of magnetizable material such as steel. If replaced with such a washer, numeral 422 could simply be referred to as washers 422 or more broadly as offset means 422. Whatever they are called is not important. The important thing is that the pawls and element 422 magnetically attract each other so that the pawls are restrained or held in place by the magnetic force therebetween at the beginning of a drive stroke, as previously described.

It will also be appreciated that washer 475 could be dispensed with altogether by simply providing ring magnet 422 with a square cut-out which would insure that it does not move at the beginning of a drive stroke and that it magnetically holds the pawls in place until a pawl engages the wheel at which point
the drive and affixed magnet will begin to turn as the drive stroke is made. It will also be appreciated that friction reducing washers such as Delrin washers (not shown) could be positioned between the pawls' ends and the steel washers 475 if friction between the steel washers and pawls were to present a problem.

The foregoing embodiments as well as several other embodiments are disclosed in our co-pending U.S. patent application Serial No. 08/808,627 which is hereby incorporated by reference.

Turning now to the new embodiment, Figures 32-36 illustrate a novel ratchet wrench 510 and socket 527 combination which defines a unique "through hole" 598 for allowing the shank of a bolt (not shown) to pass entirely through the socket and wrench head 513 of the wrench 510 so that a nut can be threaded on the bolt's shank no matter what its length is. Those skilled in the art will appreciate that the above socket and wrench head combination will reduce and possibly eliminate the need for deep well sockets which are typically used to thread nuts on and off bolts having long shanks.

As in the previous embodiments, wrench 510 utilizes a permanent ring magnet 522 to facilitate the movement of pawls 518a and 518b into engagement with the teeth or detents 524 of a ratchet wheel 516 (See Figure 34). The actual operation of wrench 510 and its components, i.e. the cooperation between the pawls 518, ratchet wheel 516 and wrench head 513 to move the pawls into and out of the locking drive position as well as reversing member's operation is very similar to that of wrench
110 and is therefore not described in detail here. It will be appreciated, however, that wrench 510 expands upon these wrenches, particularly that of Figures 21-26 having the above mentioned square drive cut-out in its wheel.

Instead of such a square cut-out, wrench 510 is provided with an octagonally shaped cut-out 517 for receiving an octagonally shaped driven end 537 of socket 527. In addition, while the opposite driving end 533 of socket 527 is similar to that of socket 388 in that it defines a drive socket cavity 535 for engagingly receiving a nut and the like (not shown), socket 527 also defines a through hole passageway 545 in communication with the drive socket cavity which together define through hole 598. Through hole 598 extends through the entire socket 527 and preferably has a diameter which is large enough to pass the shank of any bolt capable of being torqued by the socket. To accomplish this, the diameter of the socket's through hole passageway 545 must, of course, have a diameter which is large enough to pass the shank of such a bolt.

In addition, to enable socket 527 to be received in cut-out 517 and pass the shank of a bolt through its hole 598, several components of the wrench must, of course, define holes, preferably axially aligned holes, for receiving socket 527 and/or the shank of such a bolt. For example, as shown in Figures 33 and 35, cap 564 and washer 592 are provided respectively with axially aligned holes 569, 593, each of which has a diameter which is large enough to receive the socket's driving end 533. This enables the socket's collar surface 591 to rest directly against a face 551 of the ring magnet 522 and thereby directly
contact the ring magnet to provide strong magnetic attraction between the ring magnet and the socket which is made from a magnetizable material such as steel. The magnet attraction should preferably be great enough to prevent one from pulling the socket out of the hole unless one exerts enough force to meet or exceed ANSI standards.

To provide such contact between the face of the magnet and the socket's collar surface 591, hole 523 of the ring magnet must have a smaller diameter than that of holes 569, 593. However, as will be appreciated its diameter must still be large enough to receive the octagonally shaped driven end 537 of the socket.

Washer 594 and side 548 of the wrench head are also, as illustrated, provided with axially aligned holes 595, 571, respectively. These holes, as shown, should also preferably have a diameter which is large enough to pass the shank of a bolt to be torqued by the socket. They may also be provided with an even larger diameter such as that of holes 569, 593 for receiving driving end 533 of the socket. With the larger diameter, one will be able to insert the socket into the wrench head through side 548 of the wrench. This may be desirable for some applications of the wrench and if magnet 522 is a strong magnet such as a neodymium magnet it should be able to hold the socket on the wrench head. However, the magnetic attraction may not be strong enough to meet ANSI standards. Accordingly, to meet ANSI standards it may be necessary to provide this side of the wrench with another ring magnet similar to that provided in wrenches 310, 410.

Ring magnet 522 is preferably made from a rare earth
magnetic material such as neodymium-iron-boron (NdFeB) and reversing member 538 is preferably made from a friction reducing material such as Delrin. Cap 564 and wrench head 513 are preferably made from a magnetizable material such as steel because such magnetizable materials are believed to dissipate or absorb the magnetic field of the ring magnet which is quite strong if the magnet is NdFeB magnet. Washers 592 and 594 (or more generically described herein as spacers) are preferably made out of a material such as Delrin and have also been found to enhance the ease with which wheel 516 can be rotated relative to the wrench head 513. The washers or spacers not only reduce friction but are believed reduce magnetic attraction between the ring magnet/wheel and cap 564 and the area of the wrench head surrounding hole 571. This magnetic attraction, as indicated above, can be quite strong if magnet 522 is a NdFeB ring magnet.

It also should be mentioned that cap 564 does not pivot or move with reversing member 538 which moves between a forward and reverse position and maintains that position with a second magnet 558 which functions in a manner similar to that described above in connection with magnet 158. Cap 564 is prevented from such movement by virtue of its attachment to wrench head 513 with screw 536 and its end 553 which abuts up against a surface 555 of the wrench head to prevent such movement.

Pawls 518 are preferably spherical although they could be cylindrical as in the previous embodiments. The spherical pawls are preferably steel ball bearings which have been found to roll over the detents of ratchet wheel 516 very easily. Steel ball bearings are preferred particularly if ring magnet 522 is a NdFeB
magnet.

Ratchet wheel 516 and pawls 518 are also preferably made from magnetizable metal such as steel to insure that they are magnetically attracted to each other as such is set forth above in more detail. It may, however, be desirable in some instances to make ratchet wheel 516 out of a non-magnetizable steel such as stainless steel if it is desired to make the wrench quieter or silent as discussed above in connection with wrench 410.

Pockets 520a and b are also spaced from each other in an out of phase relationship similar to that described in connection with wrench 10 so that only one pawl engages wheel 516 at any given time. This out of phase relationship effectively doubles the number of detents, thereby cutting the ratcheting arc of the ratchet in half which in the disclosed embodiment reduces the arc from about twenty four degrees to twelve degrees. Thus, it will be appreciated that the number of detents 524 (which is fifteen in wheel 516) is effectively doubled to thirty which thereby provides the 12 degree ratcheting arc.

It should also be appreciated that the socket's driven end 537 and the cut-out 517 of the ratchet wheel do not have to be provided with the shown octagonal shape and could be provided with any non-circular shape such as a hex shape as long as the selected shape prevents slippage between the wheel and the socket. Indeed, if cut-out 517 were provided with a hex shape (or twelve point configuration), wrench 510 could serve as a boxed end wrench.

Finally, those skilled in the art will appreciate that the ability to insert socket 527 in wrench head 513 provides the
socket and wrench combination with an extremely low profile which facilitates the wrench's use in tight spaces.

From the foregoing, it will be appreciated that the present invention provides a magnetic ratchet/clutch-type mechanism which is ideally suited for use in a ratchet wrench in that it is extremely strong and much less likely to wear out than conventional ratcheting apparatus. The magnetic ratchet mechanism of the present invention can also be designed to produce less resistance between the pawl and ratchet wheel during the ratchet wrench's return stroke. (Indeed, in the disclosed silent ratchet mechanism there should be no such resistance during the return stroke.) Less resistance can be achieved because the pawls are not pushed by a spring into the sharp teeth of a conventional ratchet wheel which is how most conventional ratchet mechanisms work. Instead, the pawls roll over the more rounded teeth of the ratchet wheel which are rounded to facilitate such rolling. Less resistance is desirable since it means that a nut being threaded on a bolt is less likely to unthread during the wrench's return stroke. Unthreading is typically not a problem when the nut or other member is actually being tightened or untightened but it is a problem when the nut is being threaded on or off a bolt before or after actual tightening or untightening.

In addition, the ratchet wrench and socket combination defining the unique "through hole" (which allows the shank of a bolt to pass entirely through the socket and wrench head of the wrench so that a nut can be threaded on the bolt's shank no matter what its length) should reduce and possibly eliminate the
need for deep well sockets.

In addition, the embodiments which allow a socket to be inserted into the cut-out of the ratchet wheel have lower profiles than conventional female type sockets and wrenches, the sockets of which have a base portion for receiving a conventional male square drive which adds to the overall height of the socket. In addition, the cavity section of an insertable socket of the present invention can also be shallower than that of a conventional female socket since it need not be any deeper than is necessary to receive the bolt head or nut which it is designed to receive. As will be appreciated by those skilled in the relevant art, a socket/wrench combination having such a low profile should be particularly appealing to mechanics since it will make it easier for them to use the socket/wrench combination in tight spaces.

It is also believed that insertable sockets such as socket 527 are less likely to crack than conventional female sockets (which mount on a male drive) since the forces on an insertable socket (when inserted in the cut-out of the ratchet wheel) are directed inwardly and tend to cancel each other somewhat. In contrast, the outwardly directed forces on a conventional female socket mounted on a male drive are completely unopposed and therefore are more likely to crack the socket's wall.

Finally, while all disclosed embodiments use a permanent magnet for two purposes, i.e. to control pawl movement in a ratchet and to hold a socket on the wrench, the scope of the present invention is not intended to be limited to such dual purpose apparatus and it is specifically considered to be within
the scope of the present invention to use a permanent magnet(s) to hold or retain a socket on any ratchet wrench including those using a spring to urge or push the pawl into engagement with the teeth or detents of the wrench's ratchet wheel rim as such is disclosed in U.S. Patent No. 4,819,521, which is hereby incorporated by reference.

The invention has been described in detail with reference to particular embodiments thereof, but it will be understood that various other modifications can be effected within the spirit and scope of this invention. For example, the ratchet/clutch-type apparatus of the present invention may be utilized in air turbine starters, fishing reel apparatus, seat belt retraction apparatus, bearing apparatus to provide a one-way bearing, and in bicycle and wheel chair drive apparatus similar to that shown in U.S. Patent No. 5,236,398 to Barnett as well as in linear drive apparatus.
We claim:

1. A ratchet/clutch-like apparatus comprising:
   first force transmitting member;
   second force transmitting member;
   floating pawl means positioned between said first and second force transmitting members for being moved between a drive position in which said floating pawl means is engaging said first and second force transmitting members to prevent movement therebetween, thereby permitting force to be transmitted therebetween and a release position in which said floating pawl means is out of engagement with said second force transmitting member to permit movement therebetween;
   offset means for cooperating with said floating pawl means so that said offset means and said floating pawl means are magnetically attracted to each other to facilitate movement of said floating pawl means into the drive position when one of said first and second force transmitting members is moved in a first direction, said offset means and said floating pawl means further being oriented relative to each other such that the lines of magnetic force therebetween are at an angle relative to the direction in which force is transmitted between the first and second force transmitting members; and,
   means for facilitating movement of said floating pawl means into the release position when said one of said first and second force transmitting members is moved in a generally opposite second direction.
2. A ratchet/clutch-like apparatus as claimed in claim 1 wherein at least one of said offset means and said floating pawl means includes permanent magnet material.

3. A ratchet/clutch-like apparatus as claimed in claim 1 wherein at least one of said offset means and said floating pawl means includes electro-magnetic means.

4. A ratchet/clutch-like apparatus as claimed in claim 1 wherein said offset means is a permanent ring magnet.

5. A ratchet/clutch-like apparatus as claimed in claim 1 wherein said floating pawl means includes a permanent magnet.

6. An apparatus as claimed in claim 1 wherein said offset means is fixed relative to said second force transmitting member and wherein the magnetic attraction between said offset means and said floating pawl means restrains movement of said floating pawl means relative to said second force transmitting member so that said first force transmitting member facilitates movement of said floating pawl means into the drive position when said one of said first and second force transmitting member is moved in the first direction.

7. An apparatus as claimed in claim 1 wherein said second force transmitting member is magnetized to attract said floating pawl means to said second force transmitting member to facilitate said floating pawl means movement into the drive position when
said one of said first and second force transmitting members is moved in the first direction.

8. An apparatus as claimed in claim 1 wherein said floating pawl means includes a plurality of pawls which are arranged in an out of phase manner so that only a predetermined number of said pawls are moved to the drive position when said one of said first and second force transmitting members is moved in the first direction.

9. An apparatus as claimed in claim 1 wherein said floating pawl means includes a plurality of pawls.

10. An apparatus as claimed in claim 1 wherein said floating pawl means is cylindrically shaped.

11. An apparatus as claimed in claim 1 wherein said floating pawl means is spherically shaped.

12. An apparatus as claimed in claim 1 further comprising reversing means for moving between a forward and a reverse position to reverse the direction in which the apparatus operates so that in the reverse position said floating pawl means is moved into the drive position when said one of said first force transmitting member and said second transmission member is moved in the second direction.

13. An apparatus as claimed in claim 1 wherein said first
force transmitting member defines a first surface for cooperating with said second force transmitting member to engage said floating pawl means in its drive position and said means for facilitating movement of said floating pawl means into the release position includes an abutment for pushing said floating pawl means into its release position.

14. An apparatus as claimed in claim 13 wherein said first surface is defined by an inner surface of a body for said apparatus.

15. An apparatus as claimed in claim 14 wherein said abutment is defined by reversing means attached to said body for reversing the direction in which the apparatus operates so that said floating pawl means is moved to its release position when said one of said first and second force transmitting members is moved in the first direction and so that said floating pawl means is moved to its drive position when said one of said first and second force transmitting members is moved in a generally opposite second direction.

16. An apparatus as claimed in claim 1 wherein said second force transmitting member includes a wheel having a rim for engaging said floating pawl means.

17. An apparatus as claimed in claim 16 wherein said rim includes a generally smooth cylindrical surface for frictionally engaging said floating pawl means.
18. An apparatus as claimed in claim 16 wherein said rim of said wheel defines a plurality of engagement detents for engaging said floating pawl means.

19. An apparatus as claimed in claim 18 wherein each said engagement detent is arcuately shaped to complement the shape of said floating pawl means.

20. An apparatus as claimed in claim 16 wherein said offset means includes a pair of ring magnets which are coaxially aligned about the axis of said wheel on opposite sides thereof.

21. An apparatus as claimed in claim 16 further comprising a socket wrench drive for holding a socket, said drive being attached to said wheel and axially aligned therewith.

22. An apparatus as claimed in claim 16 wherein said offset means includes ring magnet means which is coaxially aligned about the axis of said wheel to a side thereof.

23. An apparatus as claimed in claim 22 wherein said ring magnet means magnetizes said wheel and said floating pawl means to provide the lines of magnetic force between said ring magnet and said wheel/said pawl means which are oriented at an angle relative to the direction in which force is transmitted between said first force transmitting member and said wheel.

24. An apparatus as claimed in claim 22 further comprising
a drive for receiving a socket and the like, said drive being axially aligned and attached to a side of said wheel and wherein said ring magnet means is mounted about said drive against said side of said wheel so as to magnetically hold a socket and the like on said drive.

25. An apparatus as claimed in claim 22 further comprising a reversing member for moving between a forward and a reverse position to reverse the direction in which the apparatus operates so that in the reverse position said floating pawl means is moved into the drive position when said one of said first force transmitting member and said wheel is moved in the second direction.

26. An apparatus as claimed in claim 22 wherein said wheel defines a cut-out aligned about its axis for removably receiving the driven end of a socket and the like and wherein the inner diameter of said ring magnet means is large enough to receive said drive member.

27. A ratchet/clutch-like apparatus comprising:
inner ratchet wheel-like means having an outer generally cylindrical rim surface;
outer body means having an inner surface defining a chamber in which said inner wheel-like means is received for rotation relative to said body means;
floating pawl means positioned generally between said inner surface of said body means and said outer rim surface of
said inner wheel-like means for being moved between a drive position in which said floating pawl means is engaging both said outer rim surface and said inner surface to prevent said body means and said wheel-like means from rotating relative to each other and a release position in which said floating pawl means is out of engagement with said outer rim surface of said inner wheel-like means to permit said body means and said wheel-like means to rotate relative to each other; and,

ring-like magnetic means coaxially aligned with said inner wheel-like means to one side thereof for attracting said floating pawl means to said outer rim surface of said inner wheel-like means to facilitate said floating pawl means movement into the drive position when said body means is rotated in a first direction; and,

means for facilitating movement of said floating pawl means into the release position when said body means is rotated in an opposite second direction.

28. A ratchet-like apparatus comprising:

pawl means;

a wheel having a generally cylindrical outer rim surface;

a body having an inner surface defining a chamber in which said wheel is received for rotation relative to said body, said inner surface of said body also defining pocket means for receiving and positioning said pawl means between said inner surface of said body and said outer surface of said wheel to facilitate its movement between a drive position in which it is
engaging both said inner and outer surfaces to prevent said body and said wheel from rotating relative to each other and a release position in which it is out of engagement with said outer surface of said wheel to permit said body and said wheel to rotate relative to each other; and,

magnetic means for restraining movement of said pawl means relative to said wheel so that said inner surface of said body moves said pawl means into the drive position when said body or wheel is rotated in a first direction; and,

means for facilitating movement of said pawl means into the release position when said body or wheel is rotated in an opposite second direction.

29. An apparatus as claimed in claim 28 wherein said magnetic means includes magnetic pawl means and a magnetically attractive washer-like means which is coaxially aligned about the axis of said wheel to one side thereof and fixed thereto, said magnetic pawl means being attracted to said washer-like means and held in place thereby so that said magnetic pawl means is in position to be moved into the drive position by said inner surface of said body when said body or wheel is rotated in the first direction.

30. A wrench comprising:

floating pawl means;

a ratchet wheel having a rim;

a wrench body defining a chamber in which said ratchet wheel is received for rotation relative to said wrench body, said
wrench body also defining pocket means for receiving and positioning said floating pawl means adjacent said ratchet wheel rim to facilitate said floating pawl means movement between a drive position in which it is sandwiched between said ratchet wheel rim and said wrench body to prevent said wrench body and said ratchet wheel from rotating relative to each other and a release position in which said wrench body and said ratchet wheel are permitted to rotate relative to each other;

ring-like magnetic means coaxially aligned with said ratchet wheel for facilitating movement of said floating pawl means into the drive position when said wrench body is rotated in a first direction; and,

means for facilitating movement of said floating pawl means into the release position when said wrench body is rotated in an opposite second direction.

31. A wrench as claimed in claim 30 further comprising reversing means for reversing the direction in which the wrench operates so that said floating pawl means is moved into the drive position when said wrench body is moved in the second direction.

32. An apparatus as claimed in claim 31 further comprising second magnetic means for cooperating with said reversing means to maintain said reversing means in its forward or reverse position.

33. A wrench as claimed in claim 30 wherein said ratchet wheel has a smooth cylindrical outer surface for engaging said
floating pawl means.

34. A wrench as claimed in claim 30 wherein said ratchet wheel rim is provided with a plurality of detents for engaging said floating pawl means.

35. A magnetic switch comprising:

reversing means for being moved between a first and a second position; and,

magnetic means for cooperating with said reversing means to pull and maintain said reversing means in its first and second positions.

36. A magnetic switch comprising:

a body having magnetically attracting first and second surfaces;

reversing means attached to said body for being moved between a first and a second position; and,

magnetic means attached to said reversing means for being attracted to and in contact with said first surface when said reversing means is moved to its first position to magnetically hold said reversing means in its first position until it is moved to its second position, said magnetic means also being attracted to and in contact with said second surface when said reversing means is moved to its second position to magnetically hold said reversing means in its second position until it is moved to its first position.
37. A magnetic switch as claimed in claim 36 wherein the magnetic attraction of said magnetic means is strong enough to pull said reversing means into its first or second position as said reversing means is being moved thereto.

38. An improved socket ratchet wrench of the type having a pawl and a ratchet wheel for engaging said pawl and receiving a wrench socket, wherein the improvement comprises permanent magnet means for providing magnetic force to magnetically hold a said wrench socket received by said ratchet wheel.

39. An improved socket ratchet wrench as claimed in claimed 38 wherein said permanent magnet means includes a permanent ring magnet axially aligned with and mounted about the rotational axis of said ratchet wheel to one side thereof.

40. A socket and ratchet wrench combination comprising:
   a wrench socket having a driving end defining a drive socket cavity for engagingly receiving a nut and the like to be driven and a driven end defining a through hole passageway in communication with said drive socket cavity for receiving and allowing an externally threaded member to pass through said socket as the nut is driven on the threaded member with said ratchet wrench; and
   a ratchet wrench including:
      an elongated wrench body;
      a ratchet wheel having an outer rim defining detents and an inner cut-out axially aligned about the rotational
axis of said wheel, said cut-out extending through said ratchet wheel for engagably receiving said driven end of said wrench socket;

floating pawl means;
said wrench body defining a chamber in which said ratchet wheel is received for rotation relative to said wrench body, said wrench body also defining pocket means opening into said chamber for receiving said floating pawl means, said ratchet wheel rim defining said detents and said pocket means being sized and configured to facilitate movement of said floating pawl means into a drive position when said wrench body is rotated in a first direction relative to said ratchet wheel, said sizing and configuring also facilitating the release of said floating pawl means from the drive position when said wrench body is rotated in a second opposite direction, said floating pawl means when in the drive position being sandwiched between a detent of said ratchet wheel rim and said pocket means to prevent said wrench body and said ratchet wheel from rotating relative to each other, said floating pawl means when released permitting said wrench body and said ratchet wheel to rotate relative to each other; and,
magnet means for facilitating movement of said floating pawl means into the drive position when said wrench body is rotated in the first direction.

41. A combination as claimed in claim 40 wherein said magnet means provides magnetic force for holding said socket in said cut-out of said ratchet wheel.
42. A combination as claimed in claim 40 further comprising reversing means for moving between a forward and a reverse position to reverse the direction in which the wrench operates so that in the reverse position said floating pawl means is moved into the drive position when said wrench body is rotated in the second opposite direction.

43. A combination as claimed in claim 42 further comprising second magnet means for cooperating with said reversing means and said wrench body to maintain said reversing means in its forward or reverse position.

44. A combination as claimed in claim 40 wherein said cut-out is non-circularly shaped for removably receiving a complementarily non-circularly shaped drive end of a said socket or other tool.

45. A combination as claimed in claim 40 wherein said ratchet wheel is magnetized by said magnet means to attract said floating pawl means into said detents.

46. A combination as claimed in claim 40 wherein said floating pawl means is cylindrically or spherically shaped.

47. A combination as claimed in claim 40 wherein said pocket means includes a plurality of pockets defined by an endless wall of said chamber and wherein said floating pawl means includes a floating pawl for each pocket.
48. A combination as claimed in claim 40 further comprising a spacer disposed between said magnet means and said wrench body.

49. A combination as claimed in claim 40 wherein said magnet means includes a pair of ring magnets which are coaxially aligned about the rotational axis of said ratchet wheel on opposite sides thereof.

50. A combination as claimed in claim 40 wherein said cut-out is accessible from either side of said ratchet wheel, thereby enabling the drive end of a said wrench socket to be inserted into said cut-out from either side of said ratchet wheel.

51. A combination as claimed in claim 40 further comprising abutment means for facilitating the release of said floating pawl means from the drive position by pushing said floating pawl means out of the drive position as said wrench body is rotated in the second opposite direction.

52. A combination as claimed in claim 40 wherein said magnet means is a permanent ring magnet which is axially aligned about the rotational axis of said ratchet wheel so that the hole of said ring magnet is capable of receiving and passing the externally threaded member which is passing through said socket.

53. A combination as claimed in claim 52 wherein said ring magnet is positioned to a side of said ratchet wheel and axially
aligned about the rotational axis of said ratchet wheel.

54. A combination as claimed in claim 52 wherein said ring magnet is positioned between the ratchet wheel and said drive socket cavity of said socket when said driven end of said socket is received in said cut-out of said ratchet wheel.

55. A combination as claimed in claim 54 wherein said wrench socket has a collar surface which is positioned against a face of said ring magnet when said driven end of said socket is received in said cut-out of said ratchet wheel, the positioning of which serves to magnetically hold the said wrench socket and the like in said cut-out.

56. A combination as claimed in claim 55 wherein said collar surface of said socket is in direct contact with said face of said ring magnet.

57. A socket ratchet wrench for receiving a wrench socket having a driving end defining a drive socket cavity for engagingly receiving a nut and the like to be driven and a driven end defining a through hole passageway in communication with said drive socket cavity for receiving and allowing an externally threaded member to pass through said socket as the nut is driven on the threaded member with said ratchet wrench, said ratchet wrench comprising:

a ratchet wheel having a detented rim and an inner cut-out axially aligned about the rotational axis of said wheel, said
cut-out extending through said ratchet wheel for engagably receiving the driven end of said wrench socket;

a pawl,

an elongated wrench body receiving said ratchet wheel for rotation relative to each other, said wrench body also receiving said pawl for (1) engaging said detented rim of said ratchet wheel when said wrench body is rotated in a first direction relative to said ratchet wheel to prevent said wrench body and said ratchet wheel from rotating relative to each other and for (2) releasing said detented rim to permit said wrench body and said ratchet wheel to rotate relative to each other when said wrench body is rotated in a second direction opposite the first direction; and,

permanent magnet means for providing magnetic force to hold the wrench socket in said cut-out of said ratchet wheel.

58. A socket ratchet wrench as claimed in claim 57 wherein said permanent magnet means includes a permanent ring magnet axially aligned with and mounted about the rotational axis of said ratchet wheel to one side thereof.

59. A socket ratchet wrench as claimed in claim 57 wherein said permanent magnet means also facilitates movement of said pawls into engagement with said detented rim of said ratchet wheel.

60. A socket ratchet wrench as claimed in claim 57 wherein engagement of said pawl with said detented rim of said ratchet
wheel is facilitated by spring loading said pawl such that a spring urges said pawl into engagement with said detented rim when said wrench body is rotated in the first direction.

61. An improved socket ratchet wrench of the type having a pawl and a ratchet wheel for engaging said pawl and receiving a wrench socket, wherein the improvement comprises permanent magnet means for providing magnetic force to magnetically hold a said wrench socket received by said ratchet wheel.

62. An improved socket ratchet wrench as claimed in claim 61 wherein said permanent magnet means includes a permanent ring magnet axially aligned with and mounted about the rotational axis of said ratchet wheel to one side thereof.

63. An improved socket ratchet wrench as claimed in claim 61 wherein said permanent magnet means is made from a magnetic material selected from the group consisting of ceramic material and rare earth material.

64. An improved socket ratchet wrench as claimed in claim 63 wherein said rare earth material includes neodymium.