Title: CONTINUOUSLY VARIABLE TRANSMISSION WITH EASILY CHANGEABLE TRANSMISSION RATIO

Abstract: A CVT 1 has a first in-output shaft (3) with a first wheel (5) attached to it, that is constituted by a pulley (5) consisting of two conical sheaves (7) and (9) and a second in/output shaft (11) with a second wheel (13) attached to it, which is constituted by a gear. The CVT 1 furthermore has transmission means (15) constituted by an intermediate shaft (17) with a third and fourth wheel (19,21) attached to it, being a further pulley (19) and a further gear (21) that meshes with gear (13), as well as a pushbelt (27) that is wrapped around the pulleys (5) and (19). For changing the transmission ratio the CVT 1 has displacement means (29) that can move the intermediate shaft (17) along a circular arc, arrow (33), changing the distance between the shafts (3) and (17). For moving the shaft (17) it is connected to the shaft (11) through connection means (35). This connection means (35) is connected to the displacement means (29), which can for instance be of the electromechanical type.

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Continuous variable transmission with easily changeable transmission ratio

DESCRIPTION:

Field of the invention.

The invention relates to a continuously variable transmission comprising a first in-/output shaft with a first wheel attached to it, a second in-/output shaft with a second wheel attached to it, transmission means, that interact with the first and second wheel and transmit torque from one wheel to the other, and displacement means for moving one or more parts of the transmission means and/or parts of one or both wheels, for controlling the transmission ratio between the first and second wheel and/or for controlling the contact force between interacting parts of the transmission means and/or the wheels.

The wheel can be embodied as a gear, a friction wheel, a pulley or a conical wheel. A conical wheel is defined as a wheel of which the side surfaces at least partly have a conical shape. A pulley can be a sheave-shaped pulley or a ring-shaped pulley. A sheave-shaped pulley is defined as a wheel with a V-shaped circumferential groove, and a ring-shaped pulley is defined as a bus with a V-shaped groove in the inner wall. In case of a sheave-shaped pulley, it consists of two conical sheaves, one or both of which can be axially moveable. The sheave sides that face each other can have a positive angle, in which case they diverge from the shaft outward, or a negative angle, in which case they converge from the shaft outward. In case of a ring-shaped pulley, it can consist of a conical ring and a conical sheave or of two conical rings, where the sheave sides facing each other can have a positive or a negative angle, and where one or both rings can be axially moveable.

The shafts in the continuously variable transmission according to the invention are preferably parallel.

Technical state-of-the-art.

A similar continuously variable transmission (CVT) is generally known. In this known CVT both wheels are embodied as sheave-shaped pulleys, where the axial
distance between the sheaves is adjustable, and where the center distance of the pulleys remains constant. The transmission means in the known CVT are embodied as a pushbelt. This is a flexible steel belt that can be loaded by pull as well as push forces. The transmission ratio in the known CVT can be adjusted by increasing the axial distance between the pulleys at one shaft and decreasing the axial distance between the pulleys at the other shaft, which causes the pushbelt to run at a smaller or larger radius, respectively. Because of the small angle of the conical sheaves, a relatively large force is needed to move the sheaves towards each other, in order to move the pushbelt that is under tension towards a larger radius. To exert this large force, usually a hydraulic cylinder is used. This requires a relatively expensive hydraulic system. Instead of a hydraulic adjustment of the axial distance between the sheaves, also electromechanical adjustment systems are known. In that case, the required relatively large force is applied via a thrust bearing, causing high losses.

Summary of the invention.

An objective of the invention is to provide a CVT as described in the introduction where the means for adjusting the transmission ratio between the shafts are embodied in a less complex manner and can be controlled more easily than in the known CVT, where the losses are lower and where higher torques can be transmitted. To this end, the CVT according to the invention is characterized in that the continuously variable transmission comprises an intermediate shaft, and that the displacement means can move at least the intermediate shaft in a direction away from or towards at least one of the shafts. The intermediate shaft in the CVT according to the invention is preferably parallel to the shafts and can be moved in a direction perpendicular to the shafts. By moving the intermediate shaft the transmission ratio is adjusted. For instance, in case the transmission means comprise a belt that is wrapped around one of the wheels and a further wheel that is located on the intermediate shaft, the running radius of the belt on at least one of the wheels embodied as pulleys, changes when moving the intermediate shaft. By increasing the center distance between the shafts, and simultaneously maintaining the distance between the sheaves of one of the pulleys, for instance, the belt pushes the sheaves of the other pulley apart, for instance against a spring force.

Since the force transmission is directed opposite to that of the known CVT
(the belt forces the sheaves to move away from or towards each other, instead of the sheaves forcing the belt to move to a different radius), a relatively small force is required to separate the sheaves, due to the relatively small angle between the sheaves. Therefore, a lighter hydraulic system than used in the known CVT suffices, or cheaper and more efficient electromechanical displacement means can be applied. The CVT according to the invention is not limited to the use of flexible pull- and/or pushbelts, but can also be equipped with rigid transmission elements that are easier to manufacture. This is especially due to the fact that the actuation can now be applied from the fixed world instead of from a rotating pulley shaft.

One embodiment of the CVT according to the invention is characterized in that the intermediate shaft is part of the transmission means and that the transmission means furthermore comprise a third and a fourth wheel that interact with the first and second wheel respectively.

An embodiment of the CVT where the intermediate shaft is part of the transmission means is characterized in that the displacement means can move the intermediate shaft away from and towards one of the shafts, where the center distance between the intermediate shaft and the other shaft remains constant.

A practically advantageous embodiment is characterized in that the displacement means move the intermediate shaft along a circular arc with its center in the second shaft and a radius that is equal to the distance between the second shaft and the intermediate shaft.

The second and fourth wheel can for instance be contacting friction wheels or chain wheels that interact via a chain wrapped around those wheels. Preferably however, the second wheel is constituted by a first gear, and the fourth wheel is constituted by a second gear that meshes with the first gear.

In order to increase the ratio coverage of the aforementioned embodiment, a further embodiment is characterized in that the first gear can be disconnected from the second shaft, furthermore a third gear is located on and can be connected to the second shaft, the first shaft consists of two shaft parts which are connected through a clutch, where at one of the shaft parts a fourth gear is located that meshes with the third gear, and where at the other shaft part a fifth gear is located which can be connected to the shaft part, which meshes with the first gear.
An embodiment of the CVT where the displacement means can move the intermediate shaft away from and towards one of the shafts and where the distance between the intermediate shaft and the other shaft remains constant, is characterized in that the first and third wheel are embodied as pulleys, and that the transmission means furthermore comprise a belt or ring that is wrapped around both pulleys or is located between both pulleys, where at least one of the pulleys comprises at least one axially moveable sheave. Here, a belt is defined as an endless flexible element, that can for instance be embodied as a pushbelt, a belt or a chain. A ring is here defined as a rigid transmission element.

In order to transmit higher torques or to enable smaller or lighter belts and pulleys, yet a further embodiment is characterized in that at the first shaft a fifth wheel constituted by a pulley is located, and that the transmission means furthermore comprise a sixth wheel constituted by a pulley that is located at the intermediate shaft, as well as a belt that is wrapped around the fifth and sixth wheel, where at least one of the pulleys comprises at least one axially moveable sheave.

A further advantageous embodiment of the previous embodiment which enables a larger ratio coverage, is characterized in that the intermediate shaft is divided in two shaft parts, where the third and fourth wheel are located on a first of the shaft parts, and the sixth and a seventh wheel are located on the second shaft part, that the seventh wheel interacts with an eighth wheel that is located on a third in-/output shaft, where the displacement means move the first and second shaft parts along circular arcs with their centers in the second and third shaft, respectively, and radii that equal the distance between the second shaft and the first shaft part and the third shaft and the second shaft part, respectively, and where the continuously variable transmission furthermore comprises an epicyclic gearing with three rotational members, a first of which is connected to the second shaft, a second of which is connected to the third shaft and a third of which is connected to a fourth in-/output shaft.

Preferably, the pulleys that constitute the first and fifth wheel comprise a common axially moveable sheave.

Another embodiment of the CVT where the displacement means can move the intermediate shaft away from and towards one of the shaft and where the distance between the intermediate shaft and the other shaft remains constant, is characterized in that the first wheel is constituted by a ring-shaped pulley and the third wheel by a conical wheel.
Another embodiment of the CVT where the intermediate shaft is part of the transmission means is characterized in that the displacement means can move the intermediate shaft away from one of the shafts and towards the other shaft.

A practically advantageous embodiment hereof is characterized in that the first, second, third and fourth wheel are embodied as pulleys, and the transmission means furthermore comprise two belts one of which is present around the first and third wheel and the other around the second and fourth wheel, where at least one sheave of the pulleys is axially moveable.

Another practically advantageous embodiment hereof is characterized in that the first and second wheel are embodied as conical wheels and the third and fourth wheel are embodied as ring-shaped pulleys, in which the conical wheels are located, and where at least one of the rings of the ring-shaped pulleys is axially moveable. In this embodiment the intermediate shaft is embodied as a bus.

Also in this case, the third and fourth wheel preferably comprise a common axially moveable sheave or ring.

Yet another further embodiment hereof is characterized in that the displacement means furthermore can move the intermediate shaft away from both shafts or towards both shafts in order to control the contact force between interacting pulleys and belts or interacting pulleys and conical wheels.

Another embodiment for realizing the clamping force between pulleys and belts is characterized in that the axially moveable sheave(s) or ring(s) of the pulleys can be moved against a spring force, where the spring force decreases as the distance between the sheaves or rings increases.

Yet another further embodiment for realizing the clamping force between pulleys and belts is characterized in that of each pulley that has an axially moveable sheave or ring the other sheave or ring is axially fixed to the shaft, where the moveable sheave or ring is located between the fixed sheave or ring and a further fixed sheave or ring, and that the continuously variable transmission comprises a further conical wheel, which is located between the moveable sheave or ring and the further fixed sheave or ring, where the displacement means can move the conical wheel away from or towards the shaft or bus on which the sheaves or in which the rings are located.
In this case the fixed sheaves are conical at one side, while the moveable sheave is conical at both sides. Here, all conical sides of the sheaves can have a positive angle in which case the ring extends beyond the sheave circumference. Preferably however, the conical side of the further fixed sheave or ring has a negative angle, and the side of the moveable sheave or ring that faces the aforementioned side also has a negative angle, where the conical wheel is located within the circumference of the sheaves or rings.

Another embodiment of the CVT according to the invention is characterized in that both the first and the second wheel are constituted by a pulley that has an axially fixed and an axially moveable sheave, where each axially moveable sheave is located between the fixed sheave and a further fixed sheave on the shaft, the transmission means are constituted by a belt that is wrapped around both pulleys, the continuously variable transmission furthermore comprises two rings with conical surfaces at both sides, where one of the rings is located between each moveable sheave and further fixed sheave, and the continuously variable transmission furthermore comprises a further wheel that is located at the intermediate shaft, that is in contact with both rings in radial direction, where the displacement means can move the intermediate shaft away from one of the shafts and towards the other shaft for changing the transmission ratio.

A beneficial embodiment hereof is characterized in that the displacement means can furthermore move the intermediate shaft away from or towards both shafts, for controlling the clamping force between pulleys and belt.

**Brief description of the drawings.**

In the following, the invention is further elucidated by drawings depicting several examples of embodiments of the CVT according to the invention.

Figure 1 depicts a top view of a first embodiment of the CVT according to the invention;

Figure 2 depicts a front view of the first embodiment of the CVT;

Figure 3 depicts a side view of the first embodiment of the CVT;

Figure 4 depicts the first embodiment of the CVT with adjusted gear ratio;

Figure 5 depicts a top view of a second embodiment of the CVT according to the invention.
Figure 6 depicts a front view of the second embodiment of the CVT; Figure 7 depicts a top view of a third embodiment of the CVT according to the invention; Figure 8 depicts a front view of a fourth embodiment of the CVT according to the invention; Figure 9 depicts a front view of a fifth embodiment of the CVT according to the invention; Figure 10 depicts a side view of the fifth embodiment of the CVT; Figure 11 depicts a front view of a sixth embodiment of the CVT according to the invention; Figure 12 depicts a front view of a seventh embodiment of the CVT according to the invention; Figure 13 depicts a front view of an eighth embodiment of the CVT according to the invention; Figure 14 depicts a front view of a ninth embodiment of the CVT according to the invention; and Figure 15 depicts a front view of an embodiment with a dual parallel belt that can be applied instead of the single belt in the previous embodiments.

**Detailed description of the drawings.**

In figures 1, 2 and 3 a first embodiment of the CVT according to the invention is depicted in top view, front view and side view, respectively. The CVT 1 has a first in-/output shaft 3 with a first wheel 5 attached to it, that is constituted by a pulley 5 consisting of two conical sheaves 7 and 9 and a second in-/output shaft 11 with a second wheel 13 attached to it, which is constituted by a gear. The CVT 1 furthermore has transmission means 15 constituted by an intermediate shaft 17 with a third and fourth wheel 19, 21 attached to it, being a further pulley 19 consisting of two conical sheaves 23 and 25 and a further gear 21 that meshes with gear 13, as well as a belt 27, constituted by a commonly known pull- or pushbelt, that is wrapped around the pulleys 5 and 19.

The conical sheaves 7, 9 and 23, 25 are tangentially fixed to the shafts 3 and 17, for instance by key ways in case the conical sheave needs to be axially moveable with
respect to the shaft. Sheave 9 of pulley 5 is fixed to shaft 3 and sheave 7 of pulley 5 is axially moveable. The sheaves 23 and 25 in this embodiment are fixed to each other causing the axial distance between these sheaves to be fixed.

For changing the transmission ratio the CVT 1 has displacement means 29 that can move the intermediate shaft 17 in radial direction (arrow 31), enabling the distance between the shafts 3 and 17 to be changed.

In order to fixate the positions of the in-/output shafts 3, 11 of the CVT, the intermediate shaft 17 with gear 21 is moveable along a circular arc (arrow 33, see figure 2) around the in-/output shaft 11.

For moving the shaft 17 it is connected to the shaft 11 through connection means 35. One of the connection means 35 is connected to the displacement means 29, which can for instance be of the electromechanical type and constituted by a spindle.

The pulley 19 is axially moveable by means of a displacement mechanism 37, constituted by a bus 39 that can be rotated around the intermediate shaft 17, which bus is axially connected to the pulley 19. The pulley 19 can rotate freely with regard to the bus 39. The bus 39 has a groove 41 in which a pin 43 that is attached to the fixed world (such as the transmission housing) is located. When moving the intermediate shaft 17 in the direction of arrow 45, see figure 4, the bus 39 and consequently also the pulley 19 will move axially along the intermediate shaft 17 in the direction of arrow 47. Figure 4 depicts the same view of the CVT 1 as figure 1 with the difference that the CVT 1 is depicted in a position where the transmission ratio is adjusted (solid lines). The position from figure 1 is depicted by dashed lines. Corresponding to this displacement of the intermediate shaft 17 in the direction of arrow 45 the belt 27 will push the sheave pair 7,9 of pulley 5 apart, during which sheave 7 moves in the direction of arrow 49 against a spring force, for instance. The pulley 19 must then move a certain distance such that the belt 27 remains perpendicular to the shafts 3 and 17. This is achieved by giving the groove 41 (that is schematically depicted here as a straight groove) a shape appropriate for this purpose, causing the pulley 19 to move either as a function of the distance between the sheaves 7 and 9, or as a function of the radial distance between the shafts 3 and 17. The displacement means 29 can move the intermediate shaft 17 such that the distance between the intermediate shaft 17 and the first in-/output shaft 3 is increased or decreased and the distance between the intermediate shaft 17 and the second in-/output shaft 11 remains
unchanged.

The mentioned spring force against which the sheave 7 is moved, is provided by a number of springs 51 that are at an angle with respect to shaft 3, which springs are attached to the moveable sheave 7 at one end, and to a sheave 53 attached to the shaft 3, at the other end. This causes the spring force to decrease as the distance between the sheaves 7 and 9 increases. Of course, the force may also be applied alternatively.

In the figures 5 and 6 a second embodiment of the CVT according to the invention is depicted in top view and front view, respectively. This CVT 61 again has a first and a second in-/output shaft 63, 65 with a first and second wheel 67 and 69, respectively, attached to it, which in this case are constituted by pulleys, where both pulleys have fixed sheaves. The transmission means 71 are constituted by an intermediate shaft 73 with a third and fourth wheel 75, 77, attached to it, which are also embodied as pulleys, in this case however with axially moveable sheaves, as well as two belts 79, 81 which are wrapped around pulleys 67, 75 and 69, 77, respectively.

Also in this CVT 61 the displacement means 83 are constituted by as spindle. As an alternative, the displacement means 83 may also be constituted by a hydraulic cylinder, the pressure of which can be controlled electronically. This is connected to the intermediate shaft 73 and it can move this intermediate shaft in a guidance 85 in the directions of double arrow 87 (although depicted here as a straight arrow, it may also be curved). With solid and dashed lines, the pulleys 75 and 77 are depicted in two different positions where the CVT 61 has different transmission ratios. The displacement means 83 can thus move the intermediate shaft 73 away from one of the in-/output shafts 63, 65 and towards the other in-/output shaft 65, 63.

The displacement mechanisms to move the pulleys 75, 77 axially are not depicted here for clarity, but these can be similar to the displacement means of the first embodiment. All axially moving parts are located on the intermediate shaft 73 here. Of course, this can also be the other way around.

The displacement means 83 can furthermore move the intermediate shaft 73 away from or towards both shafts. This way, the clamping force between the pulleys 67, 69, 75, 77 and the belts 79, 81 can be controlled. This is realized by allowing the displacement means 83 to move in the directions of double arrow 89.

Figure 7 depicts a simplified top view of a third embodiment of the CVT
according to the invention. This CVT 91 also has a first and a second in-/output shaft 93, 95 with a first and second wheel 97 and 99, respectively, attached to it, which are constituted by pulleys. The transmission means 101 are again constituted by an intermediate shaft 103 with a third and fourth wheel 5 and 7, respectively, attached to it, which are also constituted by pulleys, as well as two pushbelts 109, 111 which are wrapped around pulleys 97, 105 and 99, 107, respectively.

The axial distance between the sheaves of the pulleys 99 and 105 are adjustable. These pulleys 99 and 105 are not both located on the intermediate shaft 103, as in the second embodiment. This creates an advantageous transmission ratio (low torques to be transmitted and low speeds of the pushbelts). The fixed in-/output shafts 93 and 95 can be in line in this case.

Figure 8 depicts a front view of a fourth embodiment of the CVT according to the invention. The CVT 121 again has a first and a second in-/output shaft 123, 125 with a first and second wheel 127 and 129, respectively, attached to it, which are constituted by a pulley and gear, respectively.

In this case however, the transmission means 131 comprise an intermediate shaft consisting of to shaft parts 133, 135, where a third wheel 137 embodied as a pulley is located on a first shaft part 133 and interacts with the first wheel 127, as well as a fourth wheel 139 embodied as a gear, that meshes with the second wheel 129. At the first shaft 123, a fifth wheel 141 embodied as a pulley is furthermore located and interacts with a sixth wheel 143 embodied as a pulley that is located at the second shaft part 135. At the second shaft part 135, a seventh wheel 145 embodied as a gear is located and interacts with an eighth wheel 147 embodied as a gear and located on a third in-/output shaft 149.

The pulleys 127 and 141 located on the first shaft 123 each have a fixed sheave 151, 153 and a common axially moveable sheave 155. The transmission means 131 furthermore comprise two pushbelts 157 and 159 which are wrapped around the first and third wheel 127, 137 and the fifth and sixth wheel 141, 143, respectively.

This CVT 121 also has displacement means (not depicted) which move the intermediate shafts 133 and 135 along circular arcs with their centers in the second and third shaft 125 and 149, respectively, and radii which are equal to the distance between the second shaft 125, and the first shaft part 133 and the third shaft 149 and the second shaft part 135, respectively. This CVT 121 furthermore comprises an epicyclic gearing 161 with
three rotational members 163, 165, 167, a first rotational member 163 of which is connected to the second shaft 125, a second rotational member 165 is connected to the third shaft 149 and a third rotational member 167 is connected to a fourth in-/output shaft 169.

In this embodiment the epicyclic gearing can also be omitted, where the wheels 129 and 147 can be connected to the shaft 149 which then constitutes the in-/output shaft. In this alternative embodiment the torque is transmitted through one of the belts and by moving the other intermediate shafts in radial direction the transmission ratio and/or the clamping force between the pulleys and the belts can be controlled.

Figures 9 and 10 depict a fifth embodiment of the CVT according to the invention, in front and side view, respectively. In order to increase the ratio coverage, further gears are located on the first and second in-/output shafts which gears can be connected to those shafts. This is elucidated in the following.

This CVT 171 again has a first in-/output shaft 173 with a first wheel 175 embodied as a pulley attached to it, and a second in-/output shaft 177 with a second wheel 179 embodied by a first gear attached to it. The CVT 171 furthermore has transmission means 181, which comprise an intermediate shaft 183, with a third wheel 185 embodied as a further pulley attached to it, which interacts with the first wheel 175, as well as a fourth wheel 187 embodied as a second gear, that meshes with the second wheel 179. The transmission means 181 furthermore comprise a belt 189 that is wrapped around the pulleys 175 and 185.

The first gear 179 is located on the second shaft 177, has rotational freedom, and can be connected to this shaft by a first clutch 191. The second shaft 177 furthermore has a third gear 193 attached to it, which can be connected to the second shaft by a second clutch 195.

The first shaft 173 consists of first and second shaft parts 199 and 201, which are connected by a third clutch 197. On the first shaft part 199 a fourth gear 203 is located that meshes with the third gear 193, and on the second shaft part 201 a fifth gear 205 is located, which can be connected to this shaft part through a fourth clutch 207 and meshes with the second wheel that is embodied as first gear 179.

By closing the first and third clutch 191 and 197 and opening the second and fourth clutch 195 and 207, the same situation as in the first embodiment depicted in figures 1-3 is obtained. The torque transmission is then directed along arrow 209.
By closing the second and fourth clutch 195 and 207 and opening the first and third clutch 191 and 197, a different situation is obtained. The torque transmission is now directed along arrow 211, and a different ratio coverage is obtained than previously.

The displacement means in this CVT 171 can furthermore control the clamping force between the pulleys 175 and 185 and the pushbelt 189. To this end, the CVT 171 has a ring 213 which can be moved by the displacement means away from and towards the first shaft 173.

The pulley 175 on the first shaft 173 has a fixed sheave 215 and an axially moveable sheave 217. Furthermore, a further fixed sheave 219 is located on the first shaft 173 at the other side of the moveable sheave 217. The moveable sheave 217 has conical surfaces on both sides. The ring 213 is located between the moveable sheave 217 and the further fixed sheave 219. By moving the ring 213 away from or towards the shaft 173 the moveable sheave 217 is presses more, respectively, less firm against the belt 189. The ring 213 may also be located at the other side of the shaft 173 (depicted by a dashed line) or around the entire circumference of the shaft.

Figure 11 depicts a front view of a sixth embodiment of the CVT according to the invention. This CVT 221 is equal to the one in the fifth embodiment, with the difference that the conical side 223 of the further fixed sheave 225 and the side 227 of the moveable sheave 229 that faces the side 223 both have a negative angle, and that the ring 231 is located within the circumference of the sheaves 223 and 229. The ring 231 is here supported by an arm 233 which can be moved by the displacement means in the directions of arrow 235.

Figure 12 depicts a front view of a seventh embodiment of the CVT according to the invention. In this case the transmission ratio is not changed by moving an intermediate shaft on which one of the pulleys is located around which the belt is wrapped, but by moving an intermediate shaft that is in contact with rings.

The CVT 241 again has a first and second in/output shaft 243 and 245 on which a first and second wheel 247, 249 both embodied as pulleys are located. Both pulleys 247, 249 have an axially fixed sheave 251, 253 and an axially moveable sheave 255, 257. The transmission means are again embodied by a belt 259, that is wrapped around both pulleys.

Furthermore, on each shaft a further fixed sheave 261, 263 is located where
rings 265, 267 are located between these sheaves and the moveable sheaves 255, 257 which are equipped with conical surfaces on both sides.

The CVT 241 furthermore has an intermediate shaft 269 with a further wheel 271 attached to it, which is in contact with both rings 265, 267 in radial direction. The displacement means for changing the transmission ratio can move the intermediate shaft 269 in the directions of the arrow 273 away from one of the shafts and towards the other shaft.

The displacement means can furthermore control the clamping force between the pulleys 251, 253 and the belt 259. To this end, the displacement means can move the intermediate shaft 269 away from and towards both shafts. This is indicated with arrows 275 perpendicular to the drawing plane. When moving the intermediate shaft 269 downwards in figure 12 (the intermediate shaft is here located above-when looking at the drawing-the centerlines of the rings), the wheel 271 located on the intermediate shaft pushes both rings 265, 267 outwards, thus increasing the clamping force between the sheaves 251-257 and the pushbelt 259, whereas when moving the intermediate shaft 269 upwards in figure 12, both the rings 265, 267 move inwards, thus decreasing the clamping force between the sheaves 251-257 and the pushbelt 259.

As such, moving the intermediate shaft 269 in the directions of arrow 273 changes the transmission ratio, whereas moving the intermediate shaft 269 in the directions of arrow 275 changes the clamping force between the pulleys 247 and 249 and the pushbelt 259.

Figure 13 depicts a front view of an eighth embodiment of the CVT according to the invention. This CVT 281 again has two in-/output shafts 283, 285 on which a first and second wheel 287, 289 are located. The first wheel is embodied as a ring-shaped pulley consisting of a conical sheave 291 that is mounted in a bus 293 and a conical ring 295 that is axially moveable inside the bus. The surfaces 297 and 299 of the sheave 291 and the ring 295 which are facing each other have a negative angle. This CVT 281 also has transmission means 301 embodied by an intermediate shaft 303 with a third and fourth wheel 305, 307 attached to it. The third wheel 305 is embodied as a conical wheel (possibly a flexible conical wheel built up of segments that are loaded by push forces only) the side surfaces of which partly have a conical shape and are in contact with the surfaces 297 and 299 of the first wheel 287. The fourth wheel 307 is embodied as a further gear that meshes
with the second wheel 289.

The conical ring 295 is tangentially fixed in the bus 293, for instance by keys, and is axially moveable inside the bus 293. The ring 295 is pushed against the third wheel 305 by a spring (not depicted).

For changing the transmission ratio this CVT 281 also has displacement means (not depicted) which can move the intermediate shaft 303 in radial direction, which changes the distance between the shaft 283 and the intermediate shaft 303.

To guarantee the positions of the in-/output shafts 283 and 285 of the CVT to be fixed, the intermediate shaft 303 is again moveable along a circular arc around the in-/output shaft 285.

Finally, figure 14 depicts a front view of a ninth embodiment of the CVT according to the invention. In this CVT 311 both wheels 317, 319 located on the first and second in-/output shaft 313, 315, are embodied as conical wheels (possibly flexible conical wheels built up of segments that are loaded by push forces only). The transmission means 321 again comprise an intermediate shaft with two further wheels attached to it, however in this case the intermediate shaft is embodied as a bus 323 and the further wheels are embodied as ring-shaped pulleys 325, 327 that are located inside the bus. The ring-shaped pulleys each have a conical ring 329, 331 fixed inside the bus, as well as a common conical ring 333 that is axially moveable inside the bus.

This CVT 311 again has displacement means (not depicted) which can move the bus 323 away from one of the shafts and towards the other shaft (arrow 335) for controlling the transmission ratio. The displacement means can furthermore move the bus 323 away from or towards both shafts (double arrow 337) for controlling the contact force between the ring-shaped pulleys 325, 327 and the conical wheels 317, 319.

Figure 15 depicts a detail of an embodiment of the CVT 341 with dual parallel belts 343 that can be applied in all previous embodiments instead of the depicted single belt to enable higher torques to be transmitted. Two wheels embodied as pulleys 349, 351, 353, 355 are located on each shaft 345, 347. Here, the pulleys 349 and 351 on one of the shafts 345 comprise a common axially moveable sheave 357, whereas the other sheave 359 and 361, respectively, of one of the pulleys 349 is fixed and of the other pulley 351 is also axially moveable (this requires a hydraulic cylinder to clamp the assembly). At the other shaft 347 both pulleys 353 and 355 are fixed and mutually connected via a differential
363 (here embodied as a ball differential) in order to have an equal division of the torque between the two belts 343. This shaft 347 can be radially moved in the direction of arrow 365, to control either the transmission ratio or the clamping force between the pulleys and the belt.

Although above the invention has been elucidated using the drawings, it should be stated that the invention is in no way limited to the embodiments depicted in the drawings. The invention also extends to all embodiments that deviate from those depicted in the drawings, within the context defined by the appending claims.
CLAIMS:

1. Continuously variable transmission comprising:
   - a first in-/output shaft with a first wheel attached to it,
   - a second in-/output shaft with a second wheel attached to it,
   - transmission means, that interact with the first and second wheel and transmit torque from one wheel to the other, and
   - displacement means for moving one or more parts of the transmission means and/or parts of one or both wheels, for controlling the transmission ratio between the first and second wheel and/or for controlling the contact force between interacting parts of the transmission means and/or the wheels,

characterized in that
   - the continuously variable transmission comprises an intermediate shaft, and
   - the displacement means can move at least the intermediate shaft in a direction away from and towards at least one of the shafts.

2. Continuously variable transmission according to claim 1, characterized in that the intermediate shaft is part of the transmission means and that the transmission means furthermore comprise a third and a fourth wheel that interact with the first and second wheel respectively.

3. Continuously variable transmission according to claim 2, characterized in that the displacement means can move the intermediate shaft away from and towards one of the shafts, where the center distance between the intermediate shaft and the other shaft remains constant.

4. Continuously variable transmission according to claim 3, characterized in that the displacement means move the intermediate shaft along a circular arc with its center in the second shaft and a radius that is equal to the distance between the second shaft and the intermediate shaft.

5. Continuously variable transmission according to claim 4, characterized in that
   - the second wheel is constituted by a first gear, and
   - the fourth wheel is constituted by a second gear that meshes with the first gear.

6. Continuously variable transmission according to claim 5, characterized in that
- the first gear can be disconnected from the second shaft,
- furthermore a third gear is located on and can be connected to the second shaft,
- the first shaft consists of two shaft parts which are connected through a clutch, where:
  - at one of the shaft parts a fourth gear is located that meshes with the third gear, and
  - where at the other shaft part a fifth gear is located which can be connected to the shaft part, which meshes with the first gear.

7. Continuously variable transmission according to claim 4, 5 or 6, characterized in that:

- the first and third wheel are embodied as pulleys, and
- the transmission means furthermore comprise a belt or ring that is wrapped around both pulleys or is located between both pulleys, where at least one of the pulleys comprises at least one axially moveable sheave.

8. Continuously variable transmission according to claim 7, characterized in that:

- at the first shaft a fifth wheel constituted by a pulley is located, and
- the transmission means furthermore comprise a sixth wheel constituted by a pulley that is located at the intermediate shaft, as well as a further belt that is wrapped around the fifth and sixth wheel, where at least one of the pulleys comprises at least one axially moveable sheave.

9. Continuously variable transmission according to claim 8, characterized in that:

- the intermediate shaft is divided in two shaft parts, where the third and fourth wheel are located on a first of the shaft parts, and the sixth and seventh wheel are located on the second shaft part,
- that the seventh wheel interacts with an eighth wheel that is located on a third in-/output shaft,
- where the displacement means move the first and second shaft parts along circular arcs with their centers in the second and third shaft, respectively, and radii that equal the distance between the second shaft and the first shaft part and the third shaft and the second shaft part, respectively, and
- where the continuously variable transmission furthermore comprises an epicyclic
gearing with three rotational members, a first of which is connected to the second
shaft, a second of which is connected to the third shaft and a third of which is
connected to a fourth in-/output shaft.

10. Continuously variable transmission according to claim 8 or 9, characterized
in that the pulleys that constitute the first and fifth wheel comprise a common axially
moveable sheave.

11. Continuously variable transmission according to claim 4, 5 or 6, characterized in that the first wheel is constituted by a ring-shaped pulley and the third
wheel by a conical wheel.

12. Continuously variable transmission according to claim 2, characterized in
that the displacement means can move the intermediate shaft away from one of the shafts
and towards the other shaft.

13. Continuously variable transmission according to claim 12, characterized in
that:

15. - the first, second, third and fourth wheel are embodied as pulleys, and
- the transmission means furthermore comprise two belts one of which is present
around the first and third wheel and the other around the second and fourth wheel,
where at least one sheave of the pulleys is axially moveable.

14. Continuously variable transmission according to claim 12, characterized in
that the first and second wheel are embodied as conical wheels and the third and fourth
wheel are embodied as ring-shaped pulleys, in which the conical wheels are located, and
where at least one of the rings of the ring-shaped pulleys is axially moveable.

15. Continuously variable transmission according to claim 13 or 14, characterized in that the third and fourth wheel preferably comprise a common axially
moveable sheave or ring.

16. Continuously variable transmission according to claim 13, 14 or 15, characterized in that the displacement means furthermore can move the intermediate shaft
away from both shafts or towards both shafts in order to control the contact force between
interacting pulleys and belts or interacting pulleys and conical wheels.

17. Continuously variable transmission according to any of the preceding claims
7 to 16, characterized in that the axially moveable sheave(s) or ring(s) of the pulleys can
be moved against a spring force, where the spring force decreases as the distance between
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the sheaves or rings increases.

18. Continuously variable transmission according to any of the preceding claims 7 to 17, characterized in that:

- of each pulley that has an axially moveable sheave or ring the other sheave or ring
  is axially fixed to the shaft, where the moveable sheave or ring is located between
  the fixed sheave or ring and a further fixed sheave or ring, and

- that the continuously variable transmission comprises a further conical wheel,
  which is located between the moveable sheave or ring and the further fixed sheave
  or ring, where the displacement means can move the conical wheel away from or
  towards the shaft or bus on which the sheaves or in which the rings are located.

19. Continuously variable transmission according to claim 18, characterized in
that the conical side of the further fixed sheave or ring has a negative angle, and the side
of the moveable sheave or ring that faces the aforementioned side also has a negative angle,
where the conical wheel is located within the circumference of the sheaves or rings.

20. Continuously variable transmission according to claim 1, characterized in
that:

- both the first and the second wheel are constituted by a pulley that has an axially
  fixed and an axially moveable sheave, where each axially moveable sheave is
  located between the fixed sheave and a further fixed sheave on the shaft,

- the transmission means are constituted by a belt that is wrapped around both
  pulleys,

- the continuously variable transmission furthermore comprises two rings with
  conical surfaces at both sides, where one of the rings is located between each
  moveable sheave and further fixed sheave, and

- the continuously variable transmission furthermore comprises a further wheel that
  is located at the intermediate shaft, that is in contact with both rings in radial
  direction,

- where the displacement means can move the intermediate shaft away from one of
  the shafts and towards the other shaft for changing the transmission ratio.

21. Continuously variable transmission according to claim 20, characterized in
that the displacement means can furthermore move the intermediate shaft away from or
owards both shafts, for controlling the clamping force between pulleys and belt.