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(54) IMPROVEMENTS IN OR RELATING TO OVERLOAD COUPLINGS

(71) We, C. van der Lely N.V., of 10, Weverskade, Maasland, The Netherlands, a Dutch Limited Liability Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to overload couplings.

According to present invention there is provided an overload coupling comprising two members which are rotatable about a common axis and at least one frangible element which in normal operation interconnects the two members for rotation together in at least one direction, fracture of the frangible element permitting relative rotation between the members, advancement means being provided for advancing the remaining part of the frangible element, after such fracture, to re-interconnect the members, the construction of the coupling being such that re-interconnection of the coupling members can take place during relative rotation of the coupling members only when the relative speed of rotation of the coupling members is below a predetermined value.

Embodiments of the present invention provide overload couplings which match the desired efficiency of the use of modern machines and are particularly suitable for use in machine locations to which access is difficult for replacing a fractured frangible element, for example in large agricultural machines.

For a better understanding of the present invention and to show how it may be carried into effect, reference will now be made, by way of example only, to the accompanying drawings, in which:

Figure 1 is an elevational view partly in cross-section of a first embodiment of an overload coupling;

Figure 2 is an elevational view taken in the direction of the arrow II in Figure 1;

Figure 3 is an elevational view of part of a second embodiment of an overload coupling;

Figure 4 is a sectional view taken on the line IV-IV in Figure 3;

Figure 5 is a sectional view taken on the line V-V in Figure 3;

Figure 6 is an elevational view partly in cross-section of a third embodiment of an overload coupling;

Figure 7 is an elevational view taken in the direction of the arrow VII in Figure 6;

Figure 8 shows an alternative construction for part of the coupling of Figure 6;

Figure 9 is a sectional view taken on the line IX-IX in Figure 8;

Figure 10 is an elevational view of a fourth embodiment of an overload coupling;

Figure 11 is an elevational view taken in the direction of the arrow XI in Figure 10;

Figure 12 is a sectional view taken on the line XII-XII in Figure 11;

Figure 13 is a sectional view of a fifth embodiment of an overload coupling;

Figure 14 is an elevational view taken in the direction of the arrow XIV in Figure 13;

Figure 15 is a sectional view taken on the line XV-XV in Figure 14;

Figure 16 is an elevational view taken on the line XVI-XVI in Figure 13;

Figure 17 shows separately a component suitable for use in the coupling of Figures 13 to 16;

Figure 18 shows an alternative construction for part of the overload coupling of Figure 13;

Figure 19 is a sectional view of a sixth embodiment of an overload coupling;

Figure 20 is a sectional view taken on the line XX-XX in Figure 19;

Figure 21 is an elevational view of part of the coupling of Figure 19;

Figure 22 is a sectional view taken on the line XXII-XXII in Figure 21;

Figure 23 is a sectional view of part of a seventh embodiment of an overload coupling;

Figure 24 is a sectional view taken on

the line XXIV-XXIV in Figure 23;

Figure 25 is a sectional view of an eighth embodiment of an overload coupling;

Figure 26 is an elevational view taken in the direction of the arrow XXVI in Figure 25;

Figure 27 is a sectional view of a ninth embodiment of an overload coupling;

Figure 28 is an elevational view taken in the direction of the arrow XXVIII in Figure 27;

Figure 29 is a sectional view of part of a tenth embodiment of an overload coupling;

Figure 30 is a sectional view taken on the line XXX-XXX in Figure 29; and

Figure 31 is a sectional view of part of an eleventh embodiment of an overload coupling.

The overload coupling shown in Figure 1 comprises a coupling member 1, which is connected in this embodiment in a manner not shown with a universal shaft. The coupling member 1 comprises a hollow shaft 2 which is rigidly connected near one end to a coupling plate 3 extending for some distance in a radial direction. The plate 3 extends outwardly in the shape of a tag, as shown in the elevational view of Figure 2, and near its end remote from the shaft 2 it has a width substantially corresponding to one third of the diameter of the shaft 2. To the end of the coupling plate 3 remote from the shaft 2 is welded a ring 4 extending axially of the shaft 2 away from the plate 3. The shaft 2 is rotatable about a rotary axis 2A. The face of the ring 4 remote from the rotary axis is provided with a connecting arrangement comprising a holder 5 containing a frangible connecting element 7. The holder 5 extends away from the ring 4 in a radial direction to the side away from the axis 2A. The holder 5 comprises a cylindrical sleeve. The frangible element 7 comprises a shear pin having a plurality of weakened, breakable zones. The outermost end of the shear pin 7 is received in an annular seat 8 having, at the side remote from the shear pin, an abutment surface for a helical compression spring 9 extending from the seat 8 to near the outermost end of the holder 5. The outermost end of the spring 9 engages a circular plate 10, which abuts a guard pin 11 to restrain the spring in a radial direction. The guard pin 11 has a locking ring 12 so that the pin 11 has be fixed in place on the holder 5.

Inside the ring 4 is fitted a sleeve 13 which extends away from the holder 5 towards the rotary axis 2A and serves to absorb torque transferred by the shear pin 7. To this end, the sleeve 13 is in intimate engagement with the shear pin 7. The sleeve 13 may be made from hardened material.

The shear pin 7 normally connects the coupling member 1 with another coupling member 14. The coupling member 14 comprises a coupling plate 15 located coaxially with the rotary axis 2A and extending over some distance in an axial direction. It has near the rotary axis 2A a cylindrical cavity. The coupling plate 15 is provided with a sleeve 16 for receiving one end of the shear pin. The sleeve 16 is preferably made from hardened material and is arranged replaceably in the coupling plate 15. The sleeve 16 has an opening 17 for receiving the end of the shear pin, this opening being cylindrical in this embodiment and having a diameter slightly exceeding the diameter of the shear pin 7. The wall of the opening 17 is parallel to a cylindrical surface the axis of which extends radially of the rotary axis 2A, but may as an alternative be parallel to a conical surface the vertex of which lies on the rotary axis 2A.

The opening 17 extends radially for about one quarter of the radial length of the sleeve 16. The opening 17 is blind and its bottom is at the radially inner end for co-operation with the end of the shear pin 7. The coupling member 14 comprises a shaft portion 18 which is rigidly connected with the coupling plate 15 and is fastened in the cylindrical opening in the coupling plate 15. The shaft portion 18 extends inwardly from the coupling plate 15 for some distance towards the rotary axis 2A. The shaft portion 18, as shown in the elevational view of Figure 2, is provided with serrations 19 for transferring a high torque to a shaft (not shown) coupled to the shaft portion 18. Inside the shaft 2 the shaft portion 18 is received in a sleeve 20, which is pressed into the shaft 2, the material of this sleeve 20 being appropriate to the intermittent function of the sleeve 20 as a sliding bearing for the shaft portion 18. The sleeve 20 and the shaft portion 18 are fixed against an axial displacement by a key formed by a bolt 21 which is held in place by a nut. The sleeve 20 and the shaft portion 18 have for this purpose corresponding annular openings 22 which are coaxial with the rotary axis 2A.

In operation the overload coupling shown in Figures 1 and 2 may be employed between two shaft portions or between a shaft and machine components, for example, components of an agricultural machine, for protecting the machine components and the shafts against overloading. For this purpose the shear pin 7 is adapted to transmit a predetermined maximum torque. If this maximum torque is exceeded, the portion of the shear pin 7 engaging the wall of the opening 17, which acts as an abutment, will break off. After this portion has broken off, the coupling members rotate about the rotary axis 2A relatively to each other although they are still axially fixed together by the bolts 21. When the connection between the two coupling members is broken, the driving coupling member will continue to rotate, but the driven coupling member will very soon or after a short time come to a standstill in dependence upon the magnitude of the overload. Since the coupling member 1 continues to rotate, the holder 5 and the associated shear pin 7 also continue to rotate. As a result, centrifugal force will bias the shear pin outwardly against the pressure of the spring 9. The characteristic of the spring 9 is preferably adapted to the inertia of the sheer pin. Owing to the balance between the centrifugal force acting on the mass of the shear pin 7 and the force of the spring 9, the shear pin 7 will be urged with only very slight pressure against the supporting surface formed by the radially outer wall of the plate 15 and towards the opening 17 during the continued rotation of the coupling member 1. Thus under these conditions the shear pin 7 is not capable of re-establishing the connection between the coupling members. The connection between the two coupling members will not be established until the speed of rotation of the coupling member 1 has been appreciably reduced by uncoupling the drive, when the spring 9 will act as advancement means for advancing the pin 7 into re-engagement with the opening 17. This can be achieved by matching the circumferential extent of the opening 17 to the diameter of the pin 7, the inertia force of the pin, and the characteristics of the spring 9. The circumferential extent of the opening 17 is a function of the factor T in the formula $S=\frac{1}{2} A T^2$, in which S is the distance to be covered by the pin towards the bottom of the opening 17 in order to re-establish a connection between the two coupling members. The factor A is a function of the force of the spring 9 and the mass of the pin 7.

In order to keep the factor A constant however many times the pin 7 has been fractured, the reduction of the spring force due to the radial inward shift of the pin 7 after fracture should be proportional to the reduced mass of the pin.

The circumferential extent of the opening 17 is preferably about twice the diameter of the shear pin. The speed at which the pin 7 re-establishes the connection is preferably chosen to be lower than the minimum possible self-sustaining speed of the driving engine. In this way the pin cannot prematurely re-establish the connection while the engine is still running at a speed reduced by the overload and while the drive is still in engagement.

It should be noted that since the opening 17 extends radially, the broken-off fragment of the shear pin 7 is automatically thrown out of the opening 17, and a further portion of the shear pin 7 automatically re-establishes the connection once the speed is reduced. The opening 17 thus acts as release means or as an ejector for the broken-off fragment. Since, after overload, the operator can re-establish the connection between the two coupling members only when he has intentionally reduced the driving speed by an appreciable amount, inadvertent continuous repeated fracture of the pin will be avoided.

Such a shear pin coupling is particularly advantageous in agricultural machines, especially between parts to which access is difficult or inconvenient or to which access is not possible at all during operation. When the shear pin, which preferably has at least five breakable portions and may advantageously comprise ten portions, has been completely used up by repeated overloads, it can be removed in a very simple manner. It is only necessary to remove the guard pin 11 and to slip a new shear pin 7 into the holder 5. The shear pin can have so many breakable portions that it may be necessary to replace it only at normal periodical inspection or servicing of the machine.

Figures 3, 4 and 5 show a second embodiment of an overload coupling comprising a coupling member 23 formed by a hollow shaft portion 24 rotatable about a rotary axis 24A and having key ways 25 on its inner side for receiving a driving stub shaft (not shown). The shaft portion 24 is provided near one end with a coupling flange or plate 26 which is coaxial with the shaft portion 24. The edge of the plate 26 remote from the shaft portion is provided near the circumference with an annular supporting member 27, comprising a fastening portion 28 extending inwardly from the outer circumference of the coupling plate 26. The fastening portion 28 is fixed in place by means of equispaced bolts 29 near the circumference of the coupling plate 26. The fastening portion 28 has tapped holes for receiving the bolts 29. The free end of each bolt is not screw-threaded and forms a stub shaft 30 so that the bolts can each serve in addition as a pivot pin for a torsion spring 31 looped over the stub shaft 30. The action of this spring 31 is comparable with that of the spring 9 of the preceding embodiment. The supporting member 27 furthermore comprises a supporting part 32 which is perpendicular to the portion 28 and which is coaxial with the rotary axis 24A. The supporting part 32 has radial recesses 33 for supporting and guiding shear pins 34 each having, in this embodiment, seven portions 35. The longitudinal centre lines of the pins 35 extend substantially radially. The shear pin portions 35 are separated one from another by locally weakened transitional zones 36. The thickness of the supporting part 32, in a radial direction, is preferably such that approximately two shear pin portions 35 are accommodated in the recess 33 at any one time. The diameter of the recess 33 is such that it closely surrounds the shear pin 34, but allows movement in a radial direction. Each torsion spring 31 has a free end which bears on the outermost end 35 of the respective shear pin 34. One limb of the spring bears on the shear pin 34, whereas the other limb, which is inclinded to the first limb, passes through an opening 37 in the fastening portion 28. A bent over part of this limb is received in an annular groove 38 in the side of the outer edge of the coupling flange 26 facing the supporting member 27 (Figure 4). The spring 31, using the bolt end 30 as a fulcrum pushes the shear pin 34 towards the rotary axis 24A. The supporting member 27 is provided at equal intervals with eight similarly arranged shear pins 34. Seven of these pins are spare and only one is operative at any one time. The operative pin 34 connects the coupling member 23 with an associated coupling member 39. The coupling member 39 comprises a flange or coupling plate 40 and a shaft portion 41, whose centre line coincides with the rotary axis 24A. The shaft portion 41 has internal key ways 25 for receiving a driven shaft (not shown).

It should be noted that the two coupling members 23 and 39 are restrained against relative axial displacement by guard means (not shown), as in the preceding embodiment. In order to allow thermal expansion, it is desirable to use guard means which allow a small axial displacement of the members.

The flange 40 has an opening 42 for receiving an end of the shear pin 34 interconnecting the coupling members. The opening 42 is bounded partly by supporting member constituted by a hard metal insert or disc 43 extending radially inwardly away from the circumference of the flange 40. The centre line of the insert 43 is preferably parallel to the centre line of the respective shear pin. The insert 43 has an abutment for the shear pin 34, constituted by a recess surrounding the opening 42 over an arc of about 100°. The opening 42, whose depth approximately corresponds to the height of one shear pin portion 35 and whose radially inner end is blind has furthermore an ejecting or release means formed by a channel 44 for thrusting the broken fragment of the shear pin from the opening. The channel 44 has a wall 45, which is curved. The wall subtends an angle of about 90° and extends, near the insert, parallel to the centre line of the pin 34, whereas, away from the insert, it is at an angle to the centre line. The wall extends to the side of the coupling member 39 remote from the coupling member 23.

During operation the coupling shown in Figures 3 to 5 establishes the connection between a driving part and a driven part of a shaft and/or machine part and it rotates in the direction of the arrow A (Figure 3). The operative shear pin 34 co-operating with the opening 42 is supported in the supporting member 27, which is made of hardened material either wholly or only partly in the region of the supporting part 32. The wall of the opening 42 is furthermore protected by the insert 43 of hard material against undesired deformation. In the event of overload the portion 35 located in the opening 42 will break off and this portion will snap from the opening into the channel 44 to be ejected in an axial direction owing to the specific shape of the wall 45. This direction of ejection may be advantageous when the coupling is used with its axis 24A extending upwards. As in the first embodiment, upon fracture of the portion 35 in the opening 42, the two coupling members will rotate relatively to one another, and, due to the overload, the coupling member 39 will come to a standstill either immediately or very quickly, whereas the coupling member 23 maintains the operational speed. The torsion spring 31 acting on the shear pins 34 have the same effect as described for the compression spring 9 of the first embodiment. In this embodiment, owing to the use of a plurality of equi-spaced shear pins 34, the coupling as a whole is balanced. The coupling can be employed for a very long time without the need to replace the shear pins. The construction and disposition of the springs 31 means that the coupling can have a relatively small diameter. Once the speed of rotation of the coupling member 23 has been reduced, as in the first embodiment, the next-following portion, or a portion of one of the other pins, will re-establish the connection between the coupling members. Owing to the great number of shear pins the pins will be used at random, and the tendency will be for all the shear pins to be gradually consumed uniformly, without any one pin being used significantly more often than others. It should be noted that the locally weakened transitional zones in the shear pins 34 may also be used in the shear pin 7 of the first embodiment.

In the embodiment shown in Figures 6 and 7, a coupling member 46 is connected, in normal operation, by means of a shear pin arrangement 47 with a coupling member 48. The coupling member 46 comprises a shaft portion 49 connected with a radially extending coupling flange or plate 50. The axial end surface of the plate 50 remote from the shaft portion 49 engages a flange or plate 51 of the coupling member 48. The plate 51 is provided in the manner described with reference to Figures 1 and 2 with an inner shaft portion 52 intended to receive non-rotatably a shaft by means of axial key ways 53, whilst a key member is provided to prevent an axial movement of the two-members, this key member being located in an annular opening in the shaft portion 52 and a surrounding sleeve 54, and being constituted by a bolt 55.

The shear pin arrangement 47 extends parallel to the rotary axis 49A of the coupling. The shear pin arrangement 47 is located in an axially extending holder 56 which is similar to the holder 5 of the Figure 1 embodiment so as to form a housing for a retaining pin 57, a compression spring 58 and a shear pin 59. The shear pin 59 comprises locally weakened zones and is guided in a recess 60 in the plate 51, this recess being preferably provided in a sleeve 61 of hard material. The operative portion of the shear pin 59 is located in a blind opening 62 to limit the travel of the shear pin. This opening has ejecting or releasing means constituted by a channel 63 extending radially outwardly from the opening. The channel 63 may have a cylindrical or parallel-sided cross-section, but it may advantageously flare outwardly as illustrated. The opening 62 may be bounded at least partly by an insert of hardened material in a manner not shown. Figure 7 shows that four equispaced shear pin arrangements 47 are provided. Three shear pins 59 are spare and only one is operative at any one time. However, perhaps when a higher torque is to be transmitted, it may be advantageous to have more shear pins in the operative state simultaneously.

In operation the coupling shown in Figures 6 and 7 constitutes an overload safety device as in the preceding embodiment. In the event of overload the portion of shear pin located in the opening 62 will break off and it will be effectively and reliably ejected immediately in a radial direction. After fracture one of the shear pins 59 can independently restore the connection between the two coupling members. Also this coupling can be used for a very long time without needing to fit new shear pins. With the axial disposition of the pins 59 the coupling has only a small diameter.

Figures 8 and 9 show an alternative form of opening and the associated ejecting means suitable for use in the construction shown in Figure 6. An abutment member formed by a rotatable circular disc 64 is received in the coupling plate 50 and can be set in any one of a plurality of positions with the aid of a bolt 65 having a countersunk head, a nut 66 and a dished plate spring 67. The periphery of the disc 64 has semi-circular recesses 68 opening out on the outer side of the disc. Four recesses 68 are provided in the disc although other number of recesses could be provided. Depending on the diameter of the disc and the size of the recesses 68 more recesses, for example, six may be provided. One of the recesses 68 opens into an ejecting channel 69 extending rearwardly and outwardly away from the disc 64 with respect to the direction of rotation A of the coupling. The longitudinal centre line of this channel 69 is at an angle of about 50° to a radial line going through the recess 68. By turning of the disc, another recess 68 can be positioned to open into the channel 69. In this way the coupling member 46 is safeguarded against damage in the region near the opening 62 in the event of overload. The direction of the channel 69 with respect to the direction of rotation of the coupling is such that the release and ejection of the broken-off fragment of the shear pin 59 is satisfactorily carried out. In the event of damage of recess 68 a new recess 68 can be set and fixed by means of the nut 66 and bolt 65.

Figures 10 to 12 show a fourth embodiment of an overload coupling. This coupling comprises, as in the preceding embodiments, a coupling member 70 (Figure 10) formed by a hollow shaft portion 71 and a coupling plate or flange 72. The coupling furthermore comprises a coupling member 73 having a coupling plate 74. The coupling plate 74 extends radially of the rotary axis 71A of the coupling and is provided near part of its outer edge with a fastening part 75 extending axially for some distance away from the coupling member 70. Viewed in a direction parallel to the rotary axis 71A, this part 75 coincides at its outer circumference with part of the circumference of the coupling plate 74. In the embodiment shown the ends of the fastening part 75 subtend an angle of about 80° at the centre of the plate 74. The fastening part 75 comprises furthermore two supporting parts 76 extending radially inwardly towards the rotary axis 71A. In the niche bounded by the supporting parts 76 and the fastening part 75 is secured a shear pin unit 77, which comprises an arcuate holder or cassette 78, which can be fastened to the fastening part 75 by means of a quick-release connector 79. The quick-release connector 79 comprises a torsion spring 80 operating to depress a retaining member. The holder 78 accommodates in the embodiment shown five shear pins 81 each extending parallel to the axis 71A. Each shear pin 81 is received in a hole of the holder and this hole has a narrow portion 82 adjacent the coupling member 73. This portion 82 serves as a stop for a shoulder 83 at the end of the shear pin 81 remote from the coupling member 73. The top side of the shoulder 83 is engaged by one end of a helical compression spring 84, the other end of which engages a ring 85 and a retaining pin 86. Each of the shear pins 81 passes into a respective aperture 87 serving as a passage. Near the lower end remote from the shoulder 83 one of the shear pins is located in an opening 88 similar to the opening 62 in Figure 6. This opening 88 has an ejecting channel 89 extending radially outwardly from the opening 88. The coupling plate 74 has furthermore two tapped holes 90 for receiving means of a balancing unit (not shown) for balancing the mass of the holder 78.

In operation the coupling shown in Figures 10 to 12 constitute an overload safety unit as in the preceding embodiments. The shear pins are independently displaceable in the holder 78, whilst the holder with the springs 84 operates as advancement means or pressure means for the pins 81. The pins may each be composed of several breakable portions, but the breaking pins 81 may, as an alternative, each have only one breakable portion so that they can be fractured only once. In this case the pins 81 together form the breaking pin unit 77 which can re-establish the connection between the coupling members 70 and 73 several times. The construction in this embodiment has a great advantage in that the shear pins are located in a holder or cassette 78, which can be readily replaced after fracture of the pins by a fresh holder, with new pins. In a preferred embodiment the coupling plate 74 is provided with two diametrically opposite cassettes so that the coupling is balanced. As an alternative, only one cassette may be used, in which case separate balancing weights may be provided. The cassette 78 may be used with great advantage in cases where it may be desirable to exchange the shear pins for ones of a different tupe to suit a different application.

It should be noted that structural details of the various described embodiments of the couplings may be combined; for example, the opening 42 and the associated ejecting channel 44 of Figure 3 may be employed in the construction illustrated in Figures 10 to 12. This also applies to the use of hardened material around the whole or part of the opening with which the breaking pin portions are co-operating. It is furthermore possible to use balancing means of the kind used in the embodiment of Figures 10 to 12 also in the preceding embodiments.

It should be noted that the positions of the coupling members in these embodiments with respect to the driving shaft and the driven shaft may be inverted, i.e. drive may be transmitted in the opposite direction to that described.

In the embodiment shown in Figures 13 to 17 the overload coupling is substantially symmetrical to a plane of symmetry going through the centre line 90 of the coupling. The coupling comprises a coupling member 92 connected with fork parts 91 of a universal coupling and a coupling member 93 co-operating with the member 92 and being connectable with the stub shaft 18. The coupling member 93 comprises a hub 94 having a radial bore 95 holding a ball 96, which, in normal operation, lies in an annular groove of the stub shaft 18 and is fixed in place in a radial direction with the aid of a retaining bolt 96A. The coupling member 93 comprises furthermore a radially extending flange 98, which is rigidly secured to the hub 94. The coupling member 92 comprises a carrier 99, which is substantially concentric with the hub 94, on which it is journalled by means of a needle bearing 100. The carrier 99 is locked in place axially with respect to the hub 94 by a pressure ring 101 and a retaining ring 102. Four bolts 103 establish a connection between the fork parts 91, the carrier 99 and a circular cutting ring 104, which is at least partly in contact with the flange 98. The cutting ring 104 has a centering plate 105 having a portion 106 bent over at right angles and extending towards the coupling member 93. The bolts 103 secure to the carrier 99 a second centering plate 107 with a portion 108 bent over at right angles extending towards the coupling member 93. The bent-over portions 106 and 108 form rims which retain in place two holders 109, each of which accommodates a plurality of shear pins 110. On the side of the universal coupling, the holders 109 have an edge 11, which can be clamped beneath the portion 108. The shear pins

110 are each urged by a respective compression spring 112 towards the flange 98. In order to guide the shear pins 110 the holder is provided with sleeves 113, whilst the cutting ring 104 and the centering plate 105 have recesses closely fitting around the shear pins 110. Each spring 112 has, where it engages its pin 110 a number of turns of smaller diameter than the rest of the spring. The shear pins 110 and the springs 112 constitute together coupling means with an axial dimension corresponding substantially to the fastening portion of the stub shaft 18.

The flange 98 has an opening 114 having a substantially radially extending channel 115 opening at the outer circumference of the flange 98. The circumferential width of the opening 114 is about 10 to 20mm depending upon the diameter of the shear pin. With respect to the possibility of establishing the connection of the two coupling portions only at a reduced speed, the distance between the shear pin 110 in the opening 114 and the wall of the opening 114 opposite the pin in this embodiment is about 50 to 70% of the diameter of the shear pin. The pin is supported in an axial direction by a bottom part 116. At the side of the opening 114 there is provided a substantially circular cutting plate 117 of hardened material like the ring 104 having a diameter of about 20 to 30mms. The function of this cutting plate is comparable with that of the cutting plate 64 in Figure 8. It has three openings 118 at its circumference and by means of a locating pin 119 the cutting plate can be fixed in place. The shear pins can be fixed in the manner shown in Figure 17 in the holder 109 by means of a locking member formed by a common retaining pin 120. When the holder is put in place, the retaining pin 120 can be removed from the holder, after which the pins move into their positions. Owing to the provision of the centering plate 105 the pins slide, after the removal of the guard pin 120, without further manipulation, into the recesses in the cutting ring 104. By the quick-release connectors formed by the retaining rims 106 and 108 the holders are simply locked in place and the sleeves 113 prevent the shear pins from tipping over. If during operation by overload a portion of the connecting shear pin 110 breaks off, the fragment is rapidly conducted away through the channel 115. Since the opening 114, as in the preceding embodiments, has a critical width, shear pin 110 can slip into the opening 114 only after a reduction of the speed of the power take-off shaft 20. As in the embodiment shown in Figures 8 and 9, the cutting plate can be set in a different position, should an opening 118 be damaged. The coupling can be adjusted in a simple manner to transmit higher or lower powers by providing the holders 109 with matching breaking pins of different strength and by replacing the cutting ring 104 and the centering plate 105 by other ones having matching apertures. It should be noted that, as in the case of the holder 78 of Figure 12, the holders 109 can also operate primarily as a pressure unit for the pins 110.

The variant shown in Figure 18 comprises a holder differing from the foregoing structure. This holder 121 is closed on top by means of a cap 122. The holder 121 is preferably made from synthetic resin. The cap 122 has a cavity for accommodating the end portion of a compression spring 123, the other end of which is located in a cavity in a pressure pin 124. The pressure pin 124 presses the shear pin 110 home. The pressure pin 124 has a shoulder 125 in sliding engagement with the inner wall of the holder 121. The pressure pin 124 may also be made from synthetic resin. The holder can thus be manufactured at low cost without detracting from its effectiveness.

In the embodiment shown in Figures 19 to 22 the coupling is constructed differently from that of Figure 13. The coupling member 93 is substantially identical to that shown in Figure 13 but it is connected by a sheer pin 110 with a coupling member 126 differing from the coupling member 92. The coupling member 126 is fastened by means of a plurality of bolts 127 to a fastening portion 128 having a substantially circular circumference and serving to receive the fork parts 91. To the fastening part 128 is secured a carrier 129, the function of which is comparable with that of the carrier 99 and which is located between the fastening part 128 and the cutting ring 104. The carrier 129 has two cavities or recesses 131 disposed diametrically opposite each other about a centre line 130. These cavities 131 receive a plurality of sheer pin holders. Each cavity receives, for example, five cylindrical holders 132 each containing a shear pin 110. Each holder 132 comprises a sleeve of synthetic resin, for example, a plastic tube. The holder covers the whole space between the fastening part 128 and the cutting ring 104. Near the cutting ring 104 the holder is provided on its inside with a tapering inner ring 133 constituting both a guide for the shear pin 110 and a stop for a widened part of a pressure pin 134 largely corresponding with the pressure pin 124. The closure of the holder on the side of the end portion of the spring 123 is similar to that of Figure 18. The cap is fixed in holders 132 are enclosed in the cavity 131 place by means of retaining pin. The cavity by means of a cover 136, which is concentric with the centre line 130 and the axial sides of which are bent over to form lugs 137. The lugs 137 co-operate with clamping springs 138, having a number of turns which surround the bolt 127 and press the cover 136 towards the centre line 130. In order to limit movement of the cover with respect to the spring 138 each lug 137 has ridges 139.

In this embodiment the pin 110 is in its connecting position located in an opening 114 such as is referred to in the preceding embodiment, this opening being bounded at one end, with respect to the direction of rotation B, by the cutting plate or disc 64 of Figures 8 and 9 (see Figure 21). At the end of the opening 114 remote from the cutting plate 70 a filling plate 140 is connected with the coupling member 93 by nut and bolt connection. The dimension 141 of Figure 21 is preferably 16mms, and on this basis the filling plate 140 has the following dimensions 141a and 141b:

Shear pin diameter	141*a*	141*b*
7 mms	20.0 mms	28.0 mms
8 mms	18.5 mms	26.5 mms
10 mms	15.5 mms	23.5 mms

The operation of the coupling shown in Figures 19 to 22 largely corresponds with that of the preceding embodiments. The coupling can be readily filled with shear pin holders 132, which can be easily fixed in place by the cover 136 and the springs 138. With different pin diameters the factor T in the formula $S=1/2AT^2$ (the factor T being esentially determined by the pin diameter and the associated circumferential width 141 of the opening 114) can be kept constant in this embodiment since the filling plate 140 can be exchanged.

Figures 23 and 24 show an alternative embodiment of a breaking coupling, in which a shear pin 142 largely similar to the shear pin 110 is provided with a groove 143 extending parallel to its longitudinal centre line throughout or substantially throughout the length. This groove co-operates with a corresponding key 144 provided on the pin guide means, for example, the sleeve 113, the centering plate 105 and the cutting ring 104 of Figure 13. The key 144 prevents the breaking pin from turning with respect to the rest of the coupling.

The overload coupling shown in Figures 25 and 26 comprises a coupling member 145, which is connected with fork parts 146 of a universal coupling and a coupling portion 147, which is connected with the stub shaft 18 as in the embodiment of Figure 13. The coupling member 147 comprises a hub 148 and a flange 150 extending radially outwardly of a centre line 149. The hub 148 extends axially to each side of the flange 150 and the side of the flange 150 remote from the coupling member 145 is provided with pressure means preferably formed by a spiral blade spring 151, surrounding the hub with, for example, five turns. The format ratio of the blade spring 151 is at least 1:10. The inner end of the spring 151 is rigidly secured to the hub, whereas the outer end of the spring is connected with a cover plate 152 by a rivet or bolt joint. The plate 152 is rigidly connected near the circumference of the breaking coupling by a plurality of bolts 153 with an annular wall 154 having a substantially cylindrical shape and being provided on its outside with unevennesses in the form of knurls 155. On the inside, the wall 154 is provided with at least one spring pawl 156 (Figure 26), but preferably with three. The spring pawls extend generally in a direction indicated by the arrow B in Figure 26 but are inclined inwardly and are intended to co-operate with the outer periphery of a ring or ratchet drum 157 having, viewed along the centre line 149, a sawtooth shape for unidirectionally locking against the spring pawls 156. The spring 151, the wall 154 and the ratchet drum 157 together constitute advancement means for a frangible element constituted by a length of steel band 159. The ratchet drum 157 and the steel band 159 have a width, measured axially of the centre line 149, which corresponds to the axial dimension of the wall 154. The steel band 159 may have about ten coils and be accommodated in the space bounded by the inner wall of the ratchet drum 157. The steel band preferably has a thickness of about 1 mm and a width of 4 to 7 cms, and in this embodiment about 6 cms. The end portion 163 of the steel band 159 remote from the ratchet drum 157 is bent over from a substantially circumferential alignment towards the centre line 149. The end portion 163 passes between two cutting blocks 161 and 162, which are bolted to the flange 150. Between the blocks 161 and 162 is a gap 164 constituting a guide passage. The gap 164 guides the end portion 163 so that this end portion has locally a sharper curvature than the rest of the steel band 159. The length of the gap 164 is preferably about 2 cms. The free end of the end portion 163 lies in an opening 165 in a cylindrical carrier 166, which is axially fixed in place in a manner similar to the carrier 99 in Figure 13 with respect to the hub 148, and is journalled on the hub by means of a needle bearing 167. The carrier 166 is bolted to the fork parts 146, and constitutes the main part of the coupling member 145. The carrier 166 has an axial dimension which substantially corresponds with that of the band 159. The space bounded by the band 159 and the carrier 166 can collect broken-off fragments from the band. The opening 165 is bounded in operation in the direction of the arrow B corresponding with the direction of rotation by a cutting plate 168, which engages the end portion 163 by a slanting side joining the gap 164. As in the preceding embodiments and particularly in Figure 21 the circumferential width of the opening 165 may be varied by using cutting plates 168 of different circumferential dimensions. In this embodiment the circumferential dimension of the opening 165 is preferably about three times the thickness of the steel band 159.

The embodiment of the coupling shown in Figures 25 and 26 operates as follows:

The band 159 is delivered to the user in the form of a reel. The diameter of the reel may be chosen in accordance with the outer diameter of the rest of the auxiliary shaft so that the reel can be slipped into the coupling without the need for removing the auxiliary shaft, and the free end portion 163 is inserted into the gap 164. The other end portion 160 will engage one of the internal saw-tooth unevennesses on the inner side of the ratchet drum 157. Then the feeder spring 151 is wound up by rotating the drum formed by the wall 154 in the direction opposite the arrow B in Figure 26. The spring pawl 156 prevents an undesirable reverse rotation of the wall 154. After the spring 151 is fully wound, it urges the steel band 159 towards the carrier 166. After relative rotation between the two coupling members, the end portion 163 will be pressed into the opening 165 so that the band 159 is in a position in which it interconnects the two coupling members. In operation, the band 159 shown transfers power of up to about 100 HP with a speed of the power take-off shaft of about 540 rev/min. In the event of overload, as in the preceding embodiments, the portion of the steel band 159 located in the opening 165 will break off. The width of the opening 165 is again chosen so that only after an intentional reduction of the speed of the drive can the coupling be restored. Owing to the great length of the steel band a single reel is capable of re-establishing the coupling for about one thousand overloads. The feeder member formed by the spring 151, the wall 154 and the ratchet drum 157 is preferably constructed so that when wound up once it is capable of displacing the whole length of steel band up to the opening 165. It may, however, also be advantageous to construct the spring 151 so that it has to be wound during periodic inspection or servicing of the machine, which necessity is, therefore, a reminder for the user that the machine is due for inspection. Various thicknesses of steel band may be used in dependence on the maximum torque to be transferred, the cutting blocks 161 and 162 and the circumferential width of the opening 165 being chosen accordingly. Under certain conditions it may be advantageous to make the steel band 159 of spring steel, in which case the spiral spring 151 may be dispensed with. It may furthermore be effective to incorporate in the coupling a counter for recording the number of overloads. It should furthermore be noted that the coupling shown in Figures 25 and 26 may also be used with other curved material, for example, shear pin material.

Figures 27 and 28 show a further variant of overload coupling comprising a feeder device and further parts which largely correspond with those of Figures 25 and 26. The pawl springs 156 co-operate with a drum 169, which is adapted to co-operate with a large number of radially disposed shear pins 170, arranged in a pin ring 171. The pin ring 171 is connected by fitting pins with the flange 150. The pins 170 are clamped slightly in hardened sleeves 172, which are pressed into the pin ring 171. The radially inner side of the pin ring 171 is adjacent a cutting ring 173, which forms part of the second coupling member of the breaking coupling and has a radial opening 174 for receiving one of the shear pins to interconnect the two coupling members. The circumferential dimension of the opening, as in the preceding embodiments, is critical. The cutting ring 173 is rigidly fastened by two bolts 175 to its coupling member. The drum 169 has an inner profile for supporting the shear pins 170. This profile comprises a first supporting surface 176, which lightly supports the shear pins 170 not yet moved into a first connecting position. Viewed in a direction opposite the arrow B, the first supporting surface 176 extends to a first lug 177 having an obliquely ascending connecting ramp surface which is at an angle of about 20° to 50°, preferably 30°, to a tangent passing through it and which leads on to a second supporting surface 178, which is nearer the centre line 149 than the first supporting surface 176. The pins are provided with rounded end portions to enable them to slide up the lug 177. As is shown in Figure 28 the lug 177 exerts pressure on a shear pin 179 by the action of the spring 151, which pin is not yet in a connection position. At the same time, a shear pin 180 lies at least partly in the opening 174 and establishes a connection between the two coupling members. The end portion of the shear pin 180 engages part of the second supporting surface 178 adjacent the lug 177, A third breaking pin 181, having broken off already once subsequent to an overload, is located between the second supporting surface 178 and the interface between the pin ring 171 and the cutting ring 173. The second supporting surface 178 is coaxial with the centre line 149 and extends from the lug 177 in a direction opposite the arrow B through an arc of 170°; said second supporting surface 178 then leads on to a second lug 182 having a sloping face corresponding with that of the first lug 177. A third supporting surface 183 extends over a fairly short distance adjacent the lug 182, the circumferential extent of that surface being such that it can just support one shear pin 170. In a direction opposite the arrow B the third supporting surface 183 leads back on to the first supporting surface 176. In operation, the coupling shown in Figures 27 and 28 is provided with a series of breaking pins 170 arranged along an arc of about 160° on the ring 171; in this embodiment eleven pins are shown. The pin 181 of Figure 28 must initially be positioned in front of the lug 177, viewed in the direction of the arrow B. In this state all the pins are located between the first supporting surface 176 and the interface between the pin ring 171 and the cutting ring 173. After the spring 151 has been wound in the manner described with reference to the preceding embodiment, it will cause a radial pressure to be exerted on the pin 180 under the action of the sloping connecting ramp surface on the lug 177. Relative rotation between the two coupling members results in the pin 181 being slipped into the opening 174. At the same time the drum 169 rotates in the direction of the arrow B until the lug 177 reaches the next following shear pin 180. The coupling is then ready for normal operation. In the event of overload the portion of the shear pin 181 in its connecting position in the opening 174 will break off so that the coupling member connected with the load (which may, for example, be an implement of a harrow) will come to a standstill. As in the preceding embodiments, owing to the critical choice of the circumferential dimension of the opening 174, it is possible to slip the next-following shear pin into the opening 174 only after an appreciable reduction in the speed of the power take-off shaft. This is achieved by rotation of the drum 169 through a small angle in the direction of the arrow B, thus shifting the shear pin 180 into a connecting position. The drum then occupies a position as shown in Figure 28, in which the lug 177 bears on the shear pin 179. Fracture of a shear pin followed by rotation of the drum 169 and the positioning of a following shear pin are repeated until all the shear pins have broken off once. In this state the shear pin 181 engages the second lug 182, which pushes the pin 181 for the second time in a radial direction into the opening 174. Thus by means of the second lug 182 all the shear pins can again be used. By providing further lugs, further fracture of the pin after leaving the lug 182 may be repeated several times. The resultant breaking coupling has a compact structure, but it can nevertheless transfer a very high torque.

Figures 29 and 30 show a variant of the breaking coupling shown in Figures 27 and 28. In this embodiment a wall portion 184 is bolted to an inner part 185 and is provided on the inner side with pawl springs 186 co-operating with a drum 187. Apart from the first drum 187 a second drum 188 is provided which is in engagement with the wall 184. Like the drum 169 of the preceding embodiment the drums 187 and 188 co-operate with pin rings 189 and 190 respectively, each pin ring co-operating with an opening in the cutting ring 173. The first drum 187 has a groove 191 extending coaxially with the centre line 149 and is provided with a lug or pawl 192. The second drum 188 is provided with a catch 193 which extends axially and is located in the groove 191. In operation the drum 187 co-operates with the wall and the pin ring 189 in the same manner as in the preceding embodiment. After the pins of the first pin ring 189 are consumed, the second pin ring 190 is made operative by contact between the catch 193 and the pawl 192. Thus the pins of the second ring 190 are used in order of succession, so that the capacity of the coupling is doubled. In a similar manner several pin rings may be arranged one behind the other.

Figure 31 shows a further embodiment of the coupling shown in Figures 27 and 28, in which the outer wall is formed by a wall 194, which is coaxial with the centre line 149 and extends away from the plate 152 and is provided near the flange 150 with a plurality of pawl springs 195, which can co-operate with a drum 196. The drum 196 is provided with a lug 197 which has an upwardly slanting ramp surface 198 and is remote from the flange 150, this surface being at an acute angle to a plane perpendicular to the centre line 149, this angle preferably being about 30°. Through the lug 197, the drum 196 co-operates with a pin ring 199 having a plurality of breaking pins 200 extending parallel to the centre line 149. The other coupling member comprises a disc 201 which extends transversely of the centre line 149 and is connected with the fork parts 146. The coupling shown in Figure 31 operates basically in substantially the same way as those shown in any one of the Figures 27 to 30, the pins 200 being, however, orientated axially, whilst the lug 197 moves the respective pins 200 into a connecting position. In this way one lug will suffice and the possibility, which may be advantageous, is available of disposing the pins very near the circumference of the coupling, so that the coupling is capable of transferring a very high torque. The coupling, as described in any one of the preceding embodiments can be placed in a flywheel very effectively since the shearing pin can be completely disposed within the outer periphery of the flywheel and may even be arranged inside the flywheel.

It should be noted that the positions of the coupling members in these embodiments with respect to the driving shaft and the driven shaft may be inverted.

WHAT WE CLAIM IS:—

1. An overload coupling comprising two members which are rotatable about a common axis and at least one frangible element which in normal operation interconnects the two members for rotation together in at least one direction, fracture of the frangible element permitting relative rotation between the members, advancment means being provided for advancing the remaining part of the frangible element, after such fracture, to re-interconnect the members, the construction of the coupling being such that re-interconnection of the coupling members can take place during relative rotation of the coupling members only when the relative speed of rotation of the coupling members is below a predetermined value.

2. An overload coupling as claimed in claim 1, in which the coupling comprises at least two frangible elements, each of the elements being capable of being advanced at least twice by the advancement means to re-interconnect the members.

3. An overload coupling as claimed in claim 1 or 2, wherein the frangible element is connected with one of the members for movement in at least one direction relative to that member and is disposed for engagement with at least one abutment of the other member, the advancement means advancing the remaining part of the frangible element into re-engagement with the abutment or one of the abutments.

4. An overload coupling as claimed in claim 3, wherein the abutment is constituted by an arcuate wall portion of an opening in the said other member.

5. An overload coupling as claimed in claim 4, wherein the opening is blind, the bottom of the opening affording a limit for the advancement of the frangible element after each fracture.

6. An overload coupling as claimed in 4 or 5, wherein the wall portion is constituted by part of the surface of an abutment member hardened material.

7. An overload coupling as claimed in claim 6, wherein the abutment member comprises a disc which adjustable between a plurality of positions with respect to the opening and in each position a respective recess in the disc partly surrounds the opening.

8. An overload coupling as claimed in claim 7, wherein the disc is rotatably connected to the said other member.

9. An overload coupling as claimed in any one of the preceding claims, wherein the said other member is provided with release means for releasing a broken-off fragment of the frangible element.

10. An overload coupling as claimed in claim 9 when appendant to any one of claims 3 to 8, wherein the release means comprises a channel extending from the abutment to the exterior of the coupling.

11. An overload coupling as claimed in claim 10, wherein the channel has at least partly a substantially circular cross-section.

12. An overload coupling as claimed in claim 10 or 11, wherein the channel extends at least partly in a radial direction.

13. An overload coupling as claimed in claim 10 or 11, wherein the longitudinal centre line of the channel is at an angle of about 50° to the radial line passing through the abutment.

14. An overload coupling as claimed in any one of claims 10 to 13, wherein at least part of the channel is curved.

15. An overload coupling as claimed in any one of claims 10 to 14, wherein a wall of the channel extends, at a region adjacent the abutment, substantially parallel to the longitudinal centre line of the frangible element and extends, at a region of the channel remote from the abutment, at an acute angle to the longitudinal centre line of the frangible element.

16. An overload coupling as claimed in any one of claims 10 to 15, wherein a wall of the channel is arcuate and subtends an angle of about 90° between the abutment and the outer side.

17. An overload coupling as claimed in any one of the preceding claims, where-

in the frangible element is located at least partly in a holder which is mounted on the said one member, at least part of the holder being releasable from the said one member.

18. An overload coupling as claimed in any one of the preceding claims, wherein the coupling comprises one or more elongate frangible elements the centre lines of which extend substantially radially of the rotary axis.

19. An overload coupling as claimed in any one of claims 1 to 18, wherein the centre line of the frangible element extends substantially parallel to the rotary axis.

20. An overload coupling as claimed in any one of the preceding claims, wherein the or each frangible element comprises a shear pin.

21. An overload coupling as claimed in any one of the preceding claims, wherein the coupling is arranged in a shaft further including at least one universal coupling.

22. An overload coupling substantially as specifically described herein with reference to the accompanying drawings.

HASELTINE LAKE & CO.
Chartered Patent Agents
28 Southampton Buildings
Chancery Lane,
London WC2A 1AT
—and—
Temple Gate House
Temple Gate
Bristol BS1 6PT
9 Park Square
Leeds LS1 2LH

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Sheet 1

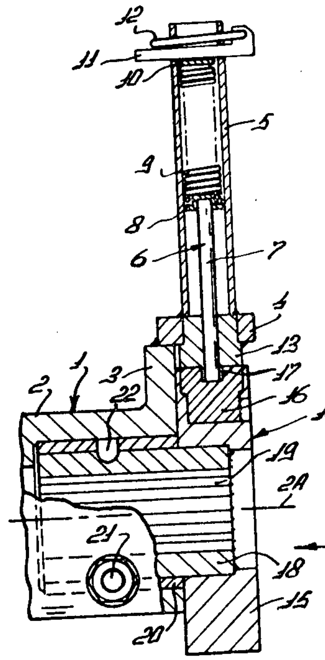

FIG. 1

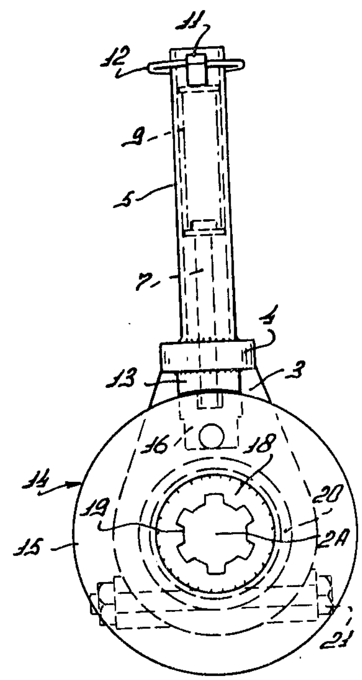

FIG. 2

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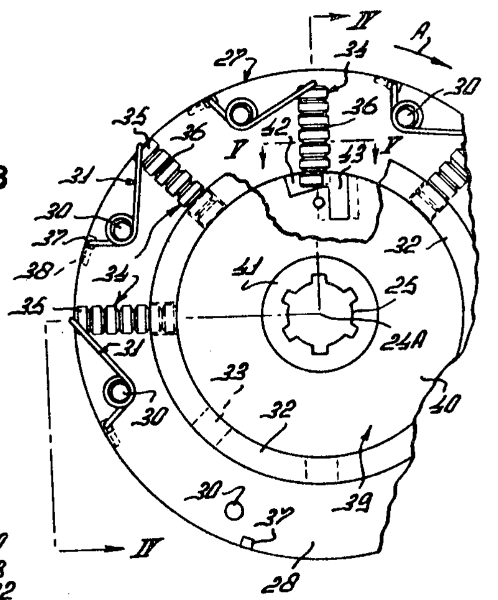


FIG. 3

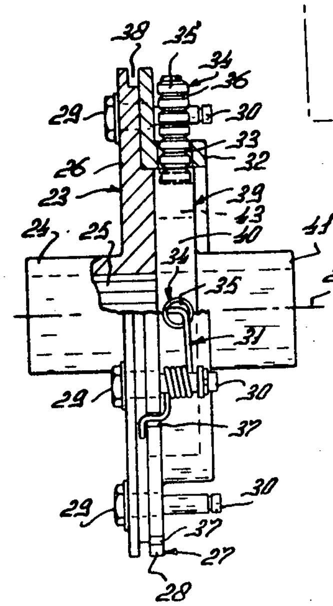


FIG. 4

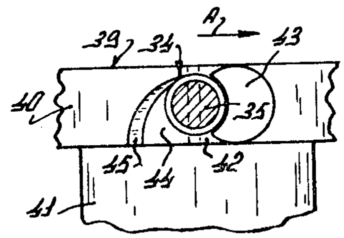


FIG. 5

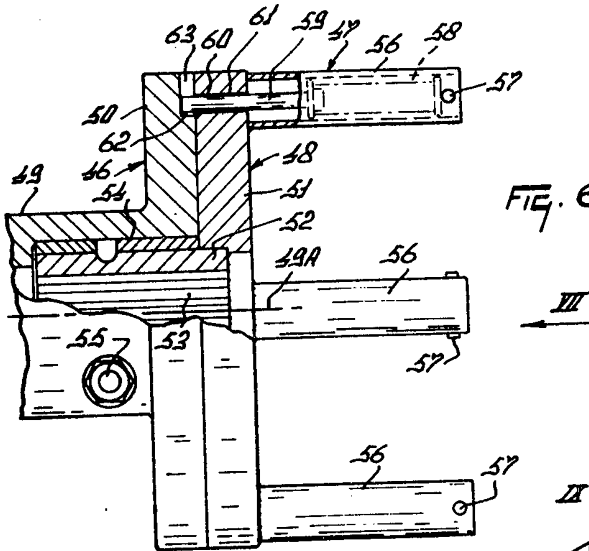


FIG. 6

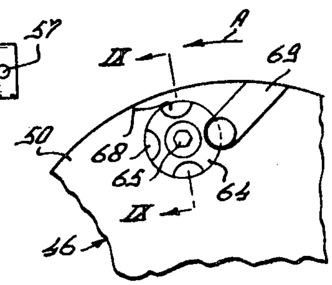


FIG. 8

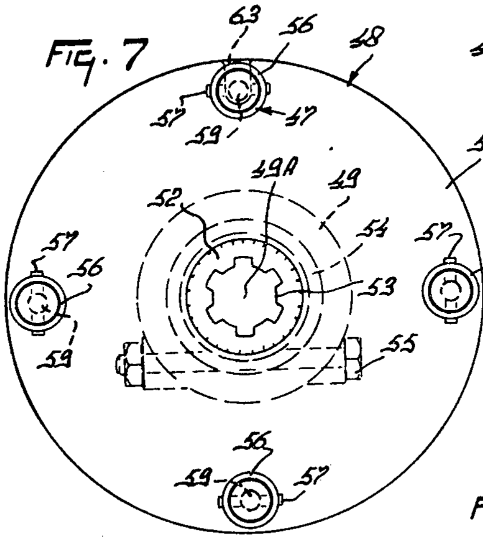


FIG. 7

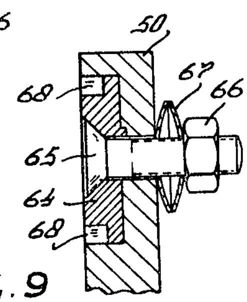


FIG. 9

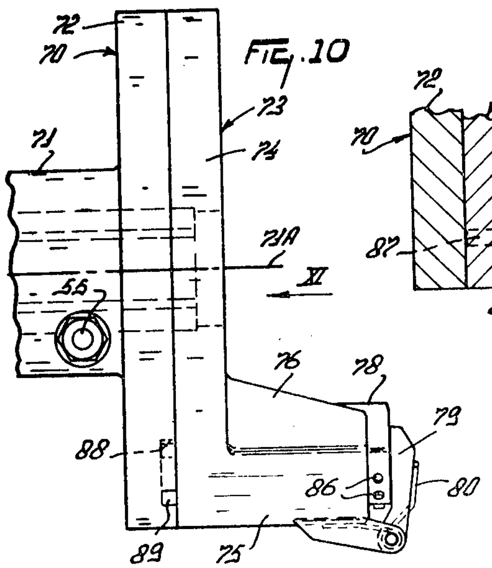


FIG.10

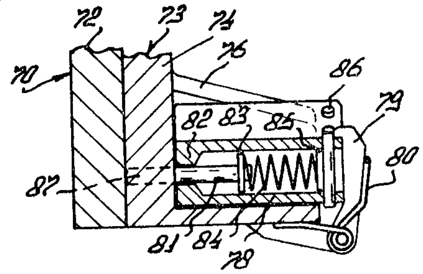
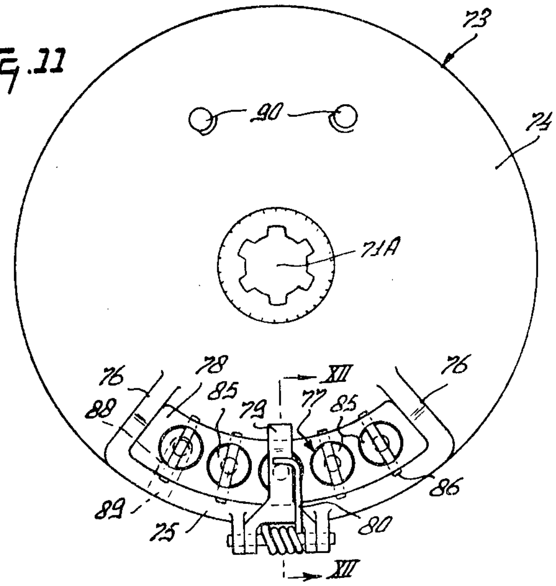


FIG.12

FIG.11



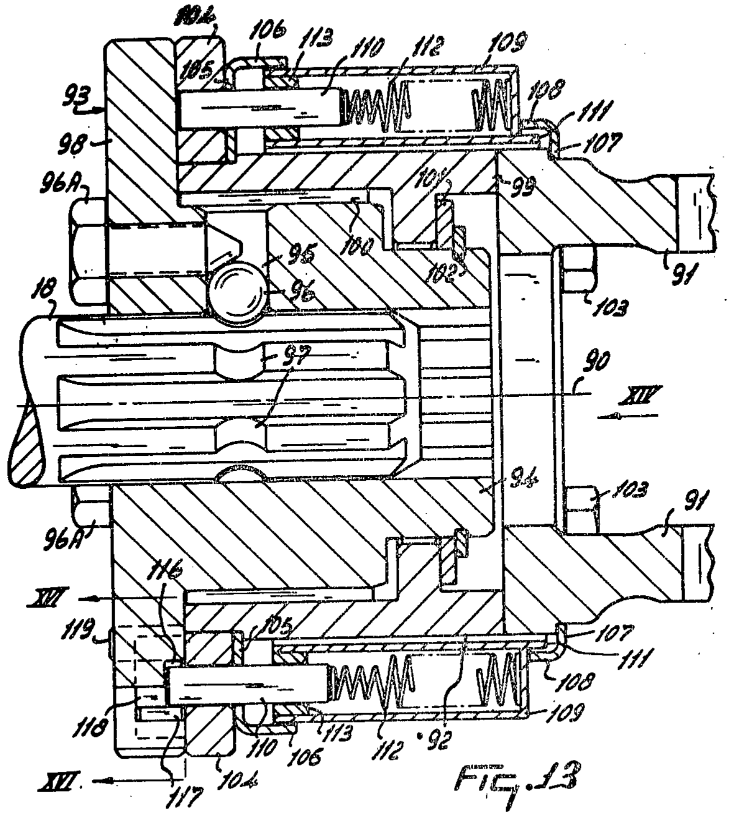

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FIG. 13

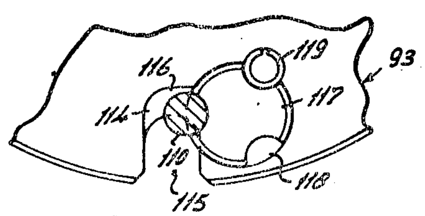
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FIG. 16

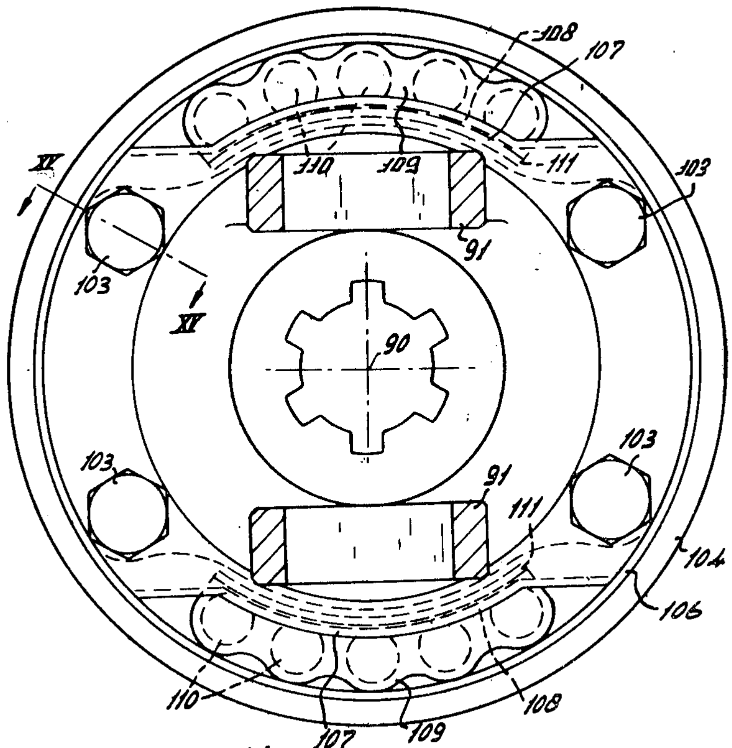
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Fig. 14

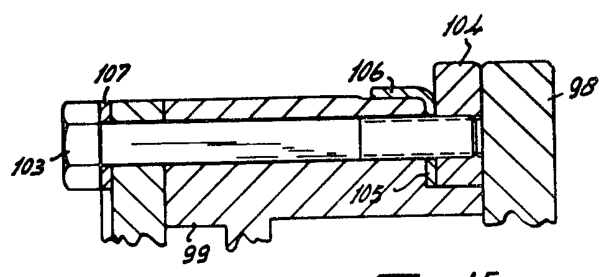
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Fig. 15

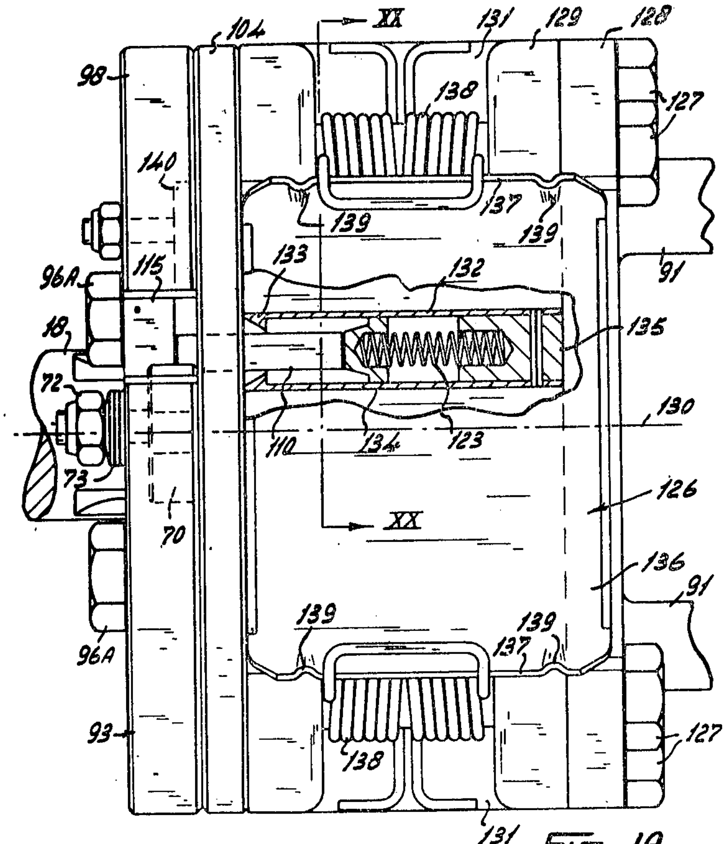
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FIG.19

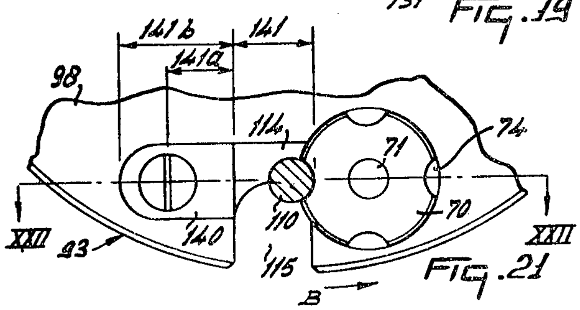
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FIG.21

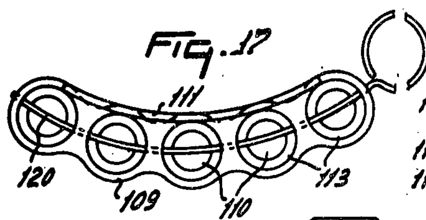

Fig.17

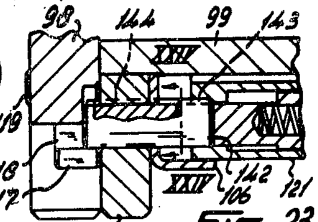

Fig.23

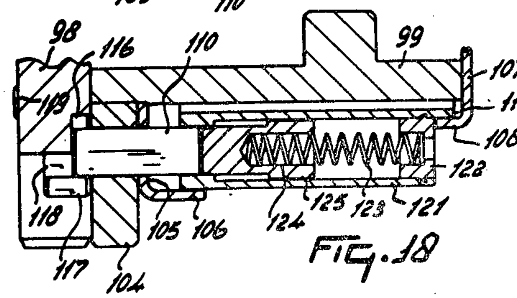

Fig.18

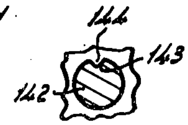

Fig.24

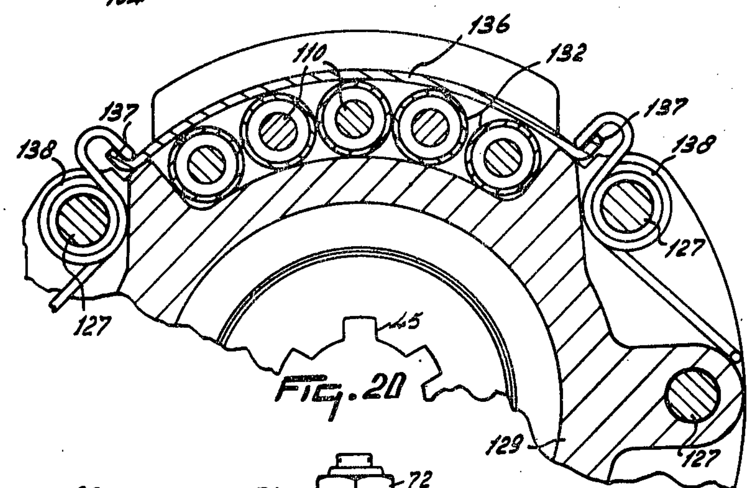

Fig.20

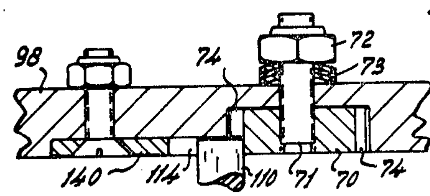

Fig.22

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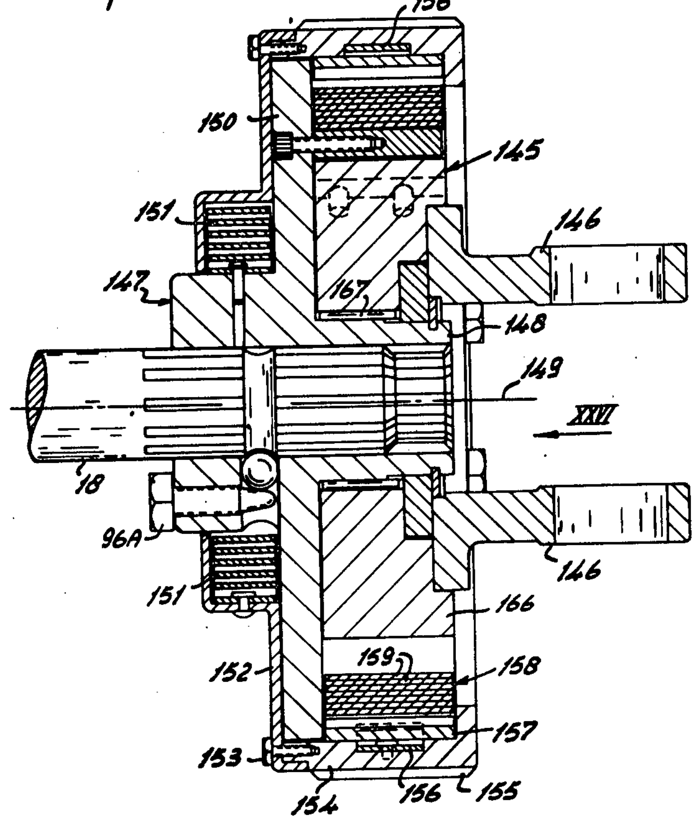
FIG. 25



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Sheet 10

FIG. 26

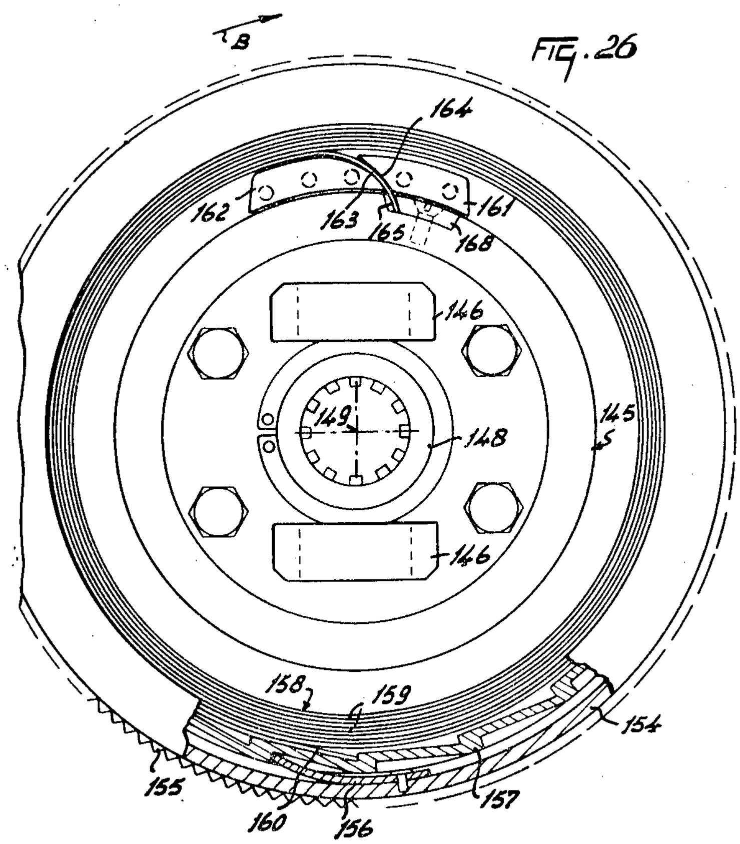


FIG. 27

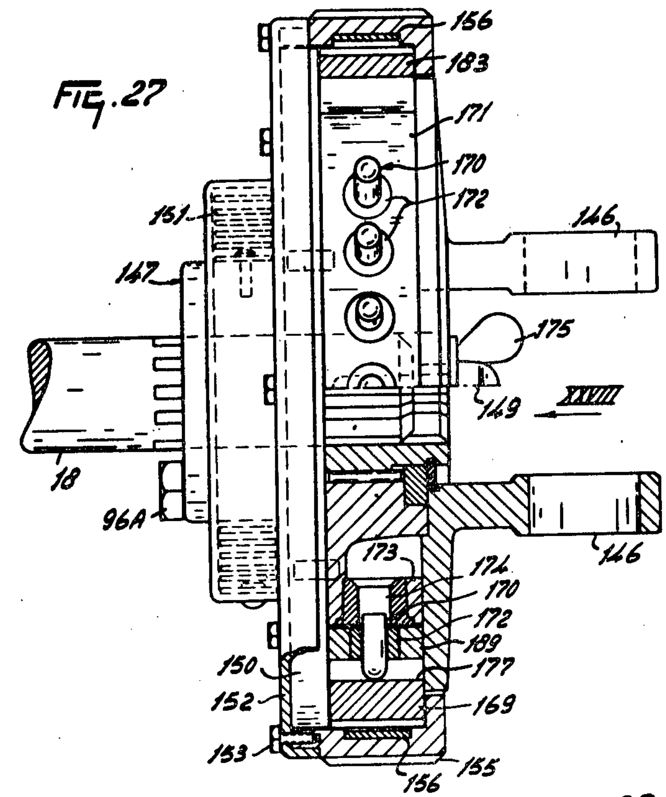


FIG. 29

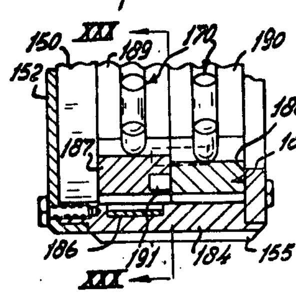
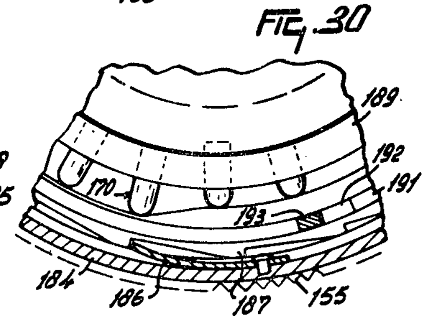


FIG. 30



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12 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 12

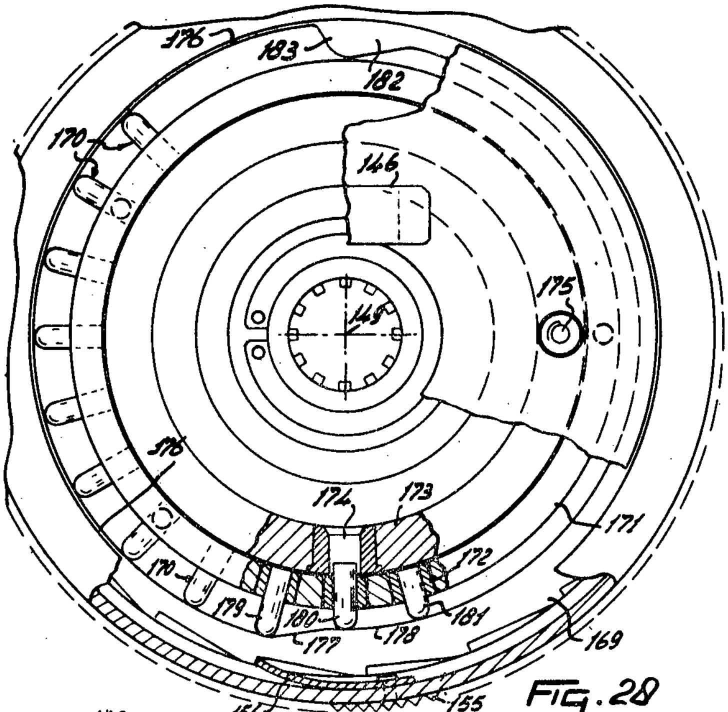

FIG. 28

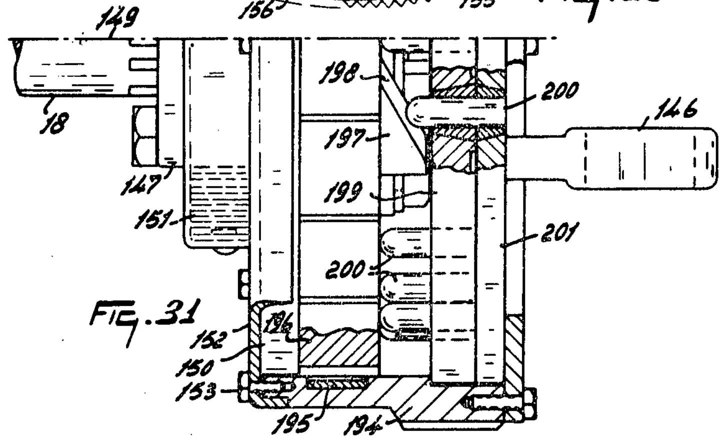

FIG. 31