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CLUTCH ASSEMBLY

Abstract

A clutch assembly includes a first coupling assembly and a second coupling assembly. The first and second coupling assemblies have a common input member wherein the first coupling assembly couples/decouples the input member and a first output member, and the second coupling assembly couples/decouples the input member and a second output member. In the first position, the first coupling assembly decouples the input member and the first output member, and the second coupling assembly couples the input member and the second output member. In the second position, the first coupling assembly couples the input member and the first output member, and the second coupling assembly decouples the input member and the second output member.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a National Stage of International Application No. PCT/US2024/026302, filed Apr. 25, 2024, and claims the benefit of U.S. Provisional Application No. 63/461,866, filed on Apr. 25, 2023. The disclosures of the above applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention generally relates to a vehicle power train or drive system; and, more specifically, a drive system using a clutch assembly including a locking element for coupling and decoupling clutch members to control power flow or power transfer in a vehicle drive train.

2. Description of Related Art

[0003] In the field of automotive technology, vehicle powertrains or drive systems typically incorporate multiple clutch elements. Existing powertrains may be configured as concentric and parallel axis architectures. The powertrains often use electric motors and controllable or selectable coupling assemblies, such as one-way clutches. These coupling assemblies can be electromagnetically operated and magnetically controlled.

[0004] These one-way clutches often include first and second members and at least one locking element, for example, a strut, moving between a deployed position, wherein the strut extends from the first member and engages the second member, and a nondeployed position, wherein the strut does not extend from the first member. Whereby the first and second members are disengaged from each other.

[0005] Various types of selectable one-way clutches are known, including those using a selector plate, a solenoid, and a linear actuator. The foregoing are examples of one-way clutches that may be used in the clutch system disclosed herein. The foregoing are not exclusive; other selective or one-way clutches may be used and are known.

SUMMARY OF THE INVENTION

[0006] A clutch assembly for use with a vehicle drive system includes an input member, a first output member, and a second output member. A first coupling assembly selectively couples the input member to the first output member, and a second coupling assembly selectively couples the input member to the second output member. The assembly includes an actuation mechanism that moves between first and second positions. In the first position, the first coupling assembly decouples the input member and the first output member and couples the input member and the second output member. In the second position, the second coupling assembly decouples the input member and the second output member and couples the input member and the first output member.

[0007] Further areas of applicability of the present invention will become apparent from the detailed description provided. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0009] FIG. **1** is a sectional perspective view of a clutch assembly according to one example of the present invention.
[0010] FIG. **2** is a sectional side view of the clutch assembly of FIG. **1**
[0011] FIG. **3** is a perspective view of a component of the clutch assembly of FIG. **1**.
[0012] FIG. **4** is an enlarged perspective view of a part of the component of the clutch assembly of FIG. **3** shown in the area of circle **4**.
[0013] FIG. **5** is a perspective sectional view of a component of the clutch assembly of FIG. **1** taken from the right-hand side.
[0014] FIG. **6** is a perspective sectional view of a component of the clutch assembly of FIG. **1** taken from the left-hand side.
[0015] FIG. **7** is a perspective, partial sectional, exploded view of part of the clutch assembly of FIG. **1**.
[0016] FIGS. **8***a* and **8***b* are perspective views of a component of the clutch assembly of FIG. **1**.
[0017] FIGS. **9***a* and **9***b* are perspective views of another component of the clutch assembly of FIG. **1**.
[0018] FIGS. **10***a* and **10***b* are perspective views of still another component of the clutch assembly of FIG. **1**.
[0019] FIG. **11** is a sectional view of one aspect of the clutch assembly of FIG. **1** in the first position.
[0020] FIG. **12** is a sectional view of another aspect of the clutch assembly of FIG. **1** in the first position.
[0021] FIG. **13** is a sectional view showing the aspect of the clutch assembly of FIG. **11** in the second position.
[0022] FIG. **14** is a sectional view showing the aspect of the clutch assembly of FIG. **12** in the second position.
[0023] FIG. **15** is a schematic side view illustrating torque transmission and a power flow path through the clutch assembly of FIG. **1**.
[0024] FIG. **16** is a schematic side view illustrating torque transmission and another power flow path through the clutch assembly of FIG. **1**.
[0025] FIG. **17** is a schematic side view illustrating torque transmission and a further power flow path through the clutch assembly of FIG. **1**.
[0026] FIG. **18** is a schematic side view illustrating torque transmission and still another power flow through the clutch assembly of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or its uses.
[0028] FIGS. **1-4** illustrate a clutch assembly **10** in accordance with at least one embodiment of the present invention. The clutch assembly **10** functions as a torque transmitting mechanism that provides a mechanical engagement between mating parts. The clutch assembly **10** includes multiple one-way clutches. Examples of one-way clutches include, a include a passive one-way clutch and a selectable or controllable one-way clutch. A passive one-way clutch or passive strut assembly includes a passive or uncontrolled locking element, for example, a strut, disposed in the pocket of the pocket plate. A resilient member or spring continuously biases the strut outward of the pocket in the pocket plate; the strut is continuously deployed. The one-way clutch is passive because the strut is not controlled. A selectable or controllable one-way clutch is one wherein the state of the one-way clutch, activated or deactivated—deployed or nondeployed, can be selected or controlled. A selectable or controllable one-way clutch may also be referred to as an active one-way clutch. A selectable or controllable one-way clutch in a nondeployed condition allows overrun in both directions and functions like a passive one-way clutch when deployed. Hence, a selectable or controllable one-way clutch is active, the state of the locking element, deployed or nondeployed

can be controlled, and passive in that the locking element, when deployed can be overrun. In one example, the one-way clutches are dynamically controllable clutches. A dynamic controllable clutch refers to a selectable or controllable one-way clutch acting between two rotating components; for example, both races are rotatable.

[0029] As shown in the drawings, the clutch assembly **10** includes an input shaft or member **12** and first and second output members, shown as inner and outer concentric shafts **14**, **16** supported for relative rotation by a bearing **18**. The clutch assembly **10** includes a first coupling assembly, seen generally at **20** and a second coupling assembly, seen generally at **22**. The pocket plate may contain two locking elements—one for clockwise and the other for counterclockwise engagement. During engagement, at least one set of locking elements is controllably deployed such that each locking element in the set simultaneously contacts the pocket and notch engagement faces of the pocket and notch plates, respectively, which couples the two plates together to either transmit torque or ground torque, in the case of a brake.

[0030] The first coupling assembly **20** controllably couples the input shaft or member **12** and the first or inner output shaft or member **14** and transfers torque between the input shaft or member **12** and the first or inner output shaft or member **14**. The second coupling assembly **22** controllably couples the input shaft or member **12** and the second or outer output shaft or member **16** and transfers torque between the input shaft or member **12** and the second or outer output shaft or member **16**.

[0031] The first coupling assembly **20** includes an input component, seen generally at **24**, connected to the input shaft or member **12**. The input component **24** rotates with the input shaft or member **12** in either a clockwise or counterclockwise direction about a rotational axis **26** of the clutch assembly **10**. In one example, the first component **24** includes a hub **28** and a radially extending disc-shaped or plate member **30** having a side surface **32**. In one example, the side surface **32** extends radially and faces axially with respect to the rotational axis **26**. The side surface **32** includes a plurality of openings, recesses, or pockets **34** communicating with the side surface **32**. The input component **24** may be referred to as a pocket plate because it includes a plurality of pockets in a surface thereof. In one example, the side surface **32** of the disc-shaped or plate member **30** includes forward recesses or pockets and reverse recesses or pockets formed in the radially extending disc-shaped or plate member **30**, wherein forward and reverse refer to a direction of vehicle movement.

[0032] As illustrated, the recesses or pockets **34** are arranged circumferentially about disc-shaped or plate member **30** relative to the rotation axis **26** in two concentric circles or rings, an inner ring of pockets **34***a* and an outer ring of pockets **34***b*. The outer ring of pockets **34***b* is radially spaced outward of the inner ring of pockets **34***a*, wherein the inner ring of pockets **34***a* is a part of the first coupling assembly **20**, and the outer ring of pockets **34***b* is part of the second coupling assembly **22**. Each pocket of the inner ring of pockets **34***a* includes a pocket shoulder **35***a*, a shoulder of the recess, and each pocket of the outer ring of pockets **34***b* includes a pocket shoulder **35***b*, a shoulder of the recess.

[0033] Each pocket **34** includes a locking member or strut, generally indicated at **36**. The struts **36** and corresponding pockets **34** are configured differently depending on their respective positions, inner pockets **34***a* or outer pockets **34***b*, and the direction of torque transfer. In addition, the locking members or struts **36** are configured based on the direction of rotation.

[0034] FIGS. **8***a*-**10***b* illustrate a locking member or strut **36** for use with the clutch assembly **10**. In general, each locking member or strut **36** includes a first end surface **38** at a free or deployed end **40** of the strut **36** and a second end surface **42** at a shoulder-engaging end **44** of the strut **36** diametrically opposite the first end surface **38**. The strut includes an upper face **46** and a lower face **48** interconnected by longitudinal side surfaces **50**. An elongated main body portion **52** extends between the respective end surfaces **38**, **42**.

[0035] Each locking member or strut **36** also includes projecting inner and outer pivot pins or members **54**, **56** extending laterally from the main body portion **52**. The inner pivot pin **54** is closer to the rotational axis **26** when the locking member or strut **36** is positioned in the pocket **34**. The pivot members **54**, **56** enable pivotal motion of the locking member or strut **36** about a pivot axis **58** of the locking member or strut **36** intersecting the pivot members **54**, **56**. The pivot axis **58** extends transversely to a longitudinal axis of the main body portion **52** of the strut **36**. The pivot axis **58** separates the free or deployed end **40** and the shoulder engaging end **44**. The free or deployed end **40** lies on one side, and the shoulder engaging end **44** lies on the other side of the pivot axis **58**. The first end surface **38** of the locking member or strut **36** pivots outward and extends above the side surface **32** of the disc-shaped or plate portion **30** in a deployed or engaged position. The locking member or strut **36** moves between an engaged position extending above the side surface of the disc-shaped or plate portion **30** and a disengaged position lying in the recess or pocket **34**. One-way torque transfer occurs in the engaged position of the locking members or struts **36**.

[0036] The first coupling assembly **20** includes inner struts **36***a* disposed in the inner pockets **34***a*. The outer pivot pin **58** is supported in a bearing **57** located between the inner component **24** and the retainer block or member **86**. The inner struts **36***a* have a laterally extending projection or paddle portion **80** and an upright post or peg **82**. A biasing or return member **84**, for example, a spring on the post or peg **82**, exerts an influence or a force between a retainer or block member **86**, secured to the disc-shaped or plate portion **30** of the first component **24**, and the paddle portion **80** to push and corresponding move the inner strut **36***a* into the pocket **34***a*. As illustrated, the laterally extending projection or paddle portion **80** is offset from the main body portion **52** of the strut **36***a*. It extends longitudinally beyond the first end surface **42** at the free or deployed end **40**. The biasing or return member **84** is retained by and acts against the retainer block or member **86**. The paddle portion **80** and the biasing or return member **84** are on the side of the free or deployed end **40** of the strut **36**. They are between the pivot axis **58** and the free or deployed end **40**. The inner component **24** includes struts **36***a* positioned opposite one another to transfer torque in both directions of rotation, clockwise and counterclockwise. The drawings, FIGS. **8***a*-**8***b* and **9***a*-**9***b* show that the struts **36***a* have a slightly modified configuration depending upon the direction of torque transfer, with the extending projection or paddle portion **80** on the radially outer side of the struts **36***a*, the side of the outer pivot pin **56**. As shown, the laterally extending projection or paddle portion **80** extends radially outward from the main body portion **52** and remains under the retainer block or member **86**. In the first position, the force of the biasing or return member **84** keeps the strut **36***a* in the pocket **34***a*. When the struts **36***a* remain in the inner pockets **34***a*, the struts **36***a* are not deployed, the input component **24** is not coupled to the first or inner output component **60**, and no torque is transferred between the two components.

[0037] The second coupling assembly **22** includes outer struts **36***b* disposed in the outer pockets **34***b*. The outer pivot pin **58** is supported in a bearing **57** located between the inner component **24** and the retainer block or member **86**. The outer struts **36***b* have a laterally and longitudinally extending projection or paddle portion **88**. As illustrated, the laterally and longitudinally extending projection or paddle portion **88** is offset from the main body portion **52** of the strut **36***b*. It extends longitudinally beyond the second end surface **42** at the shoulder engaging end **44**. A biasing or deploy member **90**, for example, a spring, exerts an influence or force between the disc-shaped or plate portion **30** of the first component **24** and the lower face **48** of the strut **36**. The biasing or deploy member **90** contacts the lower face **48** between the pivot axis **58** and the first and surface **38** at the free or deployed end **40**. The biasing or deploy member **90** pushes or urges the outer strut **36***b* and correspondingly moves the outer strut **36***b* outward from the pocket **34***b* into a deployed position. As illustrated, the laterally extending projection or paddle portion **88** is laterally and longitudinally offset from main body portion **52** of the strut **36***b* and, along with the outer actuation member **118**, the spring **118**, is held and moves under a retainer block or member **86**. As illustrated in the present example, the strut **36***b* transfers torque in one direction of rotation, for example, counterclockwise. A second outer strut **36***b* could be added to transfer torque in the second direction of rotation, for example, clockwise. Such an arrangement may look similar to the inner ring of pockets **34***a* and struts **36***a*. In the first position, the force of the biasing or deploy member **90** urges the strut **36***b* out of the pocket **34***b* and above the side surface **32** of the plate **30**. Because the struts **36***b* extend out of the outer ring of pockets **34***b*, the input component **24** is coupled to the second or outer output component **70**, and torque is transferred between the two components.

[0038] FIGS. **5-7** show the first or inner output component **60** of the first coupling assembly **20** connects to the first or inner output shaft or member **14**. Wherein, the first or inner output component **60** rotates with the first or inner output shaft or member **14** in either a clockwise or counterclockwise direction about the rotational axis **26** of the clutch assembly **10**. In one example, the first or inner output component **60** includes a hub **62** and a radially extending disc-shaped or plate member **64** having a side surface **66**. In one example, the side surface **66** extends radially and faces axially with respect to the rotational axis **26**. The first or inner output component **60** includes a plurality of recesses or notches **68** formed in the side surface **66** of the radially extending disc-shaped or plate member **64**—each of the recesses or notches **68** includes an engagement end or surface **68***a*. The notches **68** are circumferentially spaced about the side surface **66**. The first or inner output component **60** may be referred to as a notch plate, for example, the inner notch plate, because it includes a plurality of recesses or notches in an outer surface.

[0039] In the first coupling assembly **20**, the side surface **66** of the radially extending disc-shaped or plate member **64** of the first or inner output component **60** is placed adjacent to the side surface **32** of the disc-shaped or plate portion **30** of the input component **24**. The notches **68** line up with and correspond to the inner ring of pockets **34***a*, whereby deploying or extending the struts **36***a* above or past the side surface **32** of the disc-shaped or plate portion **30** of the input component **24** results in the struts **36***a* engaging the engagement ends or surfaces **68***a* the notches **68** in the side surface **66** of the radially extending disc-shaped or plate member **64** enabling torque transfer between the input component **24** and the first or inner output component **60**. When the struts **36** are nondeployed, they remain in the pockets **34** and do not engage the engagement surfaces **68***a* of the notches **68** in the side surface **66** of the radially extending disc-shaped or plate member **64**.

[0040] In a similar manner, the second coupling assembly **22** includes a second or outer output component **70** connected to the second or outer output shaft or member **16**. The second or outer output component **70** rotates with the second or outer output shaft or member **16** in either a clockwise or counterclockwise direction about the rotational axis **26** of the clutch assembly **10**. In one example, the second or outer output component **70** includes a hub **72** and a radially extending disc-shaped or plate member **74** having a side surface **76**. In one example, the side surface **76** extends radially and faces axially with respect to the rotational axis **26**. The second or outer output component **70** includes a plurality of recesses or notches **78** formed in the side surface **76** of the radially extending disc-shaped or plate member **74**. Each of the recesses or notches **78** includes an engagement end or surface **78***a*. The notches **78** are circumferentially spaced about the side surface **76**. The second or outer output component **70** may also be referred to as a notch plate, for example, the outer notch plate, because it includes a plurality of recesses or notches in an outer surface.

[0041] In the second coupling assembly **22**, the side surface **76** of the radially extending disc-shaped or plate member **74** of the second or outer output component **70** is placed adjacent to the side surface **32** of the disc-shaped or plate portion **30** of the input component **24**. The notches **78** line up with and correspond to the outer ring of pockets **34***b*, whereby deploying or extending the struts **36***b* above or past the side surface **32** of the disc-shaped or plate portion **30** of the input component **24** results in the struts **36** engaging the engagement end or surface **78***a* of the notches **78** in the side surface **76** of the radially extending disc-shaped or plate member **74** enabling torque transfer between the input component **24** and the second or outer output component **70**. When the struts **36***b* are nondeployed, they remain in the pockets **34***b* and do not engage the notches **78** in the side surface **76** of the radially extending disc-shaped or plate member **74**.

[0042] The clutch assembly **10** includes an actuation system or mechanism in the form of a linear motor or linear actuator **100**. The linear actuator **100** includes a stator **102** and a translator **104**. The stator **102** is fixed in position, for example, to a housing (not shown). The stator **102** includes a pair of copper wire induction coils **106**. Steel plates **108** house for the stator induction coils **106**. The stator coils **106** are wound in series with reversed polarity relative to one another, anti-series.
[0043] The translator **104** includes an annular ring of segmented permanent magnets **110** and steel plates **112**. The translator **104** connects to and rotates with the input member **12** and moves linearly between lateral, axial positions. The linear actuator **100** actively controls an operating mode of the clutch assembly **10** by generating an electromagnetic force with the stator **102** that interacts with the translator **104**, causing the translator to slide axially and move reciprocally in an axial direction on the input component **24**. The linear actuator **100** is a two-position actuator, with the stator **102** having a pair of induction coils **106**. Multiple-position actuators, for example, a three or four-position actuator, may also be used.
[0044] In one example, the linear actuator **100** includes a radially extending actuation plate **114**. The actuation plate **114** includes inner and outer actuation members **116**, **118**. In the disclosed example, the inner actuation member **116** is associated with the first coupling assembly **20**, and the outer actuation member **118** is associated with the second coupling assembly **22**. Axial movement of the translator **104** and correspondingly the actuation plate **114** applies a force to the actuation members **116**, **118** wherein the members **116**, **118** act on the struts **36***a*, **36***b*. In one example, the actuation members are coiled springs, received within the passages **120***a*, **120***b* to provide an actuating force to move the struts **36***a*, **36***b* between their engaged, deployed, and disengaged, nondeployed positions. Other actuators besides springs may provide the actuating forces. Also, pressurized fluid may provide the actuating forces.
[0045] The linear actuator **100**, through the translator **104**, moves the actuation plate **114** between the first and second positions. FIGS. **11-12** illustrate the first position of the actuation plate **114** and the position of the corresponding inner and outer struts **36***a*, **36***b*. FIGS. **13-14** illustrates the second position of the actuation plate **114** and the position of the corresponding inner and outer struts **36***a*, **36***bb*. s illustrated, movement of the actuation plate **114** from the first position to the second position, from the position shown in
[0046] FIGS. **11-12** to that shown in FIGS. **13-14**, causes the outer actuation member **118** to act on one end of the strut **36***b*, overcome the force of the biasing or deploy member **90**, and pivot the strut **36***b* inward into the pocket **34***b*, placing the strut **36***b* in a nondeployed or nonengaged position. Correspondingly, movement of the actuation plate **114** from the first position to the second position causes the inner actuation member **116** to act on one end of the strut **36***a*, overcome the force of the biasing or return member **84**, and pivot the strut **36***a* outward out of the pocket **34***a* placing the strut **36***a* in a deployed or engaged position.
[0047] As illustrated, in the first position, the interior or inner set of struts **36***a* in the inner ring of pockets **34***s* are or remain in the pockets **34**, and the outer set of struts **36***b* are deployed, extended outwardly from the pockets **34** of the outer ring of pockets **34***b* and engage the second or outer output component **70**. In the first position, the actuation members **116**, **118**, attached to the actuation plate **114**, do not act on their respective struts **36***a*, **36***b*. The biasing or return member **84** acts on the inner struts **36***a*, keeping them in the pockets **34***a*, in a nondeployed and disengaged position, wherein the struts **36***a* do not engage the first or inner output component **60** and no torque is transferred between the inner component **24** and the first or inner output component **60**. Regarding the outer set of struts **36***b*, the biasing or deploy member **90** acts on the strut **36***b* to urge the strut **36***b* outward into a deployed, engaged position wherein the strut **36***b* engages the second or outer output component **70**, and torque is transferred between the inner component **24** and the second or outer output component **70**.
[0048] When the translator **104** moves to the second position, closer to the hub **28** of the inner component **24**, the force applied by the inner and outer springs or actuation members **116**, **118** acts

on each of the inner and outer struts **36***a*, **36***b*. The inner actuation member **116** acts on the inner strut **36***a*, pivoting it outward into a deployed, engaged position with the first or inner output component **60** wherein torque is transferred between the input component **24** and the first or inner output component **60**. The outer actuation member **118** acts on the outer strut **36***b*, pivoting it inward into a nondeployed, disengaged position in the pocket **34***b* wherein no torque is transferred between the input component **24** and the second or outer output component **70**. Moving the actuation plate **114** to the second position disengages the outer struts **36***b* and engages the inner struts **36***a*. Depending on the position of the linear actuator **100** and corresponding translator **104**, torque is transferred from the input component **24** to either the first or inner output component **60** or the second or outer output component **70**, thereby transmitting torque from the input member **12** to one of the inner and outer output members **14**, **16**.

[0049] In one example, the clutch assembly **10** is a mechanism for coupling an input member **12** through a common input component **24** to at least one of two output members **14** using two output components **60**, **70**. The torque supplied by the input member **12** may be transferred to at least one of the two output members **14**, **16** separately using a single two-position linear motor or actuator **100**. While the present example discloses coupling the input member **14** to the first and second output members **14**, **16** separately, the strut structure of the second coupling assembly **22** could be replaced with the strut structure of the first coupling assembly **20** wherein independent actuation of one of the first and second coupling assemblies **20**, **22** deploys the associated set of struts to engage or couple the input component **24** with one of the corresponding inner and outer output components **60**, **70**. Depending upon the coupling assembly selected, each inner and outer output member **14**, **16** can rotate in both directions, clockwise and counterclockwise, with the input member **12**.

[0050] The actuation plate **114** moves axially between a first and second position, with the second position being closer to the input component **24**, wherein the clutch assembly **10** provides a mechanism for independently driving the inner and outer output members **14**, **16** from a single input member based on the position of the actuator **100**. For example, the input member **12** drives one of the inner and outer output members **14**, **16**, while the other member rotates freely or overruns. In one example, the linear motor or actuator **100** functions as a two-position actuator. In the first position torque is transferred from the input component **24** to the second or outer output component **70**, but not the first or inner output component **60**. In the second position torque is transferred from the input component **24** to the first or inner output component **60**, but not the second or outer component **70**. In another example, a three-position actuator could be used. Changing the inner and outer actuation member **116**, **118** length or, if using an actuation spring, the spring constant, provides a third clutch assembly position. For example, a three-position actuator provides an intermediary or neutral position wherein neither strut **36***a*, **36***b* is deployed or engaged.

[0051] The clutch assembly **10** transmits torque between the power flow components connected via the first and second coupling assemblies **20**, **22**. The direction of rotation and torque transmitted to the inner and outer output members **14**, **16** can be used in various ways. For example, each of the inner and outer output members **14**, **16** can supply or transmit power to various components such as a forward gear set, a reverse gear set, a front-wheel drive, a rear-wheel drive, a lower range, and a high range gearset.

[0052] In one example, as shown in FIGS. **15-18**, the foregoing clutch assembly **10** can be used with an electromagnetic friction clutch (EFC) **122** to synchronize the rotation speed and direction of the input member **12** and the second or outer output member **16**. The input component **24**, connected to the input member **12**, includes a cup-shaped body having a cylindrical drum portion **124** connected to the disc-shaped or plate portion **30**. The cylindrical drum portion **124** extends longitudinally in the direction of the rotational axis **26**.

[0053] The cylindrical drum portion **124** includes an inner peripheral surface **126** and an outer peripheral surface **128**. The inner peripheral surface **126** has a plurality of alternating grooves **130** and projections **132**, forming splines that mesh with corresponding grooves and projections in an outer peripheral surface **140** of the EFC **122**, enabling torque transfer between the input component **24** and the EFC **122**.

[0054] The EFC **122** uses friction members and includes a friction pack **142** having input friction plates **144** connected to the drum portion **124** and output friction plates **146** connected to the second or outer output component **70**. An EFC translator **148** has a translator piston **150**, a translator plate **152**, and a stator **154** with a stator core **156** and a stator coil **158**. The EFC stator **154** is fixed in position, and the EFC translator **148** is movable relative thereto. Movement of the EFC translator **148** toward the EFC stator **154** compresses the friction plates **144**, **146** of the friction pack **142**.

[0055] The friction pack **142** comprises a combination of friction plates **144**, **146** that slide axially through inner splines and outer splines. When the plates **144**, **146** are compressed, the friction between the plates **144**, **146** carries torque, and the second or outer output component **70** rotates with the input component **24**.

[0056] The EFC operates to synchronize the speed or angular velocity of the input component **24** and the second or outer output component **70**. During the speed synchronization operation, the EFC translator **148** exerts a force on the friction pack **142**, compressing together the inner and outer friction plates **144**, **146** of the friction pack **142**. The EFC friction pack **142** carries the dynamic torque between input component **24** and the second or outer output component **70** during the speed synchronization operation.

[0057] When the rotational speed or angular velocity of the input component **24** and the second or outer output component **70** are synchronized, they will rotate with or at virtually the same angular velocity. Once the input component **24** and the second or outer put component **70** are synchronized, the struts **36***b* of the input component **24** are actuated and engage the outer ring of pockets **34***b*. The engaged struts **36***b* couple the pocket plate or input component **24** and the notch plate or second or outer output component **70** and transmit torque between the input member **12** and second or outer output member **16** via the engaged pocket plate or input component **24** and the notch plate or second or outer output component **70**.

[0058] As the first and second coupling assemblies **20**, **22**, and the EFC **122** are electromagnetically actuated, the clutch assembly **10** is a fully electromagnetic actuation clutching system. The clutch assembly **10** is electromagnetic and does not depend on a hydraulic actuator. An all-electric system, not dependent on hydraulic actuation, can be smaller, lighter, cleaner, and faster in response time. The clutch assembly **10** is engageable at high differential speeds using the EFC **122**; capable of delivering high static torque using the first and second coupling assemblies **20**, **22**; controllable and can thus provide a linear response for dynamic torque using electric current modulation. The first and second coupling assemblies **20**, **22** do not require a continuous supply of electric power to stay engaged for torque delivery since the steady-state engagement can be made possible by a magnetic or mechanical latching mechanism.

[0059] While the clutch assembly **10** utilizes an EFC **122** to synchronize speed between the input component **24** and the second or outer output component **70**, a similar arrangement may also synchronize speed between the input component **24** and the first inner output component **60**. In addition, other speed synchronization systems, such as (insert different systems) may also be used.

[0060] FIGS. **15-18** illustrate a power or torque path through the clutch assembly **10** based on the positions of the translator **104** of the linear actuator **100** of the first and second coupling assemblies **20**, **22**, and the translator of the **148** of the EFC **122**. As shown in the drawings, the power or torque path changes depending upon the positions of the respective translators **104**, **148**.

[0061] FIG. **15** illustrates the power or torque path between the input component **24** and the first and second output components **60**, **70** with both the linear actuator **100** and EFC in the first position. In the first position, the translator **104** of the linear actuator **100** and the actuation plate **114** are in the far-right position, with the actuation plate **114** closer to the disc-shaped or plate portion **30**. In the first position, the translator **148** of the EFC **122** is in the far-left position, wherein

friction plates are in an uncompressed position, they carry no torque. With the linear actuator **100** in the first position, the struts **36***a* of the first coupling assembly **20** are deployed, and the struts **36***b* of the second coupling assembly **22** are nondeployed. In the first position, the first coupling assembly **20** carries torque through the deployed struts **36***a* from the input component **24** to the first or inner output component **60**, as shown by the heavy, solid line **170**. As illustrated, torque is transmitted directly from the input member **12** to the first or inner output member **14**, a direct drive.
[0062] FIG. **16** illustrates the power or torque path between the input component **24** and the first and second output components **60**, **70**, with the linear actuator **100** in the first position and the EFC **122** in the second position. In the second position, the EFC translator **148** moves to the far-right position, with the translator plate **152** adjacent the stator **154**. In the far-right position the EFC translator **148** compresses the friction pack **142** wherein the EFC **122** transmits torque from the input component **24** to the second or outer output component **70**, as shown by the heavy dashed line **172**. When the EFC is actuated, torque is transmitted to the second or outer output component **70**, and the second or outer output component **70** starts to rotate.
[0063] FIG. **17** illustrates the power or torque path between the input component **24** and the first and second output components **60**, **70** with the linear actuator **100** in the second position and the EFC **122** in the second position. In the second position, the translator **104** and the actuation plate **114** of the linear actuator **100** are in the left position, with the actuation plate **114** farther from the disc-shaped or plate portion **30**. With the linear actuator **100** in the second position, the struts **36***a* of the first coupling assembly **20** are nondeployed, and the struts **36***b* of the second coupling assembly **22** are deployed. In the second position, the second coupling assembly **22** carries torque through the deployed struts **36***b* from the input component **24** to the second or outer output component **70**, as shown by the heavy solid line **174**. Because the EFC **122** is still actuated, torque is still transmitted to the second or outer output component **70** through the EFC **122**, as shown by the heavy dashed line **172**.
[0064] FIG. **18** illustrates the power or torque path between the input component **24** and the first and second output components **60**, **70**, with the linear actuator **100** in the second position and the EFC **122** in the first position. In the second position, the second coupling assembly **22** carries torque through the deployed struts **36***b* from the input component **24** to the second or outer output component **70**, as shown by the heavy solid line **174**. In the first position, the friction pack **142** of the EFC **122** is in the far-left uncompressed position and carries no torque. The only power or torque path extends from the input component **24** to the second or outer output component **70**, shown by the heavy solid line **174**.
[0065] In one example, the EFC **122** is used as a synchronization mechanism to synchronize the rotational speed of the second or outer output component **70** with that of the input component **24** prior to moving the linear actuator **100** to the second position.
[0066] The description of the invention is merely exemplary. Thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

Claims

1. A clutch assembly for use with a vehicle drive system comprising: an input member; a first output member; a second output member; an input component connected to the input member; a first output component connected to the first output member; a second output component connected to the second output member; the input component, including a plurality of recesses arranged circumferentially on the input component in two concentric rings, an inner ring and an outer ring wherein the outer ring is radially spaced outward of the inner ring; a first coupling assembly selectively coupling the input component to the first output component connected to the first output member; a second coupling assembly selectively coupling the input member to the second output component connected to the second output member; and an actuation mechanism movable between a first position and a second position wherein in the first position, the first coupling assembly decouples the input member and the first output member and couples the input member and the second output member, and in the second position, the second coupling assembly decouples the input member and the second output member and couples the input member and the first output member.

2. The clutch assembly of claim 1 wherein: the first coupling assembly includes the inner ring of recesses; and the second coupling assembly includes the outer ring of recesses.

3. The clutch assembly of claim 1 wherein: the first output component having a surface, the surface including a plurality of recesses; and the second output component having a surface, the surface including a plurality of recesses.

4. The clutch assembly of claim 3 wherein: the first coupling assembly includes a locking member, the locking member in a recess in the inner ring of recesses, the locking member movable between a deployed and nondeployed position; and the second coupling assembly includes a locking member, the locking member in a recess in the outer ring of recesses, the locking member movable between a deployed and a nondeployed position.

5. The clutch assembly of claim 4 including: the locking member of the first coupling assembly having a pivot axis; and the first coupling assembly includes an actuation member and a return member wherein both the actuation member and return member act on the locking member on the same side of the pivot axis.

6. The clutch assembly of claim 5 including: the locking member of the second coupling assembly having a pivot axis; and the second coupling assembly includes an actuation member and a return member wherein the actuation member and return member act on the locking member on opposite sides of the pivot axis.

7. A clutch assembly for use with a vehicle drive system comprising: an input component rotatable about a longitudinal axis, the input component including a plurality of recesses; a first output component rotatable about the longitudinal axis, the first output component including a plurality of recesses; a second output component rotatable about the longitudinal axis, the second output component including a plurality of recesses; a first set of locking members, each locking member of the first set having a first end, a second end, pivot members extending transversely to a longitudinal axis of the locking member and defining a pivot axis, the pivot axis disposed between the first and second end, with the locking member pivoting about the pivot axis, and a laterally extending projection at the first end of the locking member; a second set of locking members, each locking member of the second set having a first end, a second end, pivot members extending transversely to a longitudinal axis of the locking member and defining a pivot axis, the pivot axis disposed between the first and second end, with the locking member pivoting about the pivot axis, and having a laterally extending projection at the second end of the locking member; and an actuation mechanism movable between a first position and a second position, in the first position, the first set of locking members are nondeployed, decoupling the input component and the first output component and the second set of locking members are deployed, coupling the input component and the second output component, and in the second position, the first set of locking members are deployed, coupling the input component and the second output component and the second set of locking members are nondeployed, decoupling the input component and the first output component.

8. The clutch assembly of claim 7 wherein: the input component includes a radially extending and axially facing surface, with the recesses of the input component arranged on the surface in concentric circles, the concentric circles arranged in an inner ring and an outer ring; the first output component includes a radially extending and axially facing surface, with the recesses of the first output component arranged on the surface in a circle; the second output component includes a radially extending and axially facing surface, with the recesses of the second output component arranged on the surface in a circle; and the recesses of the first output component adjacent to the inner ring of recesses of the input component and the recesses of the second output component adjacent to the outer ring of recesses of the input component.

9. The clutch assembly of claim 7 wherein: the laterally extending projection at the first end of the locking member extends longitudinally past the first end of the locking member.

10. The clutch assembly of claim 7 wherein: the laterally extending projection at the first end of the locking member extends past a side surface of the locking member.

11. The clutch assembly of claim 7 including: a biasing member between the laterally extending projection at the first end of the locking member and the input component wherein the biasing member is in a non-contacting relationship with a lower face of the locking member.

12. The clutch assembly of claim 7 including: an actuation member engaging the locking member of the first set of locking members between the pivot axis and the first end.

13. The clutch assembly of claim 7 including: a biasing member engaging the locking member of the first set of locking members between the pivot axis and the first end; and an actuation member engaging the locking member of the first set of locking members between the pivot axis and the first end.

14. The clutch assembly of claim 13 including: a biasing member engaging the locking member of the second set of locking members between the pivot axis and the first end; and an actuation member engaging the locking member of the second set of locking members between the pivot axis and the second end.

15. The clutch assembly of claim 7 wherein: the first set of locking members includes opposing locking members operative to couple the input component to the first output component in both directions of rotation.

16. The clutch assembly of claim 7 wherein: the second set of locking members includes opposing locking members operative to couple the input component to the second output component in both directions of rotation.

17. The clutch assembly of claim 7 wherein: the actuation mechanism includes a translator operative for movement wherein movement of the translator acts on both the first set of locking members and the second set of locking members.

18. A clutch assembly comprising: an input member supported for rotation about a longitudinal axis, the input member including a side surface extending transverse to the longitudinal axis, the side surface includes a plurality of recesses communicating with the side surface of the input member; a first output member supported for rotation about the longitudinal axis, the first output member having a side surface extending transverse to the longitudinal axis and faces the side surface of the input member, the first output member includes a plurality of recesses communicating with the side surface of the first output member; a second output member supported for rotation about the longitudinal axis, the second output member having a side surface extending transverse to the longitudinal axis and faces the side surface of the input member, the second output member includes a plurality of communication with the side surface of the second output member; a first coupling assembly selectively coupling the input member to the first output member, the first coupling assembly including a locking element movable between a deployed and nondeployed position, the locking element including a first end, a second end, and a pivot axis between the first end and the second end, a biasing member and an actuation member both the biasing member and actuation member engaging the locking element between the first end and the pivot axis; and a second coupling assembly selectively coupling the input member to the second output member including a locking element movable between a deployed and nondeployed position, the locking element including a first end, a second end, and a pivot axis between the first end and the second end, a biasing member and an actuation member the biasing member engaging the locking element between the first end and the pivot axis and the actuation member engaging the locking element between the second end and the pivot axis, wherein the first coupling assembly operates independent of the second coupling assembly, and the second coupling assembly operates independent of the first coupling assembly.

19. The clutch assembly of claim 18 wherein: the locking element of the first coupling assembly includes a laterally extending projection at the first end of the locking member; and the locking element of the second coupling assembly includes a projection extending from the second end of the locking member.

20. The clutch assembly of claim 19 wherein: the biasing member of the first coupling assembly engages the laterally extending projection at the first end of the locking member of the first coupling assembly; and the actuation member of the second coupling assembly engages the projection extending from the second end of the locking member of the second coupling assembly.