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(54) **Shifting apparatus for bicycles**

Gangschaltungseinrichtung für ein Fahrrad

Dispositif de changement de vitesse pour bicyclette

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EP-A- 0 361 335                      EP-A- 0 585 473  
US-A- 4 319 673                      US-A- 5 203 213

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## Description

### BACKGROUND OF THE INVENTION

[0001] The present invention is directed to shifting apparatus for bicycles and, more particularly, to a shifting device which is more compact yet easier to use than known shifting devices.

[0002] A known indexed shifting apparatus for bicycles is disclosed in U.S. Patent No. 5,203,213. As shown in Figs. 3 and 4 of that patent, this type of shifting device includes a support shaft (11) fixed to a bracket (B) mounted on a handlebar; a takeup reel (2) rotatably mounted on the support shaft (11) for alternately pulling and releasing a control cable (1); a first control lever (4) pivotable about the support shaft (11) for causing the takeup reel (2) to pull the control cable (1); and a second control lever (7) for causing the takeup reel (2) to release the control cable (1). The first control lever (4) engages feed teeth (21) on takeup reel (2) through a feed pawl (41) to cause the takeup reel (2) to rotate in the cable pulling direction. The second control lever (7) engages two sets of position retaining teeth (31,61) on takeup reel (2) through two pawls (32,62) to cause the takeup reel to rotate in the cable release direction. The first control lever (4) and the second control lever (7) are both mounted at a position below the handlebar for operation by the index finger and thumb of a cyclist's hand.

[0003] Such a bicycle shifting apparatus operates quite satisfactorily for many users. However, the construction of the shifting apparatus does present some disadvantages. For example, the requirement of two pawl mechanisms used to release the control cable increases the cost of manufacture and produces a more complicated and heavier structure. The added components also increase the overall size of the shifting device, either in thickness or diameter. The increased size tends to lower the aesthetic appearance of the shifting device.

[0004] Attempts to construct single pawl release mechanisms for indexed bicycle shifting devices with many speeds (e.g., seven or more) have usually failed. One problem arises from the fact that the amount of cable pull for each gear varies. This requires position retaining teeth with varying pitch between adjacent teeth, and the pawl which engages the position retaining teeth must be designed to accommodate the variable pitch. However, as the number of speeds increase, the pitch between the position retaining teeth must either decrease accordingly, or else the size of the shifting device must be increased. Increasing the size of the shifting apparatus is undesirable for obvious reasons. Decreasing the pitch of the position retaining teeth requires a corresponding decrease in the size of the position retaining pawl. However, as the pawl size decreases the thickness of the pawl must necessarily decrease. To accommodate the high operating forces encountered in the typical release mechanism, the pawl must then be

fabricated from sintered metal or through some other high cost method.

[0005] Furthermore, the location of the shift levers below the handlebar tend to impede high performance operation of the shifting device. Since the handlebar tends to obstruct the view of the shift levers, especially the shift lever operated by the index finger, inexperienced users, users without substantial familiarity with the location of the components, or users without substantial manual dexterity may need to visually assure themselves of the location of the shift levers or grope around before properly locating the shift levers. This wastes time and may annoy such users. Furthermore, the location of the shift levers make it impracticable to shift and brake at the same time. This limitation decreases the ability of racers to compete effectively and impedes the ability of other high performance cyclists who may wish to brake and shift at the same time.

[0006] US Patent No. 4,319,673 discloses a combined brake and shifting apparatus for bicycles in which two shift control levers comprise interconnected arms that extend radially from a common axis of rotation. The brake operating lever is disposed in the angle between the shift control and pivots about an axis at right angles to the axis of rotation of the shift control arms.

### SUMMARY OF THE INVENTION

[0007] The present invention is directed to a shifting apparatus for a bicycle which is simpler in construction and more compact than known shifting devices, and which also facilitates high performance riding. Simply stated, the shifting apparatus of the present invention reduces its size by using only a single pawl mechanism to release the control cable. To facilitate operation of the control levers, the control levers may be oriented so that the brake operating unit (for example, either the mounting bracket or the brake lever) is disposed between the control levers. This allows at least one control lever to be ready in view of the cyclist and allows simultaneous operation of the brake and shifting apparatus.

[0008] According to the present invention there is provided an apparatus for operating a bicycle transmission shifting device having an operating component adapted to be mountable to a bicycle in close proximity to a brake operating unit of the bicycle for alternately pulling and releasing a transmission element comprising:

a first lever mounted to the operating component for movement in a first plane which causes the operating component to pull the transmission element;  
 a second lever mounted to the operating component for movement, independently of the first lever, in a second plane parallel to and spaced apart from said first plane which causes the operating component to release the transmission element; and  
 wherein the first lever and the second lever are mounted to

the operating component so that the shifting device may be mounted to the bicycle in such a manner that the brake operating unit is disposed between the first and second levers.

**[0009]** Preferably, the first lever and the second lever are mounted to the operating component so that the shifting device may be mounted to the bicycle in such a manner that a mounting bracket of the brake operating unit is disposed between the first and second levers.

**[0010]** Preferably, the first lever and the second lever are mounted to the operating component so that the shifting device may be mounted to the bicycle in such a manner that an operating lever of the brake operating unit is disposed between the first and second levers.

**[0011]** Preferably, the first lever is mounted to the operating component so that movement of the first lever in a first direction causes the operating component to pull the transmission element, wherein the second lever is mounted to the operating component so that movement of the second lever in a second direction causes the operating component to release the transmission element, and wherein the first direction is substantially opposite the second direction.

**[0012]** In order to be able to construct the shifting device with only a single pawl for the release mechanism, the takeup element for the transmission element may include a control member having a plurality of position retaining teeth for engaging the single release pawl, wherein a pitch between at least two pairs of the plurality of position retaining teeth is a constant value. To accommodate the varying cable pull requirements of an index shifting system, the cable winding surface of the takeup element has a nonuniform shape. For some applications this may mean that the winding surface has a progressively increasing radius from a pivot point of the takeup element.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0013]**

Fig. 1 is a top view of a particular embodiment of a bicycle shifting apparatus according to the present invention;

Fig. 2 is a cross-sectional view of the shifting apparatus shown in Fig. 1;

Fig. 3 is an exploded view of the shifting apparatus shown in Fig. 1;

Fig. 4 is a view illustrating the position of the pawls and control member shown in Fig. 3;

Figs. 5A-5E illustrate a release operation of the shifting apparatus shown in Fig. 3;

Fig. 6 is a perspective view of another embodiment of a shifting apparatus according to the present invention; and

Fig. 7 is a cross-sectional view of the shifting apparatus shown in Fig. 6.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

**[0014]** Fig. 1 is a top view of a particular embodiment of a bicycle shifting apparatus (10) according to the present invention. Shifting apparatus (10) includes a mounting bracket (14) for mounting the shifting apparatus (10) to a handlebar (18) or other structural member of a bicycle; a housing (22) which houses the shifting components; a main lever (26) for causing the shifting apparatus (10) to pull on an inner wire (28, Fig. 2) of a shifting cable assembly (30); and a release lever (34) for causing the shifting apparatus to release the inner wire (28).

**[0015]** The detailed structure of shifting apparatus (10) is shown in Figs. 2 and 3. A lower cover (38) is mounted to bracket (14) for forming the lower portion of housing (22), and bracket (14) is adapted to be fastened to handlebar (18) by a mounting screw (40). A main pivot post (44) extends through an opening (48) in mounting bracket (14). A takeup element (52) is rotatably mounted to main pivot post (44) through a bushing (56) and is biased in a cable unwinding direction by a spring (60). A cable retainer (64) is fastened to the end of inner cable (28) and is retained by an abutment (66) formed in takeup element (52) in a well known manner. Inner cable (28) is guided within a cable winding groove (68) during the shifting operation. A control member (72) is fixed to takeup element (52) so as to rotate integrally with it, and a retainer plate (76) is mounted over control member (72). As described in more detail below, control member (72) includes a plurality of position retaining teeth (80) and a plurality of drive teeth (84) for rotating and controlling the position of takeup element (52) in conjunction with main lever (26) and release lever (34). An upper cover (88) is mounted to bracket (14) for forming the upper portion of housing (22).

**[0016]** Release lever (34) is rotatably mounted to a release pivot post (92) which, in turn, is mounted to bracket (14). A spring (94) mounted between release lever (34) and release pivot post (92) for biasing release lever (34) to a home position (shown by a solid line in Fig. 1). A release pawl (98) is also rotatably mounted to release pivot post (92) and is biased in a clockwise direction by a release pawl spring (102). Release pawl (98) includes spaced apart jaws (104, 106) for engaging position retaining teeth (80) on control member (72) in a manner discussed below. Release pawl (98) and release pawl spring (102) are retained on release pivot post (92) by a C-clip (110). A release lever tab (101) on release lever (34) cooperates with a pawl tab (103) on release pawl (98) to pivot release pawl counterclockwise in response to counterclockwise movement of release lever (34).

**[0017]** Main lever (26) is rotatably mounted to main pivot post (44) by a bushing (112) and a retainer screw (113). A screw cover (115) is mounted above screw (113). A spacer (114) is disposed between main lever (26) and retainer plate (76), and a spring (118) is mounted

ed between main lever (26) and a spring tab (122) on retainer plate (76) for biasing main lever (26) to a home position (shown by a solid line in Fig. 1). A drive pawl (130) is mounted to a drive pivot post (134) which, in turn, is mounted to main lever (26). Drive pawl (130) is biased in a clockwise direction by a spring (138), and both drive pawl (130) and spring (138) are retained on main pivot post (134) by a C-clip (142).

**[0018]** Fig. 4 is a view illustrating the detailed structure of takeup element (52) and control member (72), and how the release pawl (98) and main pawl (130) cooperate with position retaining teeth (80) and drive teeth (84), respectively. In this embodiment, there are eight position retaining teeth (80) and eight drive teeth (84) to accommodate an eight speed bicycle transmission. Jaws (104,106) are spaced apart by a distance approximately equal to a distance between adjacent position retaining teeth (80). To facilitate the following discussion, it will be assumed that the bicycle transmission in this example is a derailleur/freewheel combination wherein a derailleur moves a drive chain from one freewheel sprocket to another. Of course, other transmissions could be used, if desired. Since the takeup element (52) is biased in the counterclockwise direction by spring (60), the drive chain is engaged with the smallest freewheel sprocket when the position retaining tooth (80H) abuts against jaw (104) of release pawl (98), the drive chain is engaged with the second smallest freewheel sprocket when the position retaining tooth (80G) abuts against jaw (104) of release pawl (98), and so on until the chain is engaged with the largest freewheel sprocket wherein the position retaining tooth (80A) abuts against jaw (104) of release pawl (98).

**[0019]** When the bicycle transmission is not in the process of being shifted, an engagement projection (140) of drive pawl (130) rests on an abutment (144) of retainer plate (76). When the drive chain is to be shifted to the next largest freewheel sprocket, then main lever (26) is rotated in the clockwise direction to the position shown by broken lines in Fig. 1. This causes drive pawl (130) to move in the direction of the arrow shown in Fig. 4 so that engagement projection (140) of drive pawl (130) moves beyond the abutment (144) on retainer plate (76), drops into the gap between drive tooth (84F) and (84G), and presses against the side of drive tooth (84G). Takeup element (52) and control member (72) then rotates in the clockwise direction. Since release pawl (98) is rotatably mounted to release pivot post (92), release pawl (98) rotates counterclockwise when position retaining tooth (80F) presses against it, thus allowing position retaining tooth (80F) to move to the other side of jaw (104). Thereafter, when main lever (26) is released, spring (118) causes main lever (26) to return to the position shown in solid lines in Fig. 1, and drive pawl (130) retracts to the position shown in Fig. 4. Since takeup element (52) and control member (72) are biased in the counterclockwise direction by spring (60), control member begins to rotate. However, rotation of

control member (72) stops when position retaining tooth (80F) abuts against jaw (104), thus maintaining takeup element (52) in the desired position.

**[0020]** When the chain is to be shifted to a smaller gear, release lever (34) is rotated counterclockwise to the position shown in broken lines in Fig. 1. This causes release lever tab (101) to press against pawl tab (103) to rotate pawl (98) in the counterclockwise direction. Figs. 5A-5E show the movement of release pawl (98) in the case where the chain is to be shifted from the second smallest sprocket (the position shown in Fig. 4) to the smallest sprocket. Initially, position retaining tooth (80G) abuts against jaw (104) as shown in Figs. 4 and 5A. As release pawl (98) rotates counterclockwise, jaw (104) moves up the side of position retaining tooth (80G) until the tip of jaw (104) clears the tip of position retaining tooth (80G). When this occurs, control member (72), which is biased in the counterclockwise direction by spring (60), moves counterclockwise until position retaining tooth (80F) abuts against jaw (106) as shown in Fig. 5C. Since engagement projection (140) of drive pawl (130) is resting on abutment (144) of retainer plate (76), drive pawl (130) does not interfere with rotation of control member (72). When release lever (34) is released, spring (94) causes release lever to rotate back to the position shown in solid lines in Fig. 1, thus causing release lever tab (101) to disengage from pawl tab (103) as shown in Fig. 5D. Since release pawl is biased in the clockwise direction by spring (102), release pawl (98) begins to rotate in the clockwise direction, and jaw (106) moves up the side of position retaining tooth (80F) until the tip of jaw (106) clears the tip of position retaining tooth (80F). When this occurs, control member (72), which is biased in the counterclockwise direction by spring (60), moves counterclockwise until position retaining tooth (80H) abuts against jaw (104) as shown in Fig. 5E, thus completing the shifting operation.

**[0021]** When a bicycle transmission is shifted, the amount of displacement of the transmission cable or other transmission element varies for each gear. In a derailleur/freewheel transmission, this is caused in part by the variable distance between successive freewheel gears. In an indexed shifting apparatus, this variable displacement is accommodated by setting the position retaining teeth at different spacing from each other. This means that the release pawl must be constructed to accommodate the widest spacing between the position retaining teeth, thus increasing the size of the shifting apparatus. Furthermore, as the number of speeds increase, the spacing between the position retaining teeth must either decrease accordingly, or else the size of the shifting device must be increased. Decreasing the pitch of the position retaining teeth requires a corresponding decrease in the size of the position retaining pawl. However, as the pawl size decreases the thickness of the pawl must necessarily decrease, particularly the pawl jaws such as jaws (104,106) in release pawl (98). To accommodate the high operating forces encountered in

the typical release mechanism, the pawl must then be fabricated from sintered metal or through some other high cost method. As the number of speeds continue to increase, the jaws become too thin, and a single pawl simply cannot be made to satisfactorily perform the function.

**[0022]** The present invention solves this problem by setting a constant pitch (or space) between adjacent position retaining teeth despite the requirement of variable displacement of the transmission cable. In this embodiment, there is a constant pitch between position retaining teeth (80B,80C), (80C,80D), (80D,80E), (80E,80F), and (80F,80G). For this particular embodiment, the constant pitch is 18°, but this is not critical. The actual pitch will depend on the particular application. To accommodate the requirement of variable displacement of the transmission cable, the winding surface (68) is formed with an irregular shape. In this embodiment, the winding surface (68) has an increasing radius in the counter-clockwise direction. Thus, the amount of cable displacement will vary despite the constant pitch of the position retaining teeth, and this variable displacement is accomplished without increasing the overall size of the shifting apparatus. Of course, the actual shape of the winding surface will also depend on the application, and it may either decrease in radius, remain constant, be flat, have a temporary spike, or have some other shape depending upon the application.

**[0023]** It should be noted that not all pairs of position retaining teeth need to have a constant pitch. For example, there is a pitch of 25° between position retaining teeth (80G,80H), and a pitch of 28.8° between position retaining teeth (80A,80B). The number of pairs of position retaining teeth having a constant pitch depends on the space savings desired, the number of speeds in the bicycle transmission, and other design considerations. In this embodiment, the pitch of the position retaining teeth (80) allow control member (72) to accommodate seven or more speeds, and the control member may have a diameter of 30 mm or less

**[0024]** Fig. 6 is a top view of an alternative embodiment of a shifting device (200) according to the present invention. In this embodiment, an operation component (204) of shifting device (206) is mounted in close proximity to a brake operating unit (208) such that a first operating lever (212) is disposed below brake operating unit (208) and a second operating lever (216) is disposed above brake operating unit (208). In this embodiment, first lever (212) functions as the main lever and second lever (216) functions as the release lever, with movement indicated by the arrows, but the functions of the levers and their directions of movement could be reversed or altered as desired. Furthermore, the levers (212,216) could be disposed above or below the brake operating unit (208) at any location. For example, the levers (212,216) could be disposed above or below a mounting bracket (220), a brake lever (224), or any other portion of brake operating unit (208). This configuration

makes it possible to shift and brake at the same time, and the levers can be seen quite easily for high performance operation.

**[0025]** Fig. 7 is a cross sectional view of the shifting apparatus shown in Fig. 6. From inspection is should be readily apparent that the construction of operation component (204) is substantially the same as in the first embodiment, except the location of the main lever and the release lever has been reversed. Main pivot post (44) has been lengthened to accommodate bracket (14) which, in this embodiment, has been formed integrally with the brake operating unit (208). The components which correspond to the main components in the first embodiment are numbered the same, so a detailed description of them shall be omitted.

**[0026]** While the above is a description of various embodiments of the present invention, further modifications may be employed without departing from the spirit and scope of the present invention. For example, the embodiment shown in Figs. 6-7 may use a conventional multiple release pawl operation component. Components shown as separate parts may be integrally formed, and the shape, orientation or location of the components may be altered as desired. Although a wire (28) was shown as a winding transmission element, other transmission elements (chain, belt, etc.) may be used.

**[0027]** Thus, the scope of the invention should not be limited by the specific structures disclosed. Instead, the true scope of the invention should be determined by the following claims. Of course, although labeling symbols are used in the claims in order to facilitate reference to the figures, the present invention is not intended to be limited to the constructions in the appended figures by such labeling.

#### Claims

1. An apparatus for operating a bicycle transmission shifting device (200) having an operating component (204) adapted to be mountable to a bicycle in close proximity to a brake operating unit (208) of the bicycle for alternately pulling and releasing a transmission element (28) comprising:

a first lever (212) mounted to the operating component (204) for movement in a first plane which causes the operating component (204) to pull the transmission element (28);

a second lever (216) mounted to the operating component (204) for movement, independently of the first lever (212), in a second plane parallel to and spaced apart from said first plane which causes the operating component (204) to release the transmission element (28); and wherein

the first lever (212) and the second lever (216)

are mounted to the operating component (204) so that the shifting device (200) may be mounted to the bicycle in such a manner that the brake operating unit (208) is disposed between the first and second levers.

2. The apparatus according to Claim 1 wherein the first lever (212) and the second lever (216) are mounted to the operating component (204) so that the shifting device (200) may be mounted to the bicycle in such a manner that a mounting bracket (220) of the brake operating unit (208) is disposed between the first and second levers.
3. The apparatus according to either preceding claim wherein the first lever (212) and the second lever (216) are mounted to the operating component (204) so that the shifting device (200) may be mounted to the bicycle in such a manner that an operating lever (224) of the brake operating unit (208) is disposed between the first and second levers.
4. The apparatus according to any preceding claim wherein the first lever (212) is mounted to the operating component (204) so that movement of the first lever (212) in a first direction causes the operating component (204) to pull the transmission element (28), wherein the second lever (216) is mounted to the operating component (204) so that movement of the second lever (216) in a second direction causes the operating component (204) to release the transmission element (28), and wherein the first direction is substantially opposite the second direction.

#### Patentansprüche

1. Eine Vorrichtung zur Betätigung eines Fahrradgetriebebeschaltgeräts (200), die eine Betätigungskomponente (204) aufweist, die angepasst ist, an einem Fahrrad in nächster Nähe einer Bremsbetätigungseinheit (208) des Fahrrads montiert zu werden, um abwechselnd ein Getriebeelement (28) anzuziehen und zu lösen, bestehend aus:

einem ersten Hebel (212), der an der Betätigungskomponente (204) zur Bewegung in einer ersten Ebene montiert ist, die bewirkt, dass die Betätigungskomponente (204) das Getriebeelement (28) anzieht;

einem zweiten Hebel (216), der an der Betätigungskomponente (204) zur von dem ersten Hebel (212) unabhängigen Bewegung in einer zweiten Ebene, die parallel zu und mit Abstand von der ersten Ebene angeordnet ist, montiert

ist, die bewirkt, dass die Betätigungskomponente (204) das Getriebeelement (28) löst; und wobei

der erste Hebel (212) und der zweite Hebel (216) an der Betätigungskomponente (204) montiert sind, so dass das Schaltgerät (200) in einer Weise an dem Fahrrad montiert werden kann, dass die Bremsbetätigungseinheit (208) zwischen dem ersten und dem zweiten Hebel angeordnet ist.

2. Vorrichtung gemäß Anspruch 1, wobei der erste Hebel (212) und der zweite Hebel (216) an der Betätigungskomponente (204) montiert sind, so dass das Schaltgerät (200) in einer Weise an dem Fahrrad montiert werden kann, dass eine Halterung (220) der Bremsbetätigungseinheit (208) zwischen dem ersten und dem zweiten Hebel angeordnet ist.
3. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei der erste Hebel (212) und der zweite Hebel (216) an der Betätigungskomponente (204) montiert sind, so dass das Schaltgerät (200) in einer Weise an dem Fahrrad montiert werden kann, dass ein Betätigungshebel (224) der Bremsbetätigungseinheit (208) zwischen dem ersten und dem zweiten Hebel angeordnet ist.
4. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei der erste Hebel (212) an der Betätigungskomponente (204) montiert ist, so dass eine Bewegung des ersten Hebels (212) in einer ersten Richtung bewirkt, dass die Betätigungskomponente (204) das Getriebeelement (28) anzieht, wobei der zweite Hebel (216) an der Betätigungskomponente (204) montiert ist, so dass eine Bewegung des zweiten Hebels (216) in einer zweiten Richtung bewirkt, dass die Betätigungskomponente (204) das Getriebeelement (28) löst, und wobei die erste Richtung der zweiten Richtung im Wesentlichen entgegengesetzt ist.

#### Revendications

1. Un appareil pour actionner un dispositif de changement de vitesse à transmission pour bicyclette (200) ayant un composant d'actionnement (204) adapté pour pouvoir être monté sur une bicyclette à proximité immédiate d'un bloc d'actionnement de frein (208) de la bicyclette et destiné à tirer et à relâcher, alternativement, un élément de transmission (28) comprenant :

un premier levier (212) monté sur le composant d'actionnement (204) pour effectuer un déplacement dans un premier plan, lequel amène le

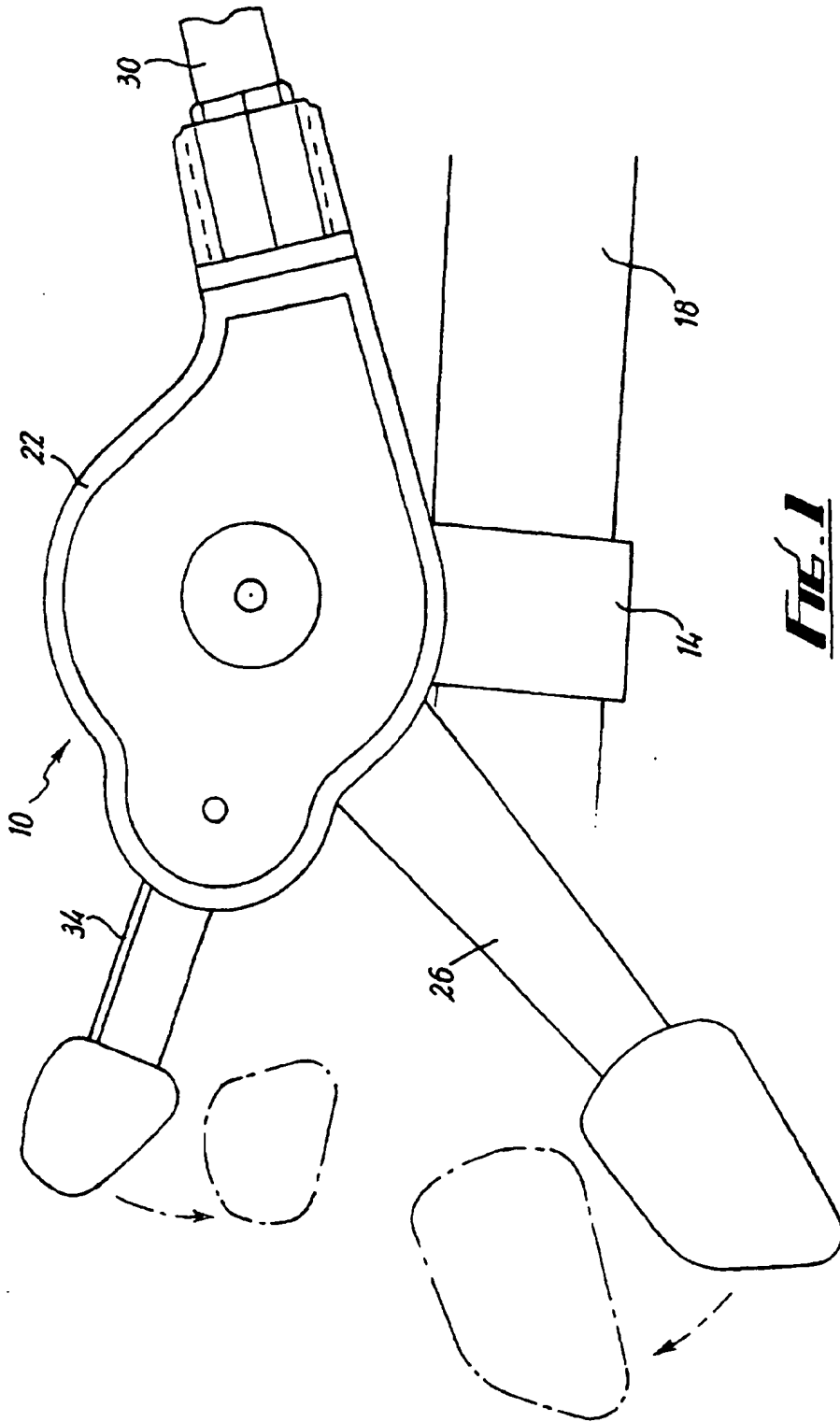
composant d'actionnement (204) à tirer l'élément de transmission (28) ;

un deuxième levier (216) monté sur le composant d'actionnement (204) pour effectuer un déplacement, indépendamment du premier levier (212), dans un deuxième plan parallèle audit premier plan et espacé de celui-ci, lequel amène le composant d'actionnement (204) à relâcher l'élément de transmission (28) ; et dans lequel

le premier levier (212) et le deuxième levier (216) sont montés sur le composant d'actionnement (204) de sorte que le dispositif de changement de vitesse (200) puisse être monté sur la bicyclette d'une manière telle que le bloc d'actionnement de frein (208) soit disposé entre le premier et le deuxième levier.

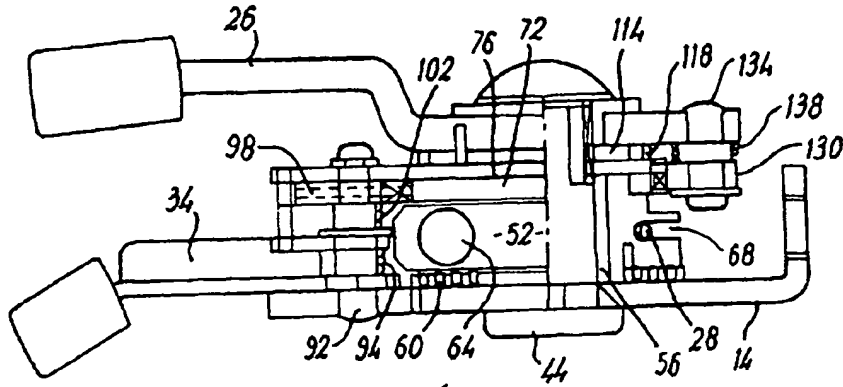
2. L'appareil selon la revendication 1 dans lequel le premier levier (212) et le deuxième levier (216) sont montés sur le composant d'actionnement (204) de sorte que le dispositif de changement de vitesse (200) puisse être monté sur la bicyclette d'une manière telle qu'une patte d'attache de montage (220) du bloc d'actionnement de frein (208) soit disposée entre le premier et le deuxième levier.
3. L'appareil selon l'une ou l'autre des revendications précédentes dans lequel le premier levier (212) et le deuxième levier (216) sont montés sur le composant d'actionnement (204) de sorte que le dispositif de changement de vitesse (200) puisse être monté sur la bicyclette d'une manière telle qu'une manette d'actionnement (224) du bloc d'actionnement de frein (208) soit disposée entre le premier et le deuxième levier.
4. L'appareil selon n'importe quelle revendication précédente dans lequel le premier levier (212) est monté sur le composant d'actionnement (204) de sorte que le déplacement du premier levier (212) dans un premier sens amène le composant d'actionnement (204) à tirer l'élément de transmission (28), dans lequel le deuxième levier (216) est monté sur le composant d'actionnement (204) de sorte que le déplacement du deuxième levier (216) dans un deuxième sens amène le composant d'actionnement (204) à relâcher l'élément de transmission (28) et dans lequel le premier sens est sensiblement opposé au deuxième sens.

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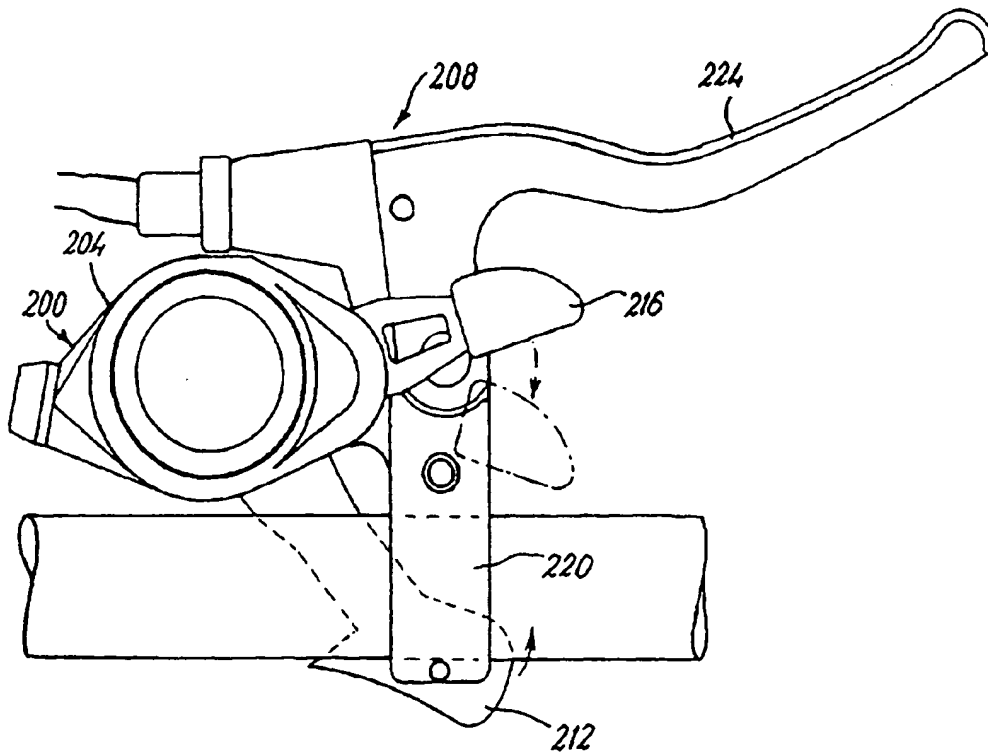


**FIG. 1**

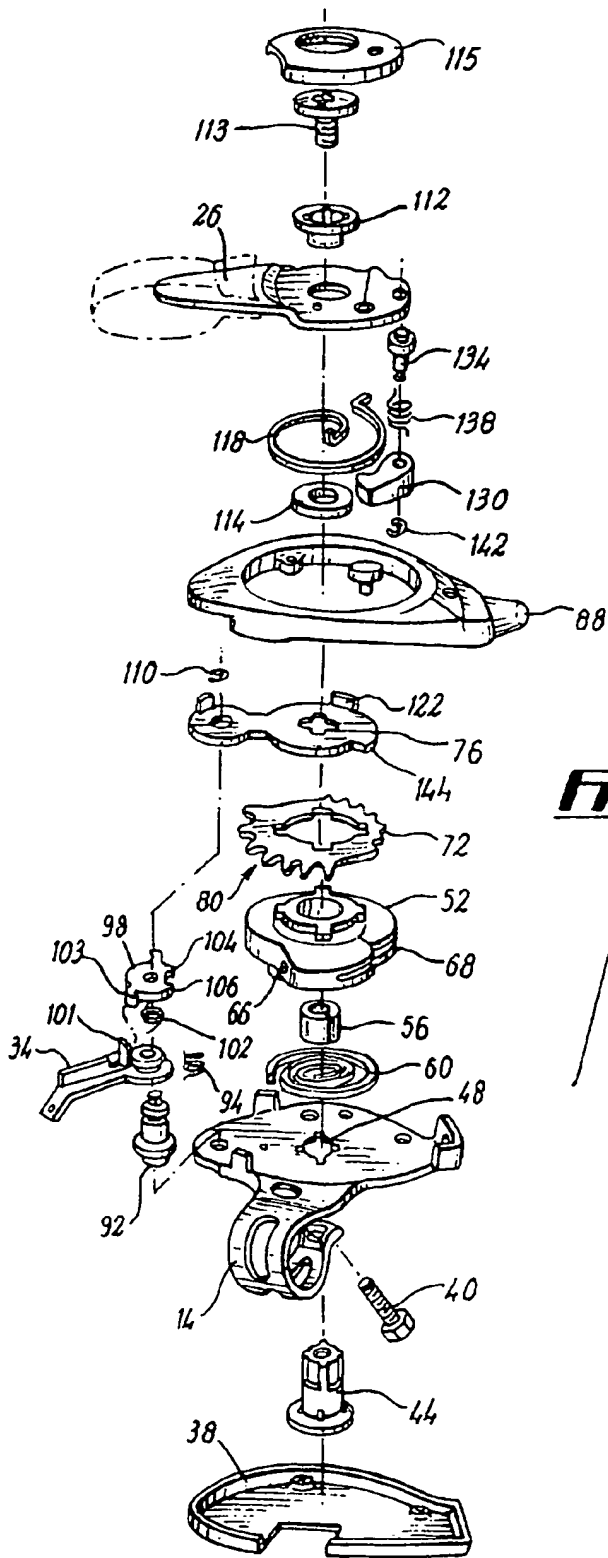




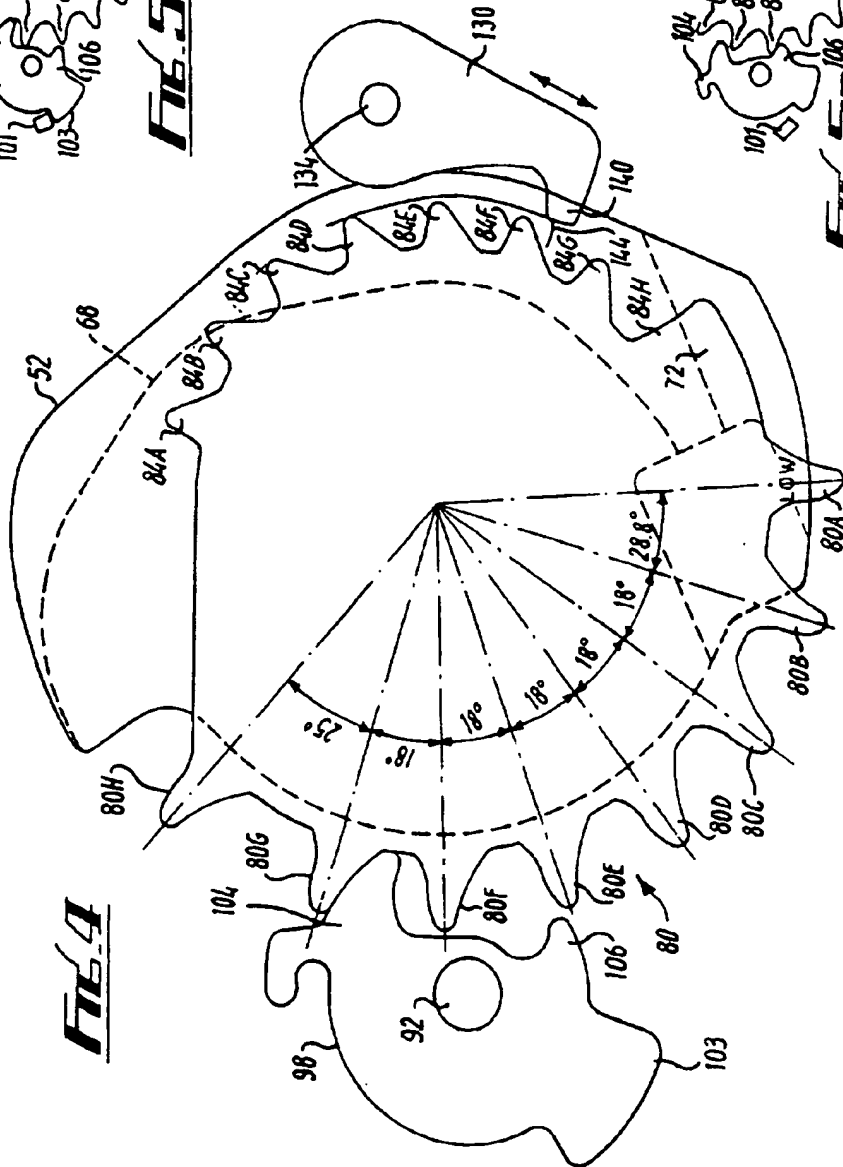
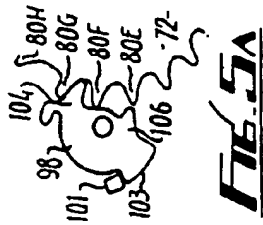
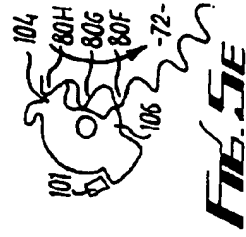
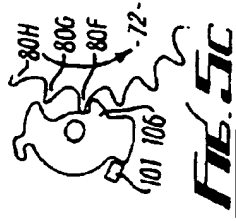
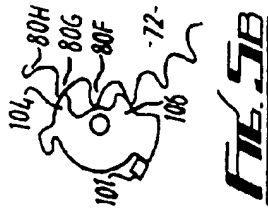
**FIG. 2**

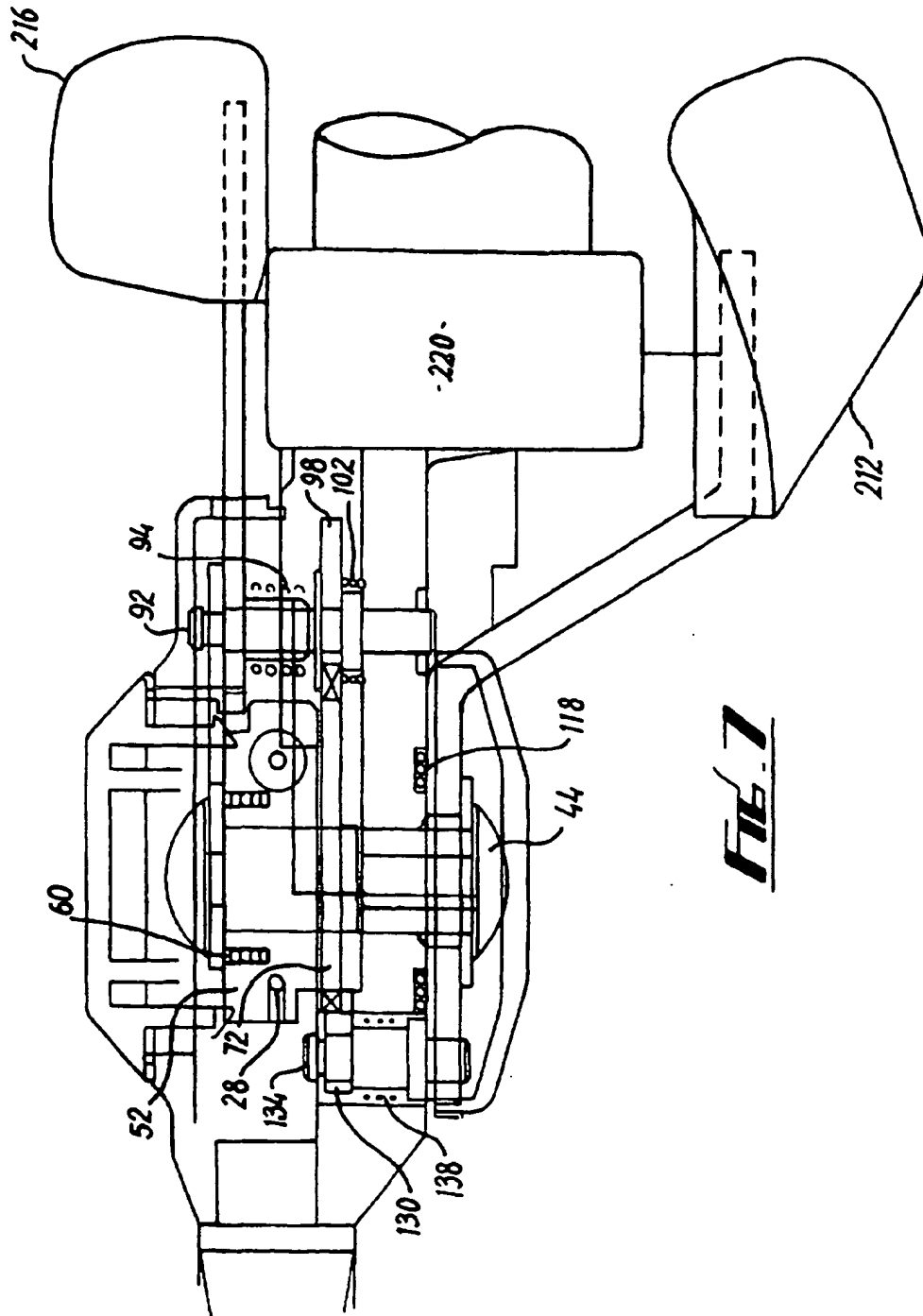


**FIG. 6**



**FIG. 3**





**FIG. 7**