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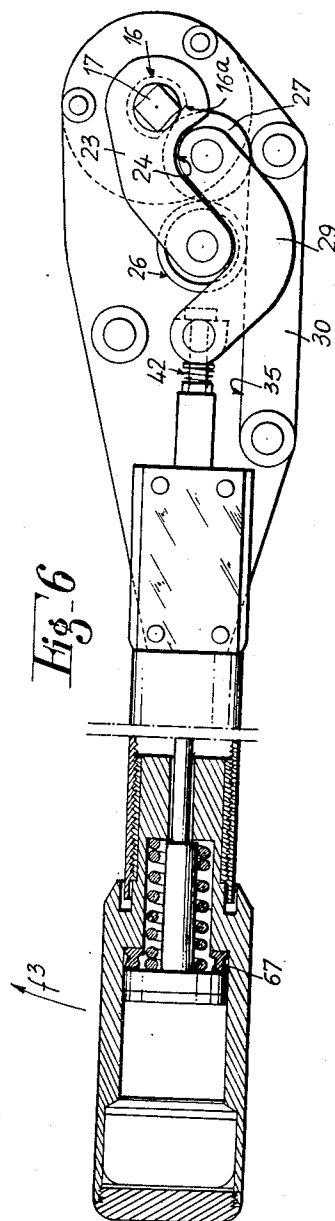
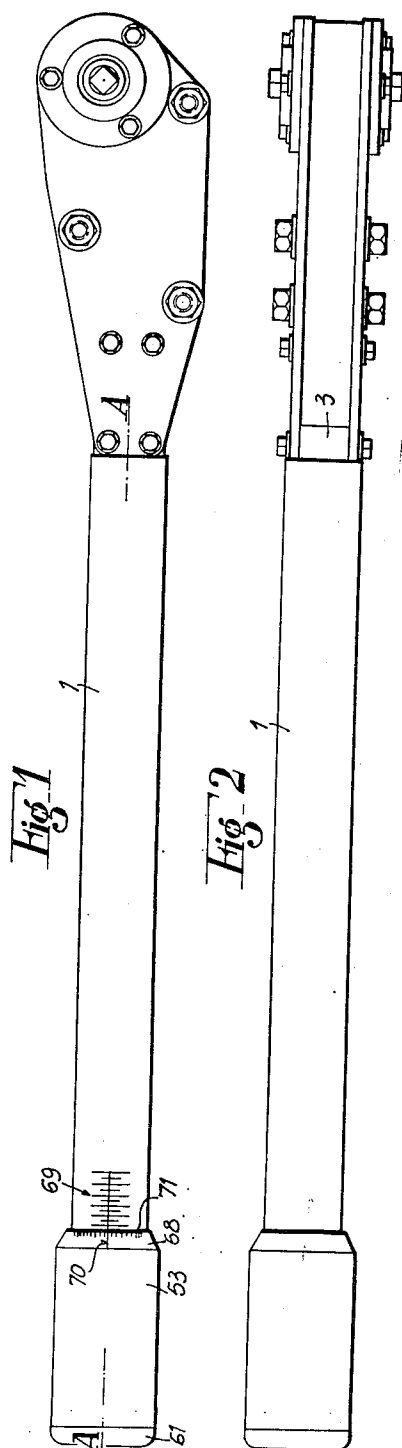
G. R. POUTOT

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PREDETERMINED TORQUE RELEASE SOCKET WRENCH

Filed April 23, 1952

2 Sheets-Sheet 1



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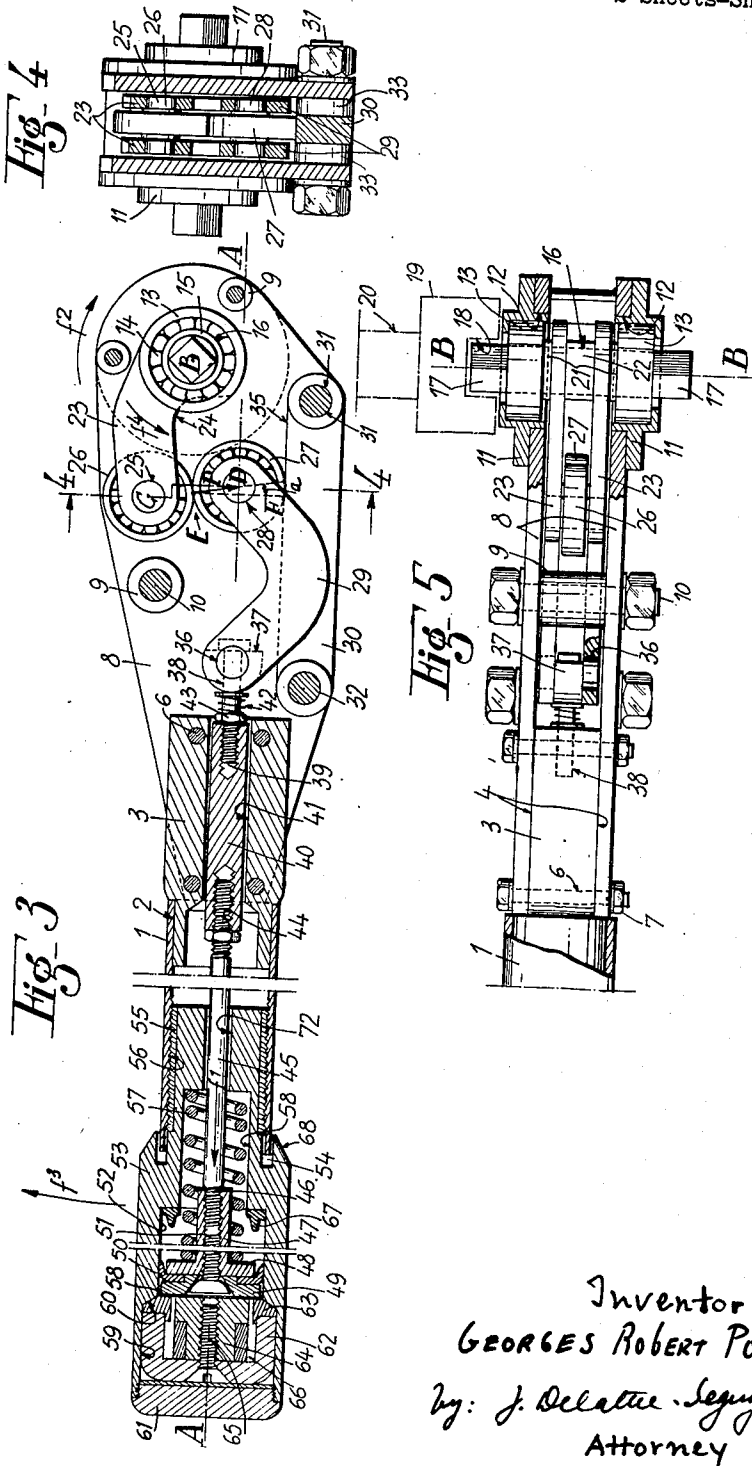
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UNITED STATES PATENT OFFICE

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PREDETERMINED TORQUE RELEASE
SOCKET WRENCH

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The present invention relates to wrenches of the "self-release" kind, i. e. wrenches which permit a force to be applied to a member to be driven in rotation and which oppose against the resistant torque a driving torque that may increase up to a given adjustable maximum, the drive connection between the wrench and said member suddenly ceasing or remaining at a fixed maximum value when said maximum driving torque is attained. In this way, the danger of subjecting the member to be driven (nut or screw for instance) to an abnormal force creating permanent deformations or a rupture is avoided.

The invention has for its object a wrench of this kind of simple construction and of great precision and having a very definite release and consistent operation for a given setting. This wrench, furthermore, permits a variation of the maximum drive torque at which the release occurs, from a very low value up to a value practically as high as desired and which is limited simply by the force the operator is able to exert, the conditions of manufacture and the resistance of the metal from which the wrench is made.

This wrench comprises in combination: a support rigidly fixed to one end of a tube forming an operating lever, a pivotable element pivotally mounted on a pin secured to said support and comprising coaxial with its pivot pin at least one male or female member for coupling with the part to be driven in rotation, a driving element also mobile on said support between an active position and a retracted position, a retaining device to exert a certain retaining force on this driving element to maintain it in said active position, and a force reduction connecting device between the two elements through which the pivotable element is driven by the driving element while the latter is in its active position, this force reduction device being so arranged that the ratio between the retaining force applied to the driving element and the resistant force exerted on the pivotable element by the element being driven which is balanced by said retaining force, is less than 1.

As will be understood the maximum torque that could be exerted by the wrench depends upon the retaining force applied to the driving element, and the drive ratio.

As soon as this maximum force is attained, the driving element is displaced against the action of the retaining force to its retracted position and the wrench no longer, or only slightly, acts upon the member being driven.

Preferably, in accordance with a further fea-

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ture of the invention, the aforementioned combination comprises in addition an adjusting device that permits an adjustment of at least one of the two factors influencing the actuation of the pivotable element by the driving element, i. e. the reduction ratio and/or the retaining force. In this way, the maximum torque at which the wrench release occurs may be adjusted.

Other features of the invention will be apparent from the ensuing description.

In the appended drawings:

Fig. 1 is a side elevation in small scale of a wrench in accordance with the invention.

Fig. 2 is a top view thereof.

Fig. 3 is a view, to a larger scale, of the wrench tube and the retaining device disposed at the end of this tube represented in longitudinal section, whereas the various elements and their bearings are shown in elevation, one of the side plates forming a support fixed to the tube having been removed.

Fig. 4 is a cross section on line 4—4 of Fig. 3.

Fig. 5 is a plan view of the head of the wrench, i. e. the support and the mechanism housed in this support.

Fig. 6 is a similar view to Fig. 3 showing the positions assumed by the various elements at the end of the wrench release travel.

In the embodiment illustrated, the wrench comprises a sleeve composed of a strong metal tube lever 1; having a longitudinal axis A—A (Figs. 1 and 3). The cylindrical seating 2 of a connecting piece 3 is a drive fit in the end of the tube 1. The portion of this piece 3 outside the tube 1 is spread out parallel to the plan of Fig. 3 whereas perpendicular to this plan it is relatively thin, this piece including two flat parallel sides 4 (Fig. 5).

On these two sides 4 are fixed, for example by means of bolts 6 and nuts 7, two parallel side plates 8 suitably braced by a certain number of tubes 9 (Fig. 3) through which bolts 10 are passed.

The two side plates 8 and the mechanism assembly housed therebetween constitutes the wrench head.

This head comprises two caps 11 constituting bearing supports fitted in holes 12 in the side plates 8, their centres being disposed on the same transverse axis BB situated a certain distance from the longitudinal axis AA of the tube 1.

In these caps are housed the outer rings 13 of two bearings being solid in rotation, by means of a drive fit or any other means, with a shaft 14 the axis of which coincides with B—B. This

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shaft 16 which emerges from the two caps 11, terminates in two prismatic portions having flat sides 17 adapted to engage in a hole of the same shape, for example in the hole 18 (Fig. 5) provided in the head 19 of a screw 20 or any other member to be driven in rotation if necessary through the medium of a sleeve between the wrench and the member to be driven.

Integral with the shaft 16, between two shoulders 21 and a central portion 22, is a pair of identical levers 23 cranked so as to form on the side adjacent to the axis A—A a deep notch 24 (see Fig. 3). On their free ends, the pair of levers 23 which comprise the driven element of the mechanism are braced by a spindle 25. On this spindle parallel to the shaft 16 is freely mounted between the two levers a ball bearing 26 only the outer ring of which is visible in the drawing.

This bearing 26 is in contact with the outer ring of a second bearing 27 rotatably mounted on a spindle 28 parallel to the spindle 25 and supported by a pair of identical arms 29 cranked in plan in the shape of a V. These two arms constitute the driving element. These identical arms 29 are housed between the side plates 8 and on opposite sides of a middle rigid slide 30.

This slide is fixed by bolts 31 and 32 (Fig. 3) to the side plates 8 with the interposition of bracing tubes 33. The side 35 of the slide 30 parallel to the axis A—A and directed towards the bearings 26 and 27 is ground perfectly flat.

The bearing 27 is adapted to roll on this face 35 and its diameter is such that its axis D on Fig. 3 always intersects the axis A—A. The bearings 26 and 27 are tangent to each other at E (Fig. 3) in the plane CD which passes through the axes C and D of said bearings and this plane presents with respect to the perpendicular EF dropped from E to the face 35 of the slide 30 a certain obliquity having an angle α .

The two arms 29 are a drive fit in the journals 36 of a block 37 with which they may, if desired, form one piece. A smooth portion of a screw 38 passes through this block on the axis A—A. The threaded portion of the screw is screwed into a tapped hole 39 in the end of a slide piece 40 freely mounted in an axial hole 41 provided in the connecting piece 3. Any play the block 37 may have along the screw 38 is taken up by a spring 42, surrounding the screw and bearing against this block 37 and a nut 43 that locks the screw against the slide piece 40.

The slide piece 40 is, furthermore, secured by a second tapped hole 44 to the front end of a rod 45 mobile along the axis A—A in the tube 1.

This rod 45 is screwed at its rear threaded portion 46 in an axial tapped hole of a tail 47 of a piston unit composed of a combination of a flange 48 solid with said tail, a washer 49 forming a field plate of an electric magnet hereinafter described, and a sealing ring 50, these three pieces being united by a screw 51 screwed into the tail 47.

The piston thus constituted is movable inside a cylindrical bore 52, provided on the axis A—A of an operating handle 53 which caps the end of the tube 1 by means of an annular groove 54 and which may be screwed onto said tube 1, thereby permitting its adjustment in position along the axis A—A with the aid of a sleeve 55 fitted on to said handle 53 and screwed into the rear tapped end 56 of the tube 1. A spring 57, housed in the axial cavity 58 of the handle and bearing against, in the front, the bottom of this

cavity and, at the rear, the head 48 of the piston, tends to urge this piston towards the rear and in consequence the rod 45 in the direction of arrow f^1 (Fig. 3), so as to maintain the washer 49 against a very thin washer 59 of a non-magnetic material.

This washer is provided to ensure a gap between the washer or field plate 49 and a permanent magnet housed in a rear chamber 59 in the handle 53 between a front shoulder 60 and a plug 61 screwed in the rear tapped end of said chamber 59. This magnet may be of any type. In the illustrated example, it is constituted by a magnetic frame in the shape of a cup 62 having an attached front edge 63, and a centre core 64 connected together by a screw 65. The annular magnet 66 is disposed between the cup 62 and the core 64 round said core.

The assembly is completed by a resilient ring 67 disposed at the front end of the cylindrical chamber 52 to absorb the force of the forward displacement in the opposite direction to the arrow f^1 of the complete mobile unit constituted by the piston (48—49—50), the rod 45, the slide piece 40, the two arms 29, the bearing 27 and the connecting elements therefor. This ring 67 is preferably of such a radial section as to be wider in front than at the rear, i. e. in Fig. 3 wider at the right than at the left, whereby the absorbing effect is progressive from the moment the flange 48 of the piston touches said ring.

The tube 1 is provided externally in front of the front end of the handle 53 possessing a chamfered portion 68, with a longitudinal graduated scale 69 (Fig. 1) in metre-kilos or torques, each division of this graduation corresponding to one of the maximum torques it is possible to obtain before the release of the wrench. The chamfer 68 is provided with a mark 70 and, preferably another graduated scale 71 the complete angular extent of which corresponds, for example, to one division of the graduation 69.

Lastly, it will be noticed that the rod 45 passes through, with a slight clearance, the axial hole 72 of the front end of the handle 53 which end is located in the tube 1 and is provided with the sleeve 55 for purposes of screwing into this tube.

The operation is as follows. The wrench is initially so adjusted as to obtain the release at the required maximum torque. This is obtained by a rotation of the handle 53 with respect to the tube 1 about axis A—A. In so rotating the handle, it screws into or unscrews out of the tapped bore 56 of said tube 1. The adjustment is complete when the values of the graduations 68 and 69 corresponding to the desired magnitudes of the maximum torque coincide. It will be supposed by way of example, that adjustment is complete in the position shown in the figures, which corresponds to a certain inclination α of the plane CD (passing through the centres and line of contact of the bearings 26 and 27) relative to the perpendicular EF.

The key being in this position, the prismatic end 17 of the shaft 16 is engaged in the hole 18 of the screw 20 or other piece to be driven in rotation about the axis BB in the direction of the arrow f^2 (Fig. 3). To obtain this rotation, the user or users, taking the tube 1 in one or both hands, urge the wrench in rotation about the axis B—B by bearing against the tube 1 in the direction of arrow f^3 (Fig. 3). As a consequence of the resistant torque exerted by the screw 20, the pair of levers 23 tend to turn in the direction of arrow f^4 with respect to the

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wrench assembly and soon take up if they were not already in this position before the start of the operation, the position represented in the Fig. 3, in which position the bearing 26 is in contact at E with the bearing 27, itself supported by the face 35 of the slide 30.

From this moment onwards, in continuing to turn the tube 1 and in consequence the slide 33 forming part of the body of the wrench, in the direction of the arrow f^3 (Fig. 3), pressure is applied to the bearing 27 which in turn presses against the bearing 26 which drives in the direction of arrow f^2 the pair of levers 23, the shaft 16 and the screw 20. This screw exerts resistant torque which is communicated to the pivotable element constituted by the pair of levers 23. This torque is transformed into a radial pressure between the bearing 26 and the bearing 27 in the direction ED. If P (Fig. 3) is this pressure and given the obliquity α of said direction relative to the perpendicular EF to the slide face 35 and the axis A—A, this pressure P has a component parallel to the axis A—A equal to $P \sin \alpha$; this component, which is with P in the reduction ratio

$$\frac{P \sin \alpha}{\alpha} = \sin \alpha$$

is smaller than P except when $\alpha=90^\circ$ and increases sinusoidally from zero when $\alpha=0$ to the value P when $\alpha=90^\circ$.

The connecting device including the bearings 26, 27 and the slide 35 which makes possible this variable reduction of force, transforms, moreover, the motion of rotation of the element 23 into a translatory motion of the sliding driving element constituted by the arms 29.

Thus, for any applied force on the tube, to which corresponds equal resistant torque, there corresponds a resistant force P and component $P \sin \alpha$. The higher the driving torque the more this component increases, it tending to move towards the right along the axis A—A in the opposite direction to arrow f^1 the mobile unit comprising the washer 49, the piston assembly of which said washer forms part, the rod 45, the arms 29 and the bearing 27.

The pull $P \sin \alpha$ exerted on the mobile unit is balanced, while the driving torque remains less than the maximum torque to which the device had been set, by the double action of the magnetic pull of the magnet 54 on the washer 49 and the spring 57, the latter tending in fact to maintain the mobile unit in the illustrated position. But at the precise moment when the driving torque attains the set maximum value, the pull constituted by the component $P \sin \alpha$ of the resisting force P in the direction A—A becomes predominant and the washer 49 is suddenly released by the magnet which had been up to this time retaining it.

As a result of this sudden release (a clear click is to be heard) the mobile unit subjected to the preponderant action of the axial component of the force $P \sin \alpha$ moves in the direction opposite arrow f^1 towards the right. The bearing 27 rolls along the slide face 35 while remaining tangent to the bearing 26 which, under the action of the resistant torque remains in contact therewith, the levers 23 continuing their displacement in the direction of arrow f^4 with respect to the rest of the wrench assembly.

But, as the bearing 27 is displaced towards the right, the angle α increases and the axial component $P \sin \alpha$ of the pull on the mobile unit also

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increases so much so that the unbalance that the release of the washer 49 provoked is accentuated. The movement of the mobile unit continues towards the right without substantial resistance from the spring 57 for the pull $P \sin \alpha$ has increased much more rapidly than the increasing resistance of the spring 57 which is progressively compressed by the displacement towards the right of the mobile unit (Fig. 3).

In practice, as soon as the washer 49 is released the user no longer feels any substantial resistance to the wrench and he can continue to move the latter through a certain angle in the direction of arrow f^3 without exerting any appreciable torque on the screw 20 or other member to be driven. This remains so until the mobile elements have assumed the position shown in Fig. 6. In this latter position the bearing 26 has encountered the face 35 of the slide 30 and the ends of the pair of arms 29 supporting the bearing 27 have moved into the notches 24 provided in the levers 23, the bearing 27 lodging in a clearance between these two levers 23 provided by a flat 16^a on the shaft 16.

The elements of the wrench are thereafter locked together, so that if the wrench is moved still further in the direction of arrow f^3 , a driving torque greater than the desired maximum could of course be applied to the shaft 16 and in consequence to the piece to be driven. But the period of displacement of the bearings 26 and 27 from the position of Fig. 3 to that in Fig. 6 corresponds to a complete cessation of the driving, i. e. a complete release or breakage in the driving action, the beginning of which is practically instantaneous at the moment of the release of the washer 49 which is not likely to occur unnoticed for the angular displacement of the tube 1 corresponding to the period of release, or breakage, is relatively wide, for example about 30° . The user, then, has ample time to release the force he applies.

In reality, in the embodiment as described and illustrated, the displacement towards the right of the bearing 27 from the position of Fig. 3 to that of Fig. 6 is slower and less sudden than would be supposed from the preceding description of the operation, due to the dash-pot braking effect of the piston (48, 49, 50) moving in its cylindrical cavity 52. During the displacement towards the right of the piston, the latter causes a partial vacuum there-behind in front of the magnet which acts as a drag on the movement of the piston, while the air existing in the cylindrical cavity 52 has to escape through the relatively small clearance provided between the rod 45 and the bore 72 in the front part of the handle 53.

It may be noticed that at the end of the travel of the mobile unit, i. e. at the end of the release period, the bearing 26 comes at least substantially into contact with the face 35 of the slide 30 and, if the force applied by the user on the wrench is too great after the release, there might be a danger of harming the surface of the edge 35. This eventuality is avoided by the provision of the resilient ring 67 at the front end of the cylindrical cavity 52 which the flange 48 of the piston encounters just before the bearing 26 contacts the face 35. This abutment ring 67 is compressed as shown in Fig. 6 and constitutes a shock absorbing stop for the end of the travel.

As soon as the wrench is removed from the piece driven in rotation and all forces are released, the mobile unit resumes the position in Fig. 3 under the action of the spring 57 and the pull, increasing with the displacement to the left of

the mobile unit, of the magnet 64 on the washer 49.

During this return motion, the displacement of the mobile unit is hardly affected by the dash-pot which offers no resistance in the return direction.

During the course of the tightening motion, the whole force is applied by the bearing 27 to the slide 39 and by the latter to the bolts employed in its attachment to the side plates 8 (especially the bolt 31 which is the nearer to the point of contact of the bearing on the slide face 35). This bolt 31 is under shear stress, but it offers, even with its relatively small diameter, a resistance clearly greater than the shear stress to which it is subjected.

The special features of the wrench are essentially a result of the force reduction device constituted by the combination of the levers 23, bearings 26 and 27, arms 29 and the slide 30.

It is noteworthy that the contacts comprising that between the bearings 26 and 27 and that between the bearing 27 and the slide 30, are rolling contacts that engender no friction and thus cause no loss of power. The wrench is, then very efficient.

The variable reduction device permits, as will be understood, an infinite range of reduction ratios since this ratio equals $\sin a$. If the angle a is zero, i. e. if the line CD is perpendicular to the slide face 35, which may be obtained by suitable adjustment, the reduction is infinite, i. e. a very weak pull by the magnet permits the application by means of the wrench of a considerable torque which is limited only by the length of the wrench tube 1, the force the user is able to exert and the mechanical resistance of the device. On the other hand, as soon as the angle a increases the reduction ratio approaches 1.

The adjusting precision depends upon the pitch of the threads on the sleeve 55 and the diameter of the tube 1. This precision is in fact considerable and permits the adjustment of the maximum release torque to the nearest 10 metres/grams.

The invention is not limited to the details of construction hereinbefore described and illustrated in the accompanying drawing which have been chosen merely by way of example.

For instance, although the presence of the magnet makes possible, by means of the release of the washer 49, a sudden "breakage" in the driving action, the device will operate without a magnet. The spring 57 itself suffices as a retaining device for the driving element constituted by the pair of arms 29 and the bearing 27, provided that, as has been hereinbefore explained, the pull $P \sin a$ increases much more rapidly with the angle a , than the resistance due to the progressive compression of the spring 57. Thus this spring, as soon as it commences to be compressed, offers a resistance that becomes less and less effective as the force of the releasing movement increases.

The dash-pot may be constructed in any other way than that illustrated as also may be the shock resisting ring 67.

It is obvious that the shaft 16 may, instead of having male ends 17, have a flat sided cavity adapted to receive a male member, for instance a nut or the head of a bolt.

Furthermore, the side plates 3 instead of being attached to the tube 1, may be part of the same material, the unit being cast in one piece.

Finally, the adjustment may be obtained not by acting on the reduction device but on the retaining device, for example by varying the gap

of the magnet or the strength of the retaining spring.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. A predetermined torque release wrench permitting the application of a driving torque on a rotative element to be driven, said wrench comprising in combination a tube forming an operating lever, a support rigidly secured to one of the ends of said tube which prolongs this tube, a driven member pivotably mounted on said support and comprising coaxial with its pivot axis at least one means for its connection in rotation with said element to be driven, a driving member also mobile on said support between an active position and an inactive retracted position, a retaining device disposed in said tube and connected to said driving member to exert a limited retaining force on said driving member to maintain it in said active position, and a force reduction connection device between the driving member and the driven member to drive said driven member so long as the driving member is in its active position, the force reduction being such that the ratio between the retaining force exerted on the driving member and the resistant force applied to the driven member by the rotative element to be driven and which is balanced by this retaining force, is less than 1.

2. A predetermined torque release wrench as claimed in claim 1 in which the retaining device adapted to exert the limited retaining force comprises a permanent magnet combined with a field plate one of these two members being integral with the driving member the other with the tube.

3. A predetermined torque release wrench as claimed in claim 1 in which the retaining device comprises a return spring one end of which is adapted to bear against the driving member and the other against the tube.

4. A predetermined torque release wrench as claimed in claim 1 in which the retaining device comprises in combination, a permanent magnet combined with a fixed plate one of these two parts being integral with the driving member and the other with the tube, and further comprises a return spring one end of which is adapted to bear against said driving member and the other against the tube.

5. A predetermined torque release wrench as claimed in claim 1, further comprising a brake device to brake the relative displacement of said members.

6. A predetermined torque release wrench as claimed in claim 5 in which said brake device comprises a dash-pot.

7. A predetermined torque release wrench as claimed in claim 1 further comprising a shock absorber stop.

8. A predetermined torque release wrench as claimed in claim 7 in which said shock absorber stop is constituted by a buffer formed of elastic material.

9. A predetermined torque release wrench permitting the application of a driving torque on a rotative element to be driven, said wrench comprising in combination a tube forming an operating lever, a support rigidly secured to one of the ends of said tube which prolongs this tube, a driven member pivotably mounted on said support and comprising coaxial with its pivot axis at least one means for its connection in rotation with said element to be driven, a

rectilinear slide fixed to said support, a driving

member mounted so as to be slidable along said slide between an active position and an inactive retracted position, a retaining device disposed in said tube and connected to said driving member to exert a limited retaining force on said driving member to maintain it in said active position, and a force reduction connection device between the driving member and the driven member, this connection device being adapted to transform the sliding motion of the driving member into an oscillatory motion of the driven member so long as the driving member is in its active position, the force reduction being such that the ratio between the retaining force exerted on the driving member and the resistant force applied to the driven member by the rotative element to be driven and which is balanced by this retaining force, is less than 1.

10. A predetermined torque release wrench as claimed in claim 9 in which the force reduction connection device comprises in combination with said fixed rectilinear slide two bearings tangent to one another and respectively rotatably mounted on the driving member and the driven member, these bearings being so disposed that the plane passing through the axes of the bearings and their line of contact forms a certain angle with a line normal to said slide along which said driving member is adapted to travel.

11. A predetermined torque release wrench, as claimed in claim 9 in which the driving member is in essentials formed of a pair of identical arms rigidly fixed together and disposed on either side of the slide which forms a guide therefor and on which they are supported through the medium of the bearings mounted on these arms.

12. A predetermined torque release wrench permitting the application of a driving torque on a rotative element to be driven, said wrench comprising in combination a tube forming an operating lever, a support rigidly secured to one of the ends of said tube which prolongs this tube, a driven member pivotably mounted on said support and comprising coaxial with its pivot axis at least one means for its connection in rotation with said element to be driven, a driving member also mobile on said support between an active position and an inactive retracted position, a retaining device disposed in said tube and connected to said driving member to exert a limited retaining force on said driving member to maintain it in said active position, a force reduction connection device between the driving member and the driven member to drive said driven member so long as the driving member is in its active position, the force reduction being such that the ratio between the retaining force exerted on the driving member and the resistant force applied to the driven member by the rotative element to be driven and which is balanced by this retaining force, is less than 1, and a regulating device to vary at least one of two factors that influence the actuation of the driven oscillatory member by the driving member, i. e. the reduction ratio and/or the retaining force.

13. A predetermined release wrench as claimed in claim 12 in which the regulating device is so actuated as to act upon the reduction device by a displacement of the driving member from its initial position.

14. A predetermined torque release wrench as claimed in claim 12 in which a handle is mounted in an adjustable position on said tube, this handle containing said retaining device and a mobile axial rod in said tube connecting this retaining device to the driving member.

15. A predetermined torque wrench permitting the application of a driving torque on a rotative element to be driven, said wrench comprising in combination a tube forming an operating lever, a support rigidly secured to one of the ends of said tube which prolongs this tube, a driven member pivotably mounted on said support and comprising coaxial with its pivot axis at least one means for its connection in rotation with said element to be driven, a rectilinear slide fixed to said support, a driving member mounted so as to be slidable along said slide between an active position and an inactive retracted position, a retaining device disposed in said tube and connected to said driving member to exert a limited retaining force on said driving member to maintain it in said active position, a force reduction connection device between the driving member and the driven member, this connection device being adapted to transform the sliding motion of the driving member into an oscillatory motion of the driven member so long as the driving member is in its active position, the force reduction being such that the ratio between the retaining force exerted on the driving member and the resistant force applied to the driven member of the rotative element to be driven and which is balanced by this retaining force, is less than 1, and a regulating device to vary at least one of two factors that influence the actuation of the driven oscillatory member by the driving member, i. e. the reduction ratio and/or the retaining force.

16. A predetermined torque release wrench as claimed in claim 15 in which a handle is mounted in an adjustable position on said tube, this handle containing said retaining device, and a mobile axial rod in said tube connecting this retaining device to the driving member so mounted as to be slidable along said slide.

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