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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
No. 06-119954- -00002-0000
Fecha: 2008-01-23 14:55:57 Dep. 2020 NUECREACIONI
Tra. 3 MODELO Eve: 1 REGDEPOSITO
Act. 538 PETICION Folios: 3

Doctora
ALIX CARMENZA CÉSPEDES DE VERGEL
DIVISIÓN DE NUEVAS CREACIONES
SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
E. S. D.

Ref: expediente 06 119954
Examen de Patentabilidad

De acuerdo con lo estipulado en los artículos 44 y 85 de la Decisión 486 de la Comunidad Andina de Naciones le estamos solicitando iniciar el examen de patentabilidad de la solicitud de la referencia.

Adjunto encontrará el recibo de pago de la tasa oficial establecida por la entidad para tal fin.

Agradeciendo de antemano la atención prestada.

Cordial Saludo

LUIS GUILLERMO GÓMEZ ESCOBAR
C.C. 2.774.136 de Medellín

21

Industria y Comercio
SUPERINTENDENCIA

Espacio reservado para el adhesivo de radicación

ANEXO
SOLICITUDES DE PATENTES PRESENTADAS POR PERSONAS NATURALES QUE CAREZCAN DE MEDIOS ECONOMICOS

Usuario: Luis Guillermo Gomez Escobar

Dirección: Calle 49 # 25 10

Teléfono: 3240192

E-mail:

Manifiesto bajo la gravedad del juramento, que carezco de los medios económicos para cancelar las tasas correspondientes a la presente solicitud y, por tanto, pido que se aplique la reducción de tasas a que se refiere el artículo 2 de la resolución número 31980 de fecha 24 de diciembre de 2004.

FIRMA SOLICITANTE: _____ CC 2774 136 MED.

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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
No. 06-119954- -00002-0000
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SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

NIT : 800176089-2

RECIBO OFICIAL DE CAJA : 08 - 6.203
FECHA : ENERO 23 DE 2008

***** C O N S I G N A C I O N *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PGO	Vr. PAGO
LUIS G GOMEZ	CONSIGNACION	BANCO DE BOGOTA	002754387	3845492	22/01/2008	70,000.00

***** C O N C E P T O *****

CANT.	RENTISTICO	CONCEPTO	TOTAL CONCEPTO
1	50005-01-01 SOLICITUDES	*** 25% EXAMEN DE PATENTABILIDAD DE N	70,000.00
		TOTAL : $	70,000.00

SON: SETENTA MIL PESOS

RESPONSABLE: _____

RECIBO DE CAJA APLICADO AL EXPEDIENTE No. _____

Industria y Comercio
SUPERINTENDENCIA

DIVISION DE NUEVAS CREACIONES

RADICACIÓN EXPEDIENTE No 06-119954

EXTRACTO DE LA PRESENTE SOLICITUD DE **MODELO DE UTILIDAD**

NUMERO FUE PUBLICADO EN LA GACETA DE PROPIEDAD INDUSTRIAL No

582 DE FECHA **30 DE NOVIEMBRE DE 2007** EL TERMINO HABIL SEÑALADO

POR LA LEY EXPIRA EL **16 DE ENERO DE 2008.**

NOTA: Dentro del plazo de los tres (3) meses siguientes a partir de la fecha de publicación en la gaceta de Propiedad Industrial, deberá solicitar y cancelar el examen de patentabilidad so pena de que la solicitud caiga en abandono, de acuerdo con lo establecido en el Artículo 44 y en concordancia con el artículo 85 de la Decisión 486/2000.

SE PRESENTARON OPOSICIONES POR PARTE DE TERCEROS.

SI _____ NO ____X____

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIRECCIÓN DE NUEVAS CREACIONES

2020
Bogotá, D.C.

Señor
Luis Guillermo Gómez Escobar
(Solicitante)

ASUNTO	Radicación	06 – 119 954
	Trámite	003
	Evento	001
	Actuación	430
	Oficio	14803
	Folios	044

Patente de Invención ☐ Patente de Modelo de Utilidad ☑

Como resultado del examen de fondo, realizado con fundamento en el artículo 86 en concordancia con el artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le comunica:

1. De los documentos estudiados

Descripción:	Folios 10 a 13 como se radicó inicialmente Folio 20 modificación.
Reivindicaciones:	Folios 11 y 12 como se radicó inicialmente
Dibujos:	Folios 14 a 16 como se radicó inicialmente

2. Del objeto de la solicitud

Título de la solicitud: *Novociclo*, folio 1

El objeto de la presente solicitud de patente de modelo de utilidad consiste en suministrar un sistema para propulsión humana de vehículos. El sistema se fundamenta en la generación de presión hidráulica mediante un mecanismo de pedal de vaivén.

El problema planteado en esta solicitud es obtener movimientos giratorios en las bicicletas y otros vehículos de tracción humana.

Para solucionar este problema técnico la solicitud en estudio proporciona un sistema hidráulico que se acciona mediante pedales oscilantes anclados en un extremo y libres en el otro, los cuales generan el movimiento de una bomba

hidráulica que conduce un fluido a presión hasta una turbina, la cual hace girar la rueda de tracción.
Clasificación Internacional de Patentes (IPC): B62M 1/04, 1/10, 19/00

3. De la solicitud de Patente de Modelo de Utilidad

Antes de entrar en detalles específicos, se le dan al solicitante ciertas indicaciones generales, algunas de las cuales son aplicables a este caso y todas deberán ser tenidas en cuenta en las eventuales modificaciones:

El título o nombre de la invención debe concordar con lo que se reclama en el capítulo reivindicatorio. Esto es, si en las reivindicaciones se reclama un producto, tal producto debe ser mencionado en el título, y si en las reivindicaciones se reclama un procedimiento o un sistema o un método, también debe ser mencionado allí. Normalmente, el título debe contener máximo diez palabras aunque eventualmente pueden ser más. El título no debe contener palabras cuyo significado no esté reconocido dentro del sector de la técnica de que se trate. Preferiblemente, deben ser palabras cuyo significado se encuentre en el Diccionario de la Real Academia Española (DRAE).

En Colombia, la máxima autoridad en cuestiones del lenguaje es la Academia Colombiana de la Lengua. En caso de duda sobre el significado de las palabras, se debe acoger la definición que trae el Diccionario de la Real Academia Española (DRAE).

En Colombia, es de uso obligatorio el Sistema Internacional de unidades. Esto implica, también, que la coma decimal es de uso obligatorio. Cuando aparezca algún valor con unidades diferentes a las exigidas, deberá incluirse su correspondiente conversión al Sistema Internacional.

La parte técnica de la solicitud se divide en tres secciones, debidamente separadas, preferiblemente en este orden: El capítulo descriptivo, el capítulo reivindicatorio y el juego de dibujos o figuras. Ninguna de estas secciones podrá llevar membretes (encabezamientos o pies de página) ajenos al contenido técnico de la solicitud.

Por lo menos el capítulo descriptivo debe estar debidamente paginado y estar escrito a doble espacio, con el fin de facilitar la referencia a los apartados del texto.
La terminología empleada en la descripción y en las reivindicaciones debe ser igual para designar las diferentes partes, piezas, elementos, detalles o aspectos de lo que se mencione en ellas; los cuales, a su vez, deben estar designados con números o signos de referencia.
Dentro del texto de la descripción y las reivindicaciones se aconseja encerrar entre paréntesis el número o signo de referencia cada vez que se mencione el detalle correspondiente, con el fin de distinguirlo de otros tipos de números o signos que eventualmente aparezcan allí. Estos números o signos de referencia deben aparecer dentro del juego de dibujos (preferiblemente, sin paréntesis, aunque pueden estar encerrados dentro de un círculo) siempre acompañados de líneas o flechas que señalen o indiquen a qué parte, pieza, elemento o aspecto se encuentran asociados.

Las reivindicaciones deben estar numeradas individual y consecutivamente (1, 2, ... 5, 6, etc.) El capítulo reivindicatorio no debe tener subtítulos.
Normalmente se pueden encontrar dos categorías de reivindicaciones: una, la de producto y la otra, de procedimiento.

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En las reivindicaciones se deben definir los alcances de la protección que desea el solicitante. En consecuencia, las reivindicaciones forman un cuerpo aparte de la descripción y como tal debe ser redactado: la primera vez que se mencione un nombre dentro de las reivindicaciones debería estar acompañado de un artículo indeterminado; y, la inclusión -entre paréntesis- de un número de referencia no sustituye la definición del elemento o aspecto al que se refiere, simplemente sirve de información complementaria. Se debe entender que la descripción sirve para interpretar las reivindicaciones y, en consecuencia, si en una reivindicación se reclama un aparato, por ejemplo, no se deberían mencionar aspectos del funcionamiento del aparato dentro de la reivindicación, limitándose a definir únicamente los elementos que constituyen el aparato.

Cada una de las figuras debe estar debidamente identificada, preferiblemente con un número consecutivo: Figura 1, figura 2, ...
Las figuras deben ser realizadas siguiendo las reglas del dibujo técnico.
Se prefiere que dentro de las figuras no se incluya ningún texto. Cada uno de los detalles ilustrados en las figuras deberá estar señalado con un número o signo de referencia, el cual será el mismo en todas las figuras en donde se encuentre el detalle en cuestión. Si en alguna figura no se encuentran números de referencia, se entiende que no se va a decir nada sobre ella dentro del texto de la descripción y, entonces, es preferible que se omita tal figura. Análogamente, si en una figura no se encuentra señalado algún detalle con el respectivo número de referencia, es preferible que se omita tal detalle.

La patente de **modelo de utilidad** no puede incluir los procedimientos, por definición. Si alguna de las reivindicaciones de una solicitud de patente de modelo de utilidad reclama un procedimiento, debe ser suprimida.

De la descripción (artículo 28 D. 486)
Durante el análisis del texto de la descripción y de las ilustraciones anexadas, se observaron los siguientes defectos:
(1) En el título o nombre del modelo de utilidad [y dentro de los capítulos descriptivo y reivindicatorio] se encuentra el término *novociclo* cuyo significado no es reconocido según el Diccionario de la Real Academia Española (DRAE). El solicitante debe sustituirlo por una expresión inteligible, que deberá concordar con lo que se reclame en el capítulo reivindicatorio.
(2) El capítulo descriptivo debe estar debidamente paginado, entre otras cosas, para facilitar la ubicación de los apartes que sean objetados.
(3) En el folio 10 aparece la expresión *el funcionamiento de dicho vehículo tiene como epicentro la presión...* en donde el término *epicentro* debe ser sustituido, porque el significado que le asigna el DRAE no concuerda con el contexto.
(4) En el mismo folio 10 aparece la expresión *...y estar las mismas turbinas fusionadas a cada llanta...* en la cual, en primer lugar, se debe sustituir el verbo fusionar porque no concuerda con el contexto; y, en segundo lugar, se debe sustituir el término *llanta* por *rueda* u otra expresión que se ajuste mejor a lo que el solicitante quiere decir. Incidentalmente, esta última sustitución sería aconsejable a lo largo del texto de la solicitud, en la mayoría de los casos. El solicitante debe consultar en el DRAE el significado de los términos que utilice.
(5) El solicitante menciona, en el mismo folio 10, una *figura 1-A*, una *figura 2-B* y una *figura 3-C*. Dado que sólo se encuentran tres figuras dentro del juego de dibujos, la doble designación es superflua, ya que no hay figuras 1-B, 2-A, 3-B.

Entonces, en aras de la claridad, se deben sustituir estas designaciones por *figura 1, figura 2, figura 3*, simplemente.
(6) En el folio 11 aparece por primera vez una expresión en la cual se hace alusión a *lanzar presión, mandar presión* lo que no es técnicamente correcto. Dentro de este contexto la presión se aumenta, se disminuye, se dirige, pero no se puede lanzar o mandar.
(7) En el mismo folio 11 aparece la expresión *multiplicará por muchas veces* que debe ser sustituida por *multiplicará muchas veces*.
(8) El texto de la descripción se interrumpe, en el folio 11, para incluir el capítulo reivindicatorio y luego, se retoma en el folio 12, se continúa en el folio 13 y se termina en el folio 20. Esto no está justificado. El capitulo descriptivo debe formar un cuerpo integral, separado del capítulo reivindicatorio.
(9) No hay una reseña de las figuras anexadas.
(10) Las figuras no fueron realizadas siguiendo las reglas del dibujo técnico, preferiblemente, deberán estar en blanco y negro. Ver los documentos adjuntos para observar ejemplos del tipo de dibujos aceptables.
(11) Dentro de las figuras, y a lo largo de la solicitud, se deben utilizar números de referencia que sean únicos para designar los mismos detalles a lo largo de todas las ilustraciones en donde aparezcan. Un mismo número de referencia no puede designar a diferentes detalles en diferentes figuras así como un mismo detalle no puede tener asignados dos o más números de referencia.
(12) Dentro de las figuras se ilustran ciertos detalles que no tienen asignado ningún número de referencia, lo que significa que no se mencionan expresamente dentro del texto, lo cual, a su vez, implica que deben ser suprimidos porque afectan negativamente la claridad de la exposición del modelo solicitado. Todos los detalles ilustrados deben tener su número de referencia correspondiente así como su definición dentro del texto.
(13) El mecanismo de pedal que se ilustra en la figura 1-A es diferente del mecanismo de pedal de la figura 2-B. Incidentalmente, la figura 2-B no mereció una descripción detallada.
(14) La descripción no es suficientemente completa como para que un tercero pueda ejecutarla. Se sugiere aclarar cómo se hace girar la turbina y cómo es que la turbina hace mover la rueda.

La descripción no cumple con los requisitos de claridad y de completitud que exige el Art. 28 de la Decisión 486.

<u>De las Reivindicaciones</u> (artículo 30 D 486)
Durante el análisis del texto de las reivindicaciones se observaron los siguientes defectos:
1) El solicitante debe sustituir el término *novociclo,* que aparece en las reivindicaciones, por una expresión que sea inteligible.
2) El solicitante debe aclarar si lo que desea proteger es un sistema de propulsión hidráulico por tracción humana o una bicicleta, una silla de ruedas,... (deberá tener presente que la solicitud tiene que tener unidad de concepto inventivo para que sea patentable).
3) Ninguna de las cinco reivindicaciones presentadas define un producto concreto. Si el solicitante desea proteger el sistema (esto es, el conjunto de elementos físicos) para producir la potencia necesaria para mover un vehículo o bien, si desea proteger el vehículo, debe definir concretamente qué componentes lo conforman. En otras palabras, si desea proteger un producto tangible debe definir las características tangibles que lo distinguen de los demás de su especie.
4) En la reivindicación 2, folio 11, aparece la expresión *puede ser de doble tracción* que es una expresión ambigua, ya que lleva implícita la posibilad opuesta:

puede no ser de doble tracción. El solicitante debe sustituirla por una expresión asertiva: *es de doble tracción.*
5) En la reivindicación 3, folio 11, aparecen expresiones negativas para intentar definir el producto que se reclama. El solicitante debe sustituir estas expresiones por otras que sean afirmativas, taxativas, ya que es imposible agotar las posibilidades de lo que no es la invención. Una objeción similar es aplicable a la reivindicación 4, folio 12.
6) Lo reclamado en la reivindicación 5, folio 12, dado que no está soportado por la descripción, deberá ser suprimida.

Las reivindicaciones que dependen de una reivindicación objetada también se objetan por las mismas causas.
Las reivindicaciones no cumplen con los requisitos de claridad, de concisión y de sustento por la descripción que exige el Art. 30 de la Decisión 486.

Se deben presentar, entonces, nuevos capítulos descriptivo y reivindicatorio, ambos completos, junto con un nuevo juego de dibujos, donde se hayan corregido todas las objeciones que se han hecho arriba. Esto con el fin de evitar -cuando solo se presentan algunas páginas sueltas corregidas- que el lector tenga que desplazarse desde un sitio a otro de la solicitud y luego regresar a donde estaba antes sin perder la ilación de la lectura, porque esto produce confusión y afecta negativamente la claridad de dichos capítulos.

4. De la determinación del estado de la técnica

La fecha que se ha tenido en cuenta para determinar el Estado de la Técnica es la

Fecha de presentación de la solicitud nacional 2006-11-28

Durante la búsqueda de anterioridades se encontraron los siguientes documentos, que forman parte del estado de la técnica más cercano al objeto de la solicitud:

n.°	Documento	Título	Fecha de publicación
D1	Patente US 3 729 213, cuyos inventores son Steve A. Hudspeth y John B. Lunsford	«Hydraulic drive for a bicycle»(Una fuente de potencia hidráulica para una bicicleta)	1973-04-24
D2	Patente US 4 546 990, cuyo inventor es George A. Harriger	«Hydraulic drive system for bicycles and the like»(Un sistema de fuente de potencia hidráulica para bicicletas y similares)	1985-10-15
D3	Patente US 4 688 815, cuyo inventor es William V. Smith, quien le cedió sus derechos a la Lectrolarm Custom Systems, Inc.	«Hydraulically driven bicycle»(Una bicicleta con fuente de potencia hidráulica)	1987-08-25
D4	Patente US 5 772 225, cuyo inventor es Douglas C. Brackett	«Hydraulic bicycle with conjugate drive motors»(Una bicicleta hidráulica con motores conjugados)	1998-06-30
D5	Patente US 5 938 224, cuyo inventor es Douglas C. Brackett	«Hydraulic bicycle with conjugate drive motors and variable stroke crankshaft»(Una bicicleta hidráulica con motores conjugados y un cigüeñal de paso variable)	1999-08-17

n.°	Documento	Título	Fecha de publicación
D6	Patente US 6 032 968, cuyo inventor es Jesse Chattin, quien le cedió sus derechos a la Chattin Hydro-Cycle, inc.	«Hydraulic transmission for bicycles»(Una transmisión hidráulica para bicicletas)	2000-03-07

Se anexan copias de las páginas pertinentes de estos documentos.

NOTAS: No se realizó una evaluación de los demás requisitos de patentabilidad, porque se objetó la claridad, sustento y definición de las reivindicaciones. Una vez hayan sido superadas las objeciones establecidas en este Concepto Técnico, se podrán hacer los exámenes correspondientes.

No obstante lo anterior, con base en los documentos encontrados hasta el momento, no se prevén objeciones respecto a la novedad del objeto solicitado.

5. De las conclusiones:

Los requisitos de patentabilidad de la presente solicitud se encontrarían afectados *negativamente por la falta de claridad* de la descripción y las reivindicaciones y por la falta de definición y de sustento de estas últimas.

En cumplimiento del artículo 85 en concordancia con el artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le indica al solicitante que debe dar respuesta dentro del término de treinta días contados a partir de la fecha de notificación de la presente comunicación. En caso de no dar respuesta al presente requerimiento, o si a pesar de la respuesta subsistieran los impedimentos para la concesión, se denegará la patente.

Notifíquese el presente oficio conforme a lo dispuesto en el artículo 8 de la resolución reglamentaria n.° 00210 del 15 de enero de 2001, advirtiendo que contra él no procede recurso alguno en la vía gubernativa.

JESÚS FERNEL GARCÍA GARCÍA
Director de Nuevas Creaciones (E)

El anterior requerimiento fue notificado por fijación en lista, de fecha 24 DIC. 2009

CONCEPTO TÉCNICO n.° 4350	**EXAMINADOR TÉCNICO** Código n.° 202009

United States Patent [19]

Hudspeth et al.

[11] **3,729,213**

[45] **Apr. 24, 1973**

D1

[54] HYDRAULIC DRIVE FOR A BICYCLE

[76] Inventors: **Steve A. Hudspeth**, 906 6th Street; **John B. Lunsford**, 1061 "B" Street, both of Springfield, Oreg.

[22] Filed: **June 11, 1971**

[21] Appl. No.: **152,209**

[52] U.S. Cl. **280/216**, 280/226, 280/234, 280/276

[51] Int. Cl. B62m 1/10, B62m 1/20

[58] Field of Search 280/212, 214, 215, 280/216, 226, 234, 276

[56] **References Cited**

UNITED STATES PATENTS

376,538	2/1897	Bellamy	280/216
2,049,010	7/1936	Horton	180/54 R
498,888	6/1893	Rockwell	280/216
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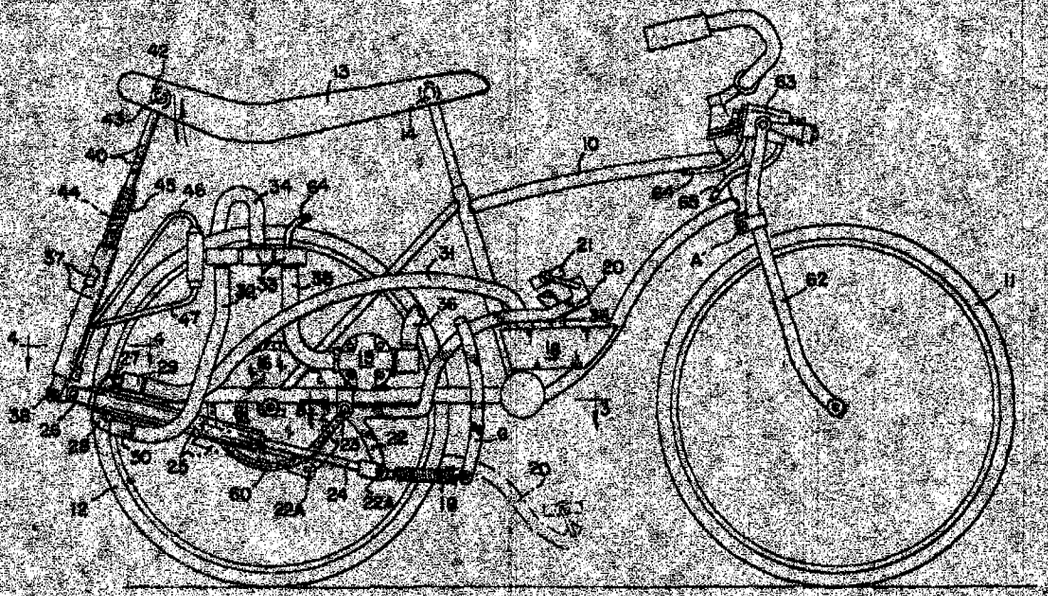
614,992	11/1898	Schmidt	280/216
735,628	8/1903	Waxel	280/216
2,144,538	1/1939	Kuskell	280/216
2,160,034	5/1939	Schwinn	280/276

Primary Examiner—Kenneth H. Betts
Assistant Examiner—Leslie J. Paperner
Attorney—James D. Givnan et al.

[57] **ABSTRACT**

A bicycle having a fluid powured motor. A primary source of fluid for motor operation provided by a pair of hydraulic cylinders with pistons therein powered by the feet of the rider. A secondary or auxiliary source of fluid under pressure for motor operation residing in a pair of seat actuated fluid pumps. The bicycle seat is mounted to permit the weight of the rider to be yieldably supported with fluid being exhausted from said pumps upon bicycle seat movement while the rider is negotiating irregular ground surfaces. An additional source of fluid pressure may be provided by still another cylinder operatively coupled to the front fork of the bicycle.

2 Claims, 5 Drawing Figures



3/

Patented April 24, 1973 3,729,213

D1

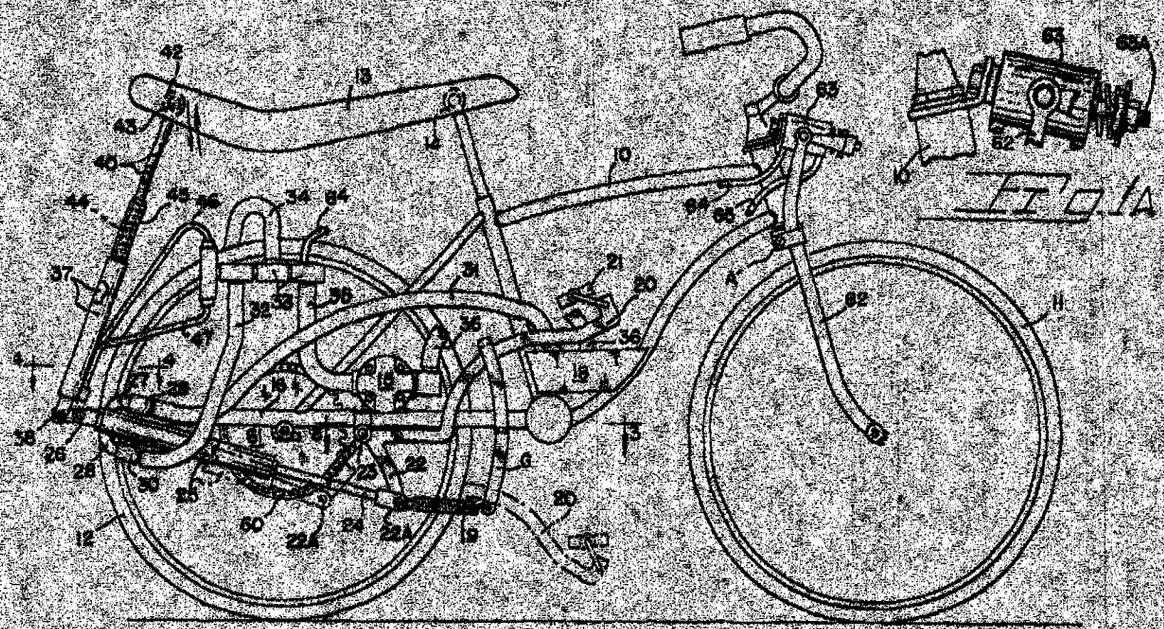


Fig 1

Fig 1A

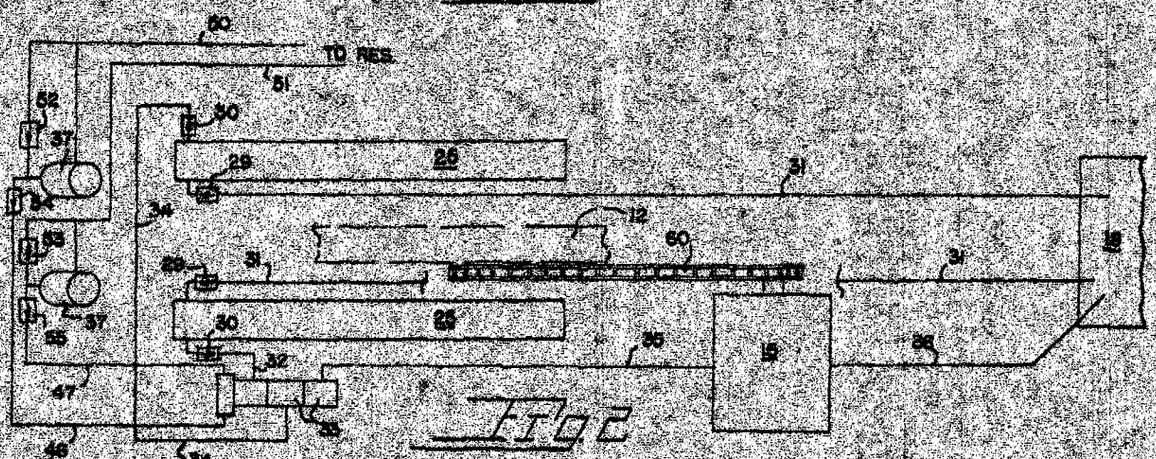


Fig 2

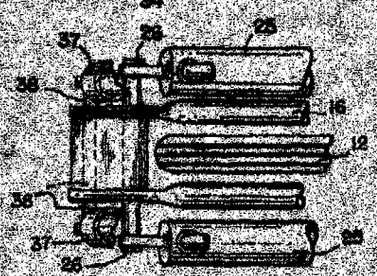


Fig 4

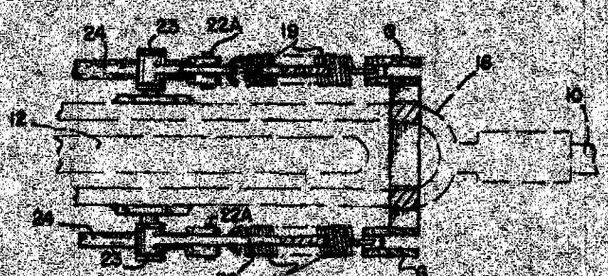


Fig 3

STEVE A. HUDSPETH
JOHN B. LUNSFORD
INVENTORS

BY

AGENT

1

HYDRAULIC DRIVE FOR A BICYCLE

BACKGROUND OF THE INVENTION

The present invention relates generally to a hydraulic drive for a bicycle wherein the fluid is pressurized by both physical effort exerted by the rider and the weight of the rider actuating hydraulic means during travel.

To the extent the prior art is known, bicycles typically include power transmission means embodied in the well known sprocket and roller chain components. Recent advances in the art have brought about multi-speed drive ratios wherein the rider may select the ratio best suiting the course being travelled. While these last mentioned improvements provide for efficient power transmission the rider's pedaling effort constitutes the only source of power. The present hydraulic drive enables an auxiliary source of the power to be added to such pedaling effort.

SUMMARY OF THE INVENTION

The present invention is embodied in a hydraulic drive for a bicycle having a pair of hydraulic cylinders constituting pumps for actuation by the rider's feet. Foot operated pedals are linked to the pistons of said cylinders for pressurizing a fluid flow for ultimately powering the rear wheel of the bicycle. A hydraulic motor, powered by the fluid flow, is in driving engagement with said rear wheel.

An auxiliary flow of hydraulic fluid, supplementing the fluid from the foot powered cylinders, results from the vertical motion of the rider weighted bicycle seat during travel. Accordingly, the hydraulic flow from the foot powered cylinders is intermittently supplemented by a fluid flow resulting from varying loads imparted to the bicycle seat while underway. The pistons of said seat actuated cylinders retract upon the bicycle encountering an uneven ground surface to discharge the auxiliary hydraulic flow with subsequent elevation of the seat being spring actuated.

Additional auxiliary pump means may be located so as to derive a powering force during relative movement between the front fork of the bicycle and the bicycle frame.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing,

FIG. 1 is a side elevational view of a bicycle equipped with the present hydraulic drive with the unseen side being substantially identical,

FIG. 1A is an enlarged detail view of fluid pump means associated with the front fork of the bicycle,

FIG. 2 is a schematic of the hydraulic system,

FIG. 3 is a view taken downwardly along line 3—3 showing details of the pedal arm structure, and

FIG. 4 is a view taken downwardly along line 4—4 of FIG. 1 showing details of mounting means for the auxiliary and foot powered cylinders.

DESCRIPTION OF PREFERRED EMBODIMENTS

With continuing reference to the drawings wherein applied reference numerals identify parts similarly identified in the following specification, the reference numeral 10 indicates a bicycle frame of substantially conventional construction.

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The frame 10, supported by front and rear wheels 11 and 12, supports an elongate seat 13 for the rider or riders, the latter being pivotally mounted at 14 at its forward end for purposes later elaborated upon. A hydraulic motor at 15 is frame mounted to a modified rear fork structure at 16 which serves as a mounting base for additional hydraulic components as later described. The rear fork 16, in distinction to a conventional bicycle frame, is lengthened and terminates rearwardly past the rear tire 12 whereat a spacer block 17 serves to rigidly interconnect the fork ends. The hydraulic motor 15 is suitably secured to the seen side of the rear fork structure 16 as viewed in FIG. 1 alongside the rear wheel. A fluid reservoir 18 is carried by frame 10 with return and discharge conduits terminating therein as later described.

Swingably suspended from the rear fork structure 16 are pedal arm structures 20 for foot actuation. A typical arm structure 20, as seen in FIG. 1, locates a pedal 21 forwardly to conveniently receive a rider's foot. A throw portion 22 of the arm moves about an arm pivot 23 carried by the frame, with the throw end being in pivoted attachment at 22A at its outer end with the end of a piston rod 24. Helical springs at 19 serve to return the pedal arm structures 20 to their raised position. Pedal guides are provided at G and also carry springs 19.

A pair of foot actuated cylinders at 25 are swingably mounted at their base ends as at 26 to fork 16 of frame 10 to permit arcuate cylinder movement during retraction and extension of their respective piston rods. At the base end of each cylinder are inlet and exhaust fittings 27–28 typically shown in FIG. 1 in communication with the bore of the cylinder and also check valves 29 and 30. A fluid supply is provided the cylinders by conduits 31 drawing from reservoir 18. As best seen in FIG. 2 fluid exhausted sequentially from cylinders 25 passes via conduits 32 and 34 to a series of stacked T-fittings at 33 with pressurized hydraulic fluid ultimately entering motor 15 via a conduit 35.

With continuing regard to the motor, the same may be of the sliding vane type with exhausted fluid from the motor returning to the reservoir via a conduit 36. The use of other types of hydraulic motors, as for example, the piston type, is within the scope of the present invention.

A pair of seat powered cylinders are indicated at 37 pivotally mounted in an upright manner at the rearward end of fork 16. With reference to FIG. 4, the base ends of the cylinders are movably mounted on a shaft 38 or otherwise suitably mounted to permit cylinder movement during operable movement of their piston rods indicated at 40. Each of the piston rods 40 terminates upwardly in pivoted attachment at 42 about a crosswise extending seat member 43. Accordingly, as the bicycle is ridden with the rider's weight bearing on seat 13, movement of the seat will occur about the seat pivot means 14 as uneven loads are imparted to the seat as by travel over irregular ground surfaces. Also acting on the piston rods 40 but in an upward direction are a pair of spring members indicated at 44 each within a housing 45. For exhausting a pressurized fluid flow from the lower ends of cylinders 37 a pair of conduits 46–47 are provided terminating in communication with the series of stacked T-fittings 33. For supplying both ends of the

cylinders 37 with hydraulic fluid branched hydraulic lines 50–51 draw from reservoir 18. Check valves 52–53 and 54–55 ensure the desired flow of the exhausted fluid.

From the foregoing description it will be seen that the fluid flow the rider's physical effort exerted on the earlier described pedal arm structures 20 will be supplemented by an auxiliary fluid flow exhausted from cylinders 37. Operation of the bicycle solely with the rider's effort is entirely satisfactory with the auxiliary fluid flow permitting a reduction in the pedalling effort.

The bicycle is, as aforementioned, largely of conventional design and preferably incorporates a conventional rear hub of the well known "3 speed" type. Such hubs permit the rider to select the most suitable gear ratio by means of a handle bar mounted selector not shown. Further explanation of the hub is believed unnecessary as such are well known to those skilled in the art.

The motor 15 with sprocket drives a roller chain 60 (FIG. 2) in driving engagement with a hub mounted sprocket 61. The latter sprocket may be of conventional 48 tooth size while the driving sprocket on the motor output shaft may be a 9 tooth sprocket.

A modified form of the invention encompasses the addition of a second auxiliary source of hydraulic pressure such being by movement of the front wheel fork of the bicycle relative to the bicycle frame. In this modified form of the invention the bicycle is of the type having a yieldable front fork 62 attached to a steerable member in a manner permitting movement of the fork about a normally horizontal, transverse axis indicated at A. Such structure has been embodied in bicycles manufactured in the past by the Schwinn Bicycle Company and was originally manufactured for use in combination with a compression spring element biasing the front wheel to a lowermost position. In the present modification the compression spring element is dispensed with and a hydraulic pressure source at 63 is substituted in its place. A pair of hydraulic lines 64-65 serve the ends of said source of hydraulic pressure with one of said lines drawing from reservoir 18 while the second line exhausts into the stacked T-fittings 33. The pressure source 63 may be embodied in a double acting hydraulic cylinder with internal check valves permitting both charging and simultaneous exhausting of

hydraulic fluid on opposite sides of a piston during either direction of movement of a piston rod 63A. A U-shaped bracket couples the upper end of the fork to the piston rod.

While I have shown but a few embodiments of the invention it will be apparent to those skilled in the art that the invention may be embodied still otherwise without departing from the spirit and scope of the invention.

Having thus described the invention what is desired to be secured under a Letters Patent is:

1. A hydraulic drive for a bicycle, said drive comprising,

a hydraulic motor,

a source of hydraulic fluid,

a power transmission means coupling said motor to the rear wheel of the bicycle,

hydraulic cylinders with reciprocating pistons constituting hydraulic pumps,

pedal arm structures swingably mounted on the frame of the bicycle for actuation by the rider's feet and including a throw portion for reciprocal movement within an arc, said arm structures coupled to the pistons of said hydraulic cylinders for operation of same to pressurize fluid therein,

said hydraulic cylinders being swingably mounted at their base to the bicycle frame and including piston rods terminating at their outer ends in pivoted attachment to said throw portions of the pedal structures whereby foot actuated movement of the throws will exhaust hydraulic fluid under pressure in a sequential manner from said cylinders, and

hydraulic circuitry communicating said hydraulic cylinders with said motor for delivery of a pressurized flow to the motor.

2. The hydraulic drive as claimed in claim 1 additionally including a secondary source for pressurizing hydraulic fluid comprising a pair of upright cylinders pivotally attached at their base ends to the bicycle frame, piston rods extending upwardly from said cylinders for pivoted attachment to the seat component of the bicycle for exhausting fluid from said upright cylinders upon closing movement between said seat and the bicycle frame, means biasing said piston rods and the seat in an opposite direction to a raised position.

* * * * *

United States Patent [19]

Harriger

[11] **Patent Number: 4,546,990**

[45] **Date of Patent: Oct. 15, 1985**

D2

[54] **HYDRAULIC DRIVE SYSTEM FOR BICYCLES AND THE LIKE**

[76] Inventor: George A. Harriger, 1217 E. 7th Ave., Houghton, Mich. 49931

[21] Appl. No.: 529,590

[22] Filed: Sep. 6, 1983

[51] Int. Cl.[4] B62M 19/00

[52] U.S. Cl. 280/216; 280/259; 60/452; 60/491

[58] Field of Search 280/259, 216, 201; 418/29; 60/452, 491; 180/307, 308

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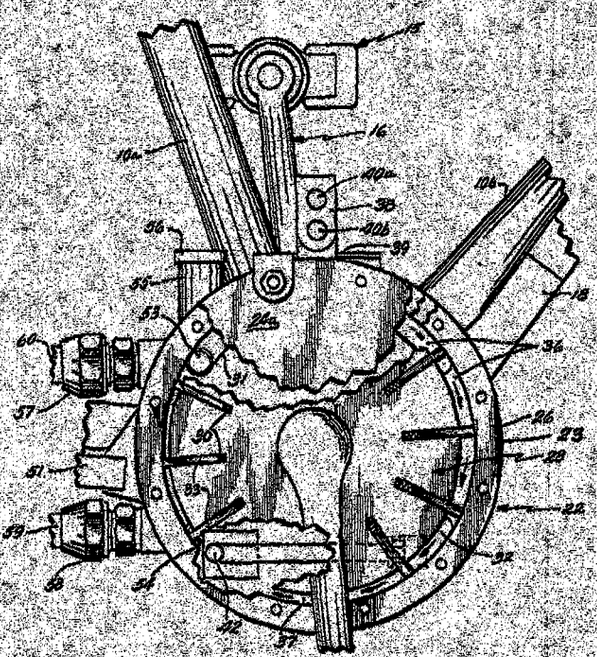
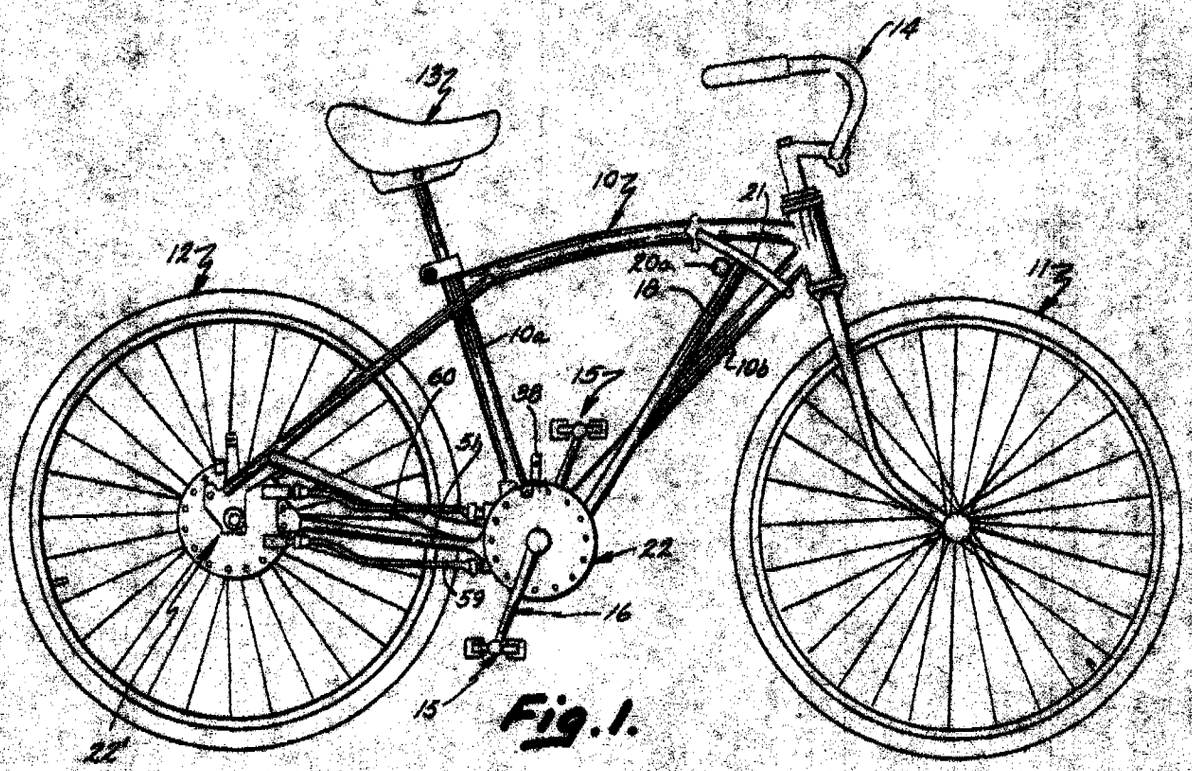
Primary Examiner—Joseph F. Peters, Jr.
Assistant Examiner—Charles R. Watts
Attorney, Agent, or Firm—Price, Heneveld, Huizenga & Cooper

[57] **ABSTRACT**

A hydraulic drive system and a bicycle having such system as its drive train, the system including a pump, preferably a vane pump, operably connected to the bicycle pedal crank, the pump delivering pressurized fluid to a hydraulic motor operably connected to the wheel or mechanism to be driven, e.g., the bicycle drive wheel. The pump has an impeller eccentrically disposed in a housing, and a piston-cylinder mechanism is provided to change the eccentricity of the pump impeller with respect to the pump housing as a function of hydraulic system pressure, to thereby maintain a constant input force, e.g., pedal pressure, and rotation rate, for a wide range of speeds. The motor also has an impeller eccentrically disposed in a housing, and a spacer bar connected between the pump and motor housings automatically adjusts the motor impeller eccentricity with changes in the pump impeller eccentricity, thereby further maintaining constant pedal pressure and rotation rate for a wide range of speeds. A pretensioned spring opposes the movement of the piston in the cylinder, thereby requiring that a predetermined pedal pressure level be exerted before the pump and motor eccentricities will change. A lever is provided for manually setting, and varying, the pretension of the spring to thereby set the pedal pressure level at which the pump and motor impeller eccentricities will be charged.

10 Claims, 7 Drawing Figures




14
13
10
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38
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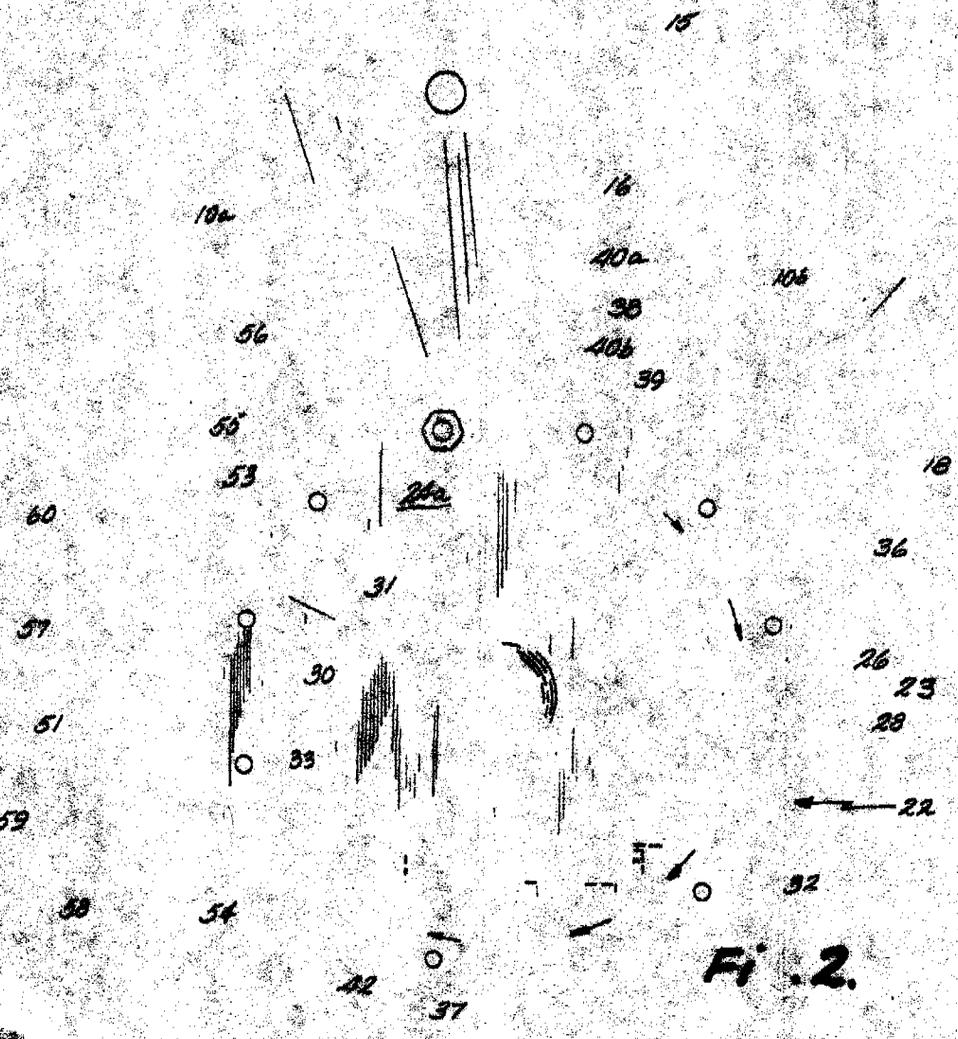
Fig. 1.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16
10a
40a
10b
38
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40b
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55
53
24a
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Fig. 2.

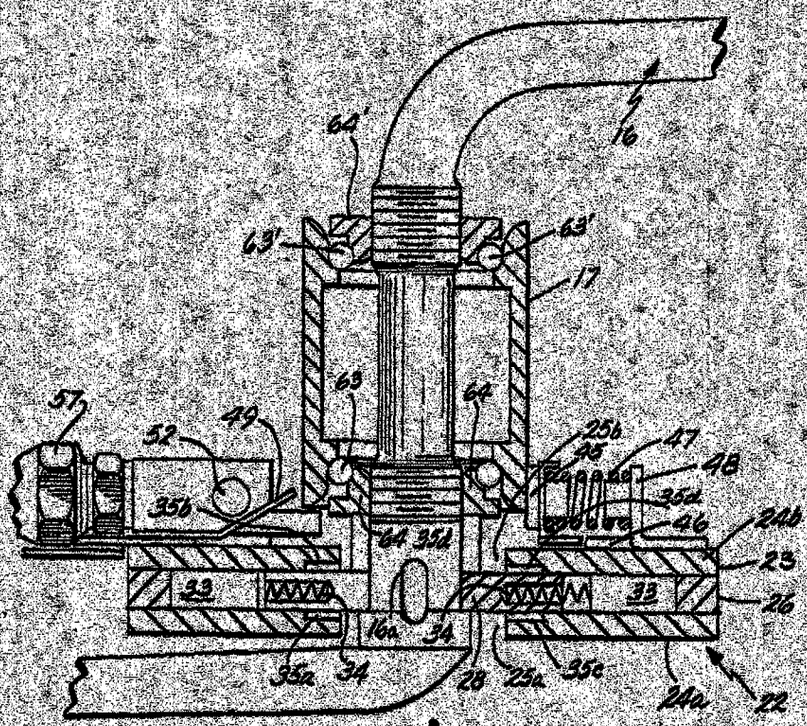
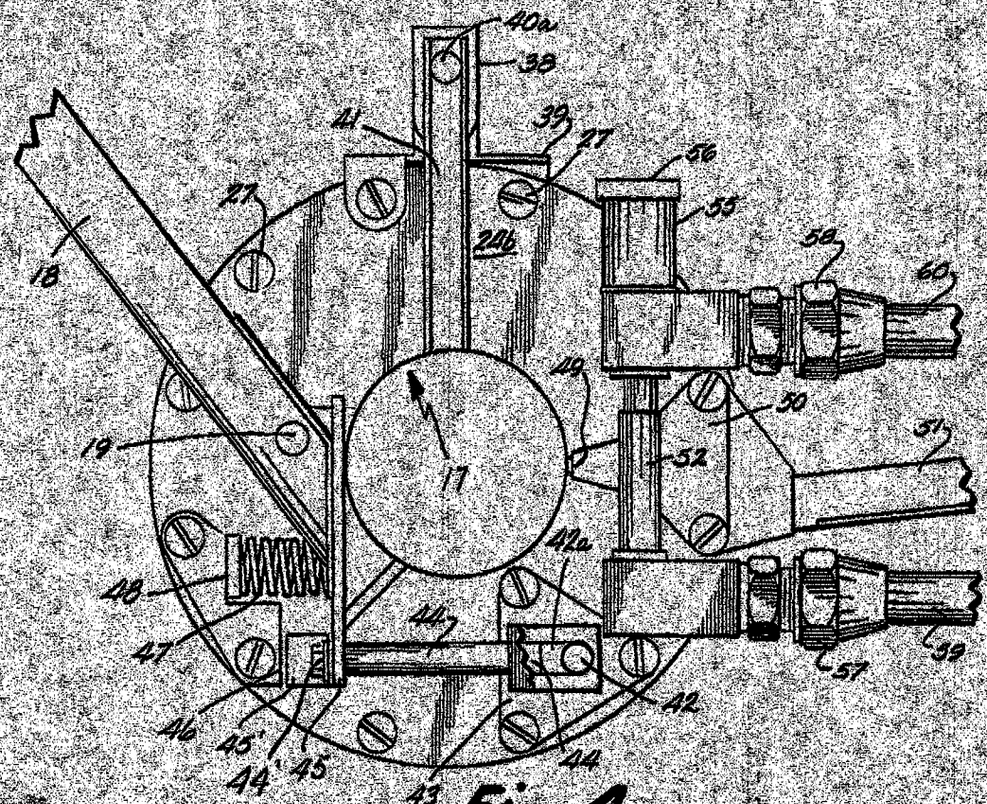

64'
16
63'
63'
17
57
52
49
63
64
25b
35
47
48
35b
35d
46
24b
64
35d
23
33
33
26
16a
34
35a
34
28
25a
35c
24a
12

Fig. 3.


40a
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41
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28b
58
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49
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17
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42a
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Fig. 4.

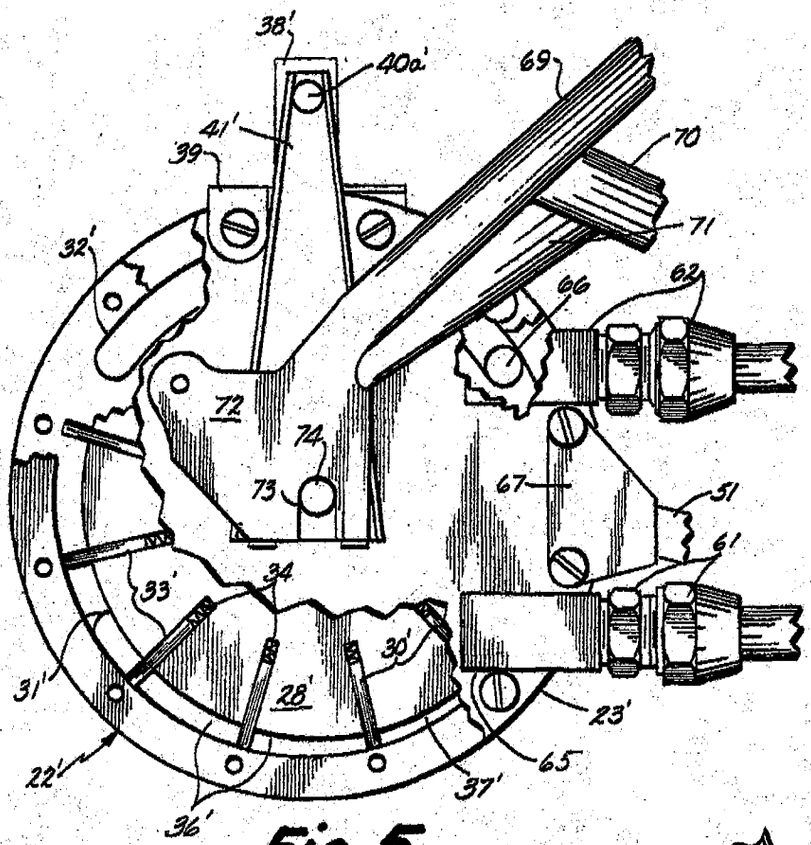

Fig. 5.

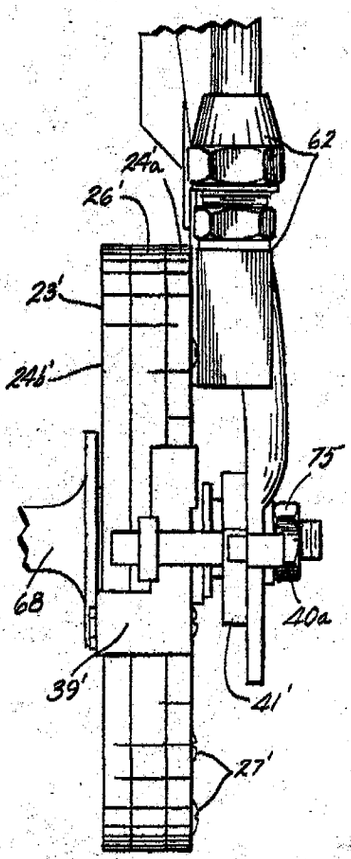

Fig. 6.

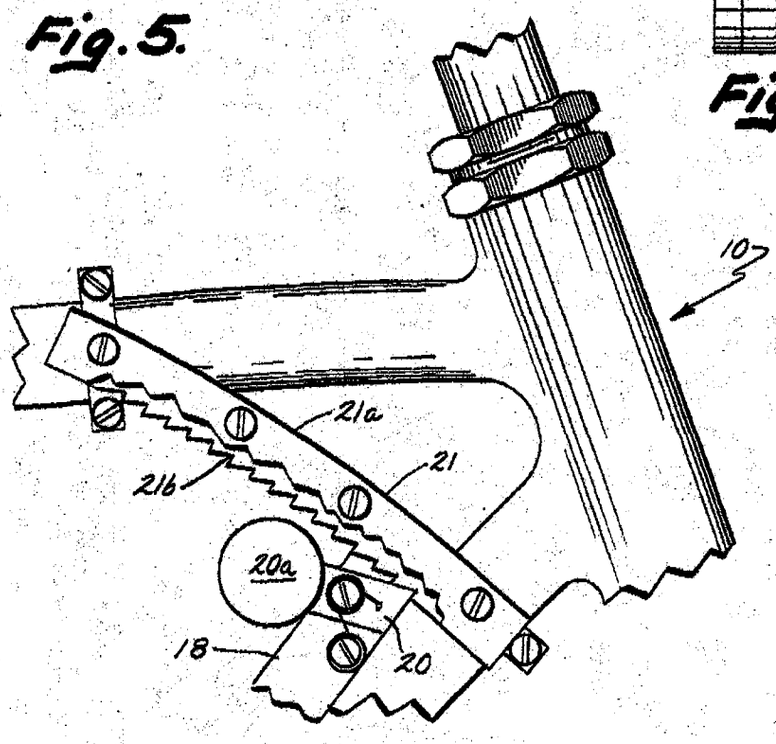

Fig. 7.

HYDRAULIC DRIVE SYSTEM FOR BICYCLES AND THE LIKE

BACKGROUND OF THE INVENTION

The present invention relates to hydraulic drive systems, for vehicles such as bicycles for example, and more particularly to bicycles having a hydraulic variable speed drive mechanism.

In the past, bicycles have typically been driven by chain and sprocket mechanisms. In recent years with the addition of one or more drive sprockets on the crank and a cluster of sprockets on the rear wheel, the bicyclist has been able to select any one of a number of gear ratios by means of a manual shift mechanism which "derails" the chain from one sprocket and moves it to another. Such a shift mechanism can frequently become subject to erroneous operation or result, and can be a clumsy mechanism to operate, the bicyclist sometimes moving the shift mechanism to select a desired gear ratio only to find that the chain has missed the desired gear, sometimes engaging an undesired one. Furthermore, the drive sprocket/sprocket cluster arrangement does not provide a constant pedal pressure or pedal rotation rate over a wide range of bicycle speeds. In other words, the pedal rotation rate and pedal pressure will vary within a given range for any selected gear ratio, from a low rotation rate where considerable pedal pressure may be required to maintain the bicycle's speed to a high pedal rotation rate where the legs have to be moved very rapidly, at a very tiring pace, to maintain the desired speed. Between these extremes, for any particular road condition encountered there is no doubt some gear ratio which will produce a reasonably optimum pedal rotation rate which corresponds to an optimum leg speed and strength for a given individual, but the rider must frequently search for those optimum conditions by shifting the "derailer" mechanism. It can clearly be seen, therefore, that a constant pedal rotation rate and pedal pressure is not maintained across a wide range of bicycle speeds by even the multiple-geared chain and sprocket drive systems.

At least a small number of bicycles have been proposed heretofore employing hydraulic drive mechanisms. In particular, U.S. Pat. No. 4,290,621 issued to Davey discloses a hydraulic multi-speed drive mechanism which employs a plurality of gear pumps and gear motors to drive the bicycle. The drive mechanism of this patent has many of the same disadvantages as the chain/sprocket mechanism discussed above, since it employs a plurality of manually operated valves to adjust the pumping of the hydraulic fluid and the rate at which the hydraulic motor is driven. While it may theoretically be possible for the user of the aforementioned device to continuously adjust the valves to produce a constant pedal pressure and pedal rotation rate for a wide range of bicycle speeds, to do so would be extremely inconvenient and the probable result would be that the bicyclist would not in fact achieve a constant pedal pressure and rotation rate over a wide range of bicycle speeds.

The device of the Davey patent and other prior proposals thus leave a great deal to be desired from a practical standpoint, and do not fulfill much of the promise which a hydraulic drive system really has for bicycles, since they do not provide the essential element of selectably variable "mechanical advantage", particularly by way of mechanisms or means which do not require constant vigilence and manipulation by the rider.

SUMMARY OF THE INVENTION

It is the primary object of this invention to provide an improved hydraulic drive system, for bicycles and other applications, which will automatically maintain a constant actuation force and rotation rate over a wide range of loading, e.g., hills and other terrain conditions, and over a wide range of operating speeds.

It is a further important object of the invention to provide a hydraulic drive system for bicycles and other applications which makes possible the easy and convenient selection and change of actuating (operating) force required by the operator.

It is another object of this invention to provide a hydraulic mechanism which permits the rear wheel of the bicycle to be separated from the frame for service without breaking the fluid connection between the hydraulic pump and hydraulic motor.

The present invention comprises, in a particular embodiment, a bicycle having a vane-type hydraulic pump powered by the conventional pedal and crank arrangement. The vane pump has inlet and outlet ports which are in fluid communication with a hydraulic motor which powers one or more bicycle drive wheels, the pump and motor, and their interconnecting lines being charged with a hydraulic fluid. The vane pump includes a housing having a cylindrical cavity therein in fluid communication with the ports and a cylindrical impeller eccentrically disposed within the housing cavity. A plurality of vanes project radially from the impeller and contact the inner periphery of the cavity. The vanes are spring-loaded to be radially displaceable outward from the impeller, so as to maintain contact with the inside surfaces of the cavity as the impeller rotates eccentrically within the cavity. The vanes define a plurality of segmental chambers between the housing and the impeller, which chambers rotate as the crank and impeller turn in unison. During such rotation of the eccentrically-disposed impeller, each of the chambers will sequentially progressively expand while in fluid communication with the inlet port drawing fluid into the expanding chambers from the inlet port. Each of the chambers then sequentially progressively contracts while in fluid communication with the outlet port, forcing fluid outward from the outlet to the hydraulic motor mechanism. The progressive sequential expansion and contraction of the chambers during impeller rotation is, of course, due to the eccentricity of the impeller with respect to the housing cavity. The hydraulic motor mechanism drives one or more drive wheels of the bicycle, with the fluid pressure in the hydraulic circuit being dependent upon the degree of eccentricity between the impeller and its housing chamber. In accordance with the present invention, this degree of eccentricity is manually variable by the operator so that a desired operating pressure, equating to desired pedal speed and load condition, may be selected. Furthermore, upon selection of any such desired operating pressure, a constant pedal pressure is maintained by automatic adjustment means which continuously varies the impeller eccentricity as necessary to compensate for fluid pressure increases or decreases.

In narrower aspects of the invention, the hydraulic motor comprises a vane-type hydraulic motor essentially like the vane pump described above. The hydraulic motor may also incorporate means for adjusting the

eccentricity of the motor impeller with respect to the motor housing cavity.

In other aspects of the invention, the constant pedal pressure at which the bicycle will be maintained may be manually adjusted over a very wide range, to accommodate bicyclists ranging from the weakest to the strongest, and such adjustments may be made on an essentially continuous basis, i.e., in very small increments, or very large increments, as may be desired, in a smooth and continuous manner and without having to interrupt pedalling.

These and other objects, advantages, and features of the present invention will be more fully understood and appreciated by reference to the written specification and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation of a bicycle embodying the present invention;

FIG. **2** is a fragmentary, side elevation, partly in section, of the vane pump unit;

FIG. **3** is a fragmentary, sectional view of the structure shown in FIG. **2**;

FIG. **4** is a fragmentary, side elevation of the vane pump of the present invention from the side of the pump opposite that shown in FIG. **1**, shown with the pedals and crank removed;

FIG. **5** is a fragmentary, side elevation, partly in section, of the hydraulic motor unit of the present invention;

FIG. **6** is a fragmentary, overhead plan view of the hydraulic motor unit shown in FIG. **5**;

FIG. **7** is a fragmentary, side elevation, partly in section, of an exemplary manual means for selecting, and adjusting the constant pedal pressure at which the bicycle will be operated.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1** of the drawing, the bicycle shown is in many ways conventional, having a frame **10**, a front wheel **11**, a rear wheel **12**, seat **13**, handlebars **14**, pedals **15** and crank **16**. With the exception of the mode of powering the rear drive wheel, the operation and interaction of the above elements are well known. The drive mechanism shown in FIG. **1** comprises a vane-type hydraulic pump **22** and a vane-type hydraulic motor **22'**, both of which will be described in more detail below. The motor **22'** and pump **22** are held in spaced relationship by a spacer bar **51** and are connected by oil pressure line **59** and return oil line **60**. Both the pump **22** and the motor **22'**, as well as the oil lines **59**, **60**, are filled with a light hydraulic oil which is preferably of very low viscosity. An oil reservoir **55** with cap **56** shown in FIG. **4** is provided to keep the hydraulic system fully charged.

Referring specifically to FIG. **2**, the pump **22** of the present invention comprises a housing **23** which includes two side plates **24**(*a*), **24**(*b*) held in spaced relationship by an annular plate spacer or case **26**. Plates **24**(*a*), **24**(*b*) and plate spacer **26** are held together by fastening means such as screws **27** shown in FIG. **4**. Plates **24**(*a*) and **24**(*b*) have central openings **24**(*a*) and **25**(*b*) respectively to receive crank **16**, and conventional seal means (e.g., resilient washer or chevron seals, described subsequently) should be used to prevent hydraulic leakage therebetween.

The volume enclosed by plates **24**(*a*) and **24**(*b*) and spacer **26** forms a cylindrical cavity **37**. Disposed in cavity **37** is an impeller **28**. Vanes **33** extend radially from impeller **28**, the vanes being inserted in radial vane slots **30** in impeller **28**.

Because the rotational speed of impeller **28** is not high enough to create sufficient centrifugal force to hold vanes **33** in contact with the surfaces of cavity **37** radially outward from impeller **28**, vane springs **34** are employed to bias vanes **33** radially outwardly from impeller **28**.

The center of impeller **28** has a bore (not shown) therethrough and is keyed to crank **16** at impeller key slot **16**(*a*) shown in FIG. **3**. Thus, impeller **28** will turn with crank **16** as the latter is rotated by pedalling, the crank being rotatably supported on the bicycle frame in the customary way by bearings described hereinafter.

As shown in FIGS. **2** and **3**, impeller **28** is generally cylindrical or disc-shaped, the center of the cylinder being positioned eccentrically with respect to the center of cavity **37**, as shown in FIG. **2**. Also shown in FIG. **2** are manifold slots **31** and **32** on plate **24**(*b*). As crank **16** and impeller **28** are turned in the clockwise direction as shown in FIG. **2**, vanes **33** will draw hydraulic fluid through pump inlet **53** from return line **60** into a chamber **36** roughly at the ten o'clock position as shown in FIG. **2**. As chambers **36** move in the clockwise direction from the ten o'clock position, they expand until they reach a point near the two o'clock position as shown in FIG. **2**. Between the ten o'clock position and the two o'clock position, chambers **36** are in fluid communication with pump inlet **53** by means of manifold slot **31** in plate **24**(*b*). Manifold slot **31** is an arcuate groove in plate **24**(*b*) and permits fluid to flow around vanes **33** and into expanding chambers **36** between the ten and two o'clock positions as shown in FIG. **2**. Therefore, as chambers **36** expand while moving from the ten o'clock to the two o'clock position, they will draw additional hydraulic fluid through inlet opening **53** and around the vanes **33**. As chambers **36** rotate from about the four o'clock to the eight o'clock positions, chambers **36** progressively contract due to the eccentricity of impeller **28** with respect to cavity **37**. As the fluid in the chambers **36** between the four o'clock and the eight o'clock positions is subjected to increasing pressure by the decreasing volume of chambers **36**, the pressurized fluid is forced through manifold slot **32** on plate **24**(*b*) and out pump outlet **54**, manifold slot **32** being an arcuate groove in plate **24**(*b*), disposed at, and interconnecting, the four o'clock and eight o'clock positions. As chambers **36** move between the eight and ten o'clock positions, they are of relatively constant volume; they are filled with fluid and they repeat the cycle as described above once they pass the ten o'clock position and the pump inlet **53**.

The function of manifold slots **31** and **32** is to maintain the chambers of expanding volume in fluid communication with inlet port **53** and to maintain the chambers of contracting volume in fluid communication with the outlet port **54**. As one skilled in the art will realize, such manifolding means is needed, and conventionally utilized, due to the incompressible nature of the fluid.

The pressurized fluid delivered from pump **22** through pressure oil line **59** can be used to drive practically any desired type of hydraulic motor operably connected to rear wheel **12**. Of course, a hydraulic motor also can be used to drive more than one rear wheel, for instance, on a three-wheeled bicycle.

From FIG. **2**, it should be apparent that the pressure of

fluid delivered to pump outlet 54 will depend upon the eccentricity of impeller 28 with respect to cavity 37, assuming the applied pedal force remains the same. The more eccentric impeller 28 is with respect to cavity 37, the more pressurized the fluid delivered to pump outlet 54 will be, with uniform pedal force. Conversely, the less eccentric impeller 28 is with respect to cavity 37, the less pressurized the fluid will be which is delivered to pump outlet 54 (again assuming uniform pedal force). Thus, impeller 28 is maintained at a constant eccentricity with respect to cavity 37, the pressure of the fluid delivered to pump outlet 54 must be increased if the bicycle is to be driven uphill, i.e., pedal force must increase. Likewise, if the eccentricity is held constant and the bicycle is driven on level ground, pedals 15 and crank 16 would have to be rotated at a progressively faster rate to increase the speed of the bicycle. These characteristics, common in conventional bicycles known heretofore, are not necessarily desirable, as they require the user either to exert high pedal force and/or to move his legs too quickly at a given speed, either condition being unnecessarily tiring.

Therefore, the present invention provides means for changing the eccentricity of impeller 28 with respect to cavity 37. Basically, eccentricity is varied by operation of a piston 44 which is slidably received within cylinder 42, which is in fluid communication with manifold groove 32. Cylinder 42 is fixedly attached to plate 24(*b*) while piston 44 is fixedly attached, by a bolt 44' (FIG. 4), to a piston anchor bracket 45 which in turn is fixedly attached to crank housing 17.

As shown in FIG. 3, crank 16 extends through crank housing 17 and is held in spaced relationship to the walls of crank housing 17 by bearings 63, 63' and bearing races 64 and 64', races 64, 64' being threadably secured to crank 16 as shown in FIG. 3. Since impeller 28 is fixedly attached to crank 16, impeller 28 cannot move laterally with respect to crank housing 17.

By contrast, pump housing 23 is not fixedly attached to either crank housing 17 or crank 16. Instead, pump housing 23 is suspended from crank housing 17 by suspension stand 41 and suspension bracket 39. Suspension bracket 39 is fixedly attached to pump housing 23 as shown in FIGS. 2 and 4. Suspension bracket 39 is in turn pivotally attached to and received between the arms of suspension clevis 38 by clevis pin 40(*b*) shown in FIG. 2. Suspension clevis 38 is also pivotally attached to suspension stand 41 by clevis pin 40(*a*). As shown in FIG. 3, spacer 26 on crank 16 also maintains the pump 22 in spaced relation to crank housing 17.

Further details of the suspension stand apparatus can be seen in FIGS. 5 and 6 which illustrate a virtually identical arrangement used on the rear wheel hydraulic motor mechanism of the bicycle. As can be seen from a top view of the suspension apparatus as shown in FIG. 6, suspension clevis 38' receives suspension bracket 41 and housing 23' is suspended from clevis pin 40(*a*)' by suspension stand 41'.

Referring back to FIG. 4, it should be seen that as fluid pressure increases in the contracting chambers 36 in fluid communication with manifold slot 32 and cylinder 42, piston 44 will force housing 23 in a rearward direction since the top of the piston is exposed to the pressurized fluid. As piston 44 thus moves, housing 23 will simultaneously pivot about suspension stand 41 on clevis pins 40(*a*) and 40(*b*). Referring to FIG. 2, it can be seen that as housing 23 is shifted rearwardly, the eccentricity of impeller 28 with respect to cavity 37 is reduced. As indicated earlier, when the eccentricity is reduced, the pump output pressure is reduced. As shown in FIG. 4, the pressure at which piston 44 will move can be predetermined by selecting a spring 47 of suitable tension to oppose the rearward movement of housing 23 at a given amount of fluid pressure. Spring 47 is biased rearward against piston anchor bracket 45 and forward against return spring bracket 48. Therefore, as the pressure in cylinder 42 increases, the force of spring 47 will oppose the rearward movement of housing 23.

It should be evident that, as is well known in pumps generally, there are practical limits to the allowable movement of housing 23 around impeller 28. For instance, if housing 23 is moved too far rearwardly, the pump will no longer pump pressurized fluid out of pump outlet 54 because the contracting chambers 36 containing pressurized fluid will no longer be in fluid communication with outlet port 54. In addition, the movement of pump housing 23 too far forward will cause it to contact impeller 28, potentially causing damage either to impeller 28, vanes 33 or vane springs 34. Therefore, it is desirable to provide a stop in order to limit the allowable forward movement of housing 23 with respect to impeller 28. It is for this purpose that stop 49, shown in the preferred embodiment of FIGS. 3 and 4, is provided, and stop 46 is provided to limit the allowable rearward movement of housing 23 with respect to impeller 28, stop bracket 46 preferably being formed integrally with return spring bracket 48. The rearward movement of housing 23 beyond an established limit is stopped by a projection 45' on piston anchor bracket 45 when projection 45' meets stop bracket 46.

It is desirable that the fluid pressure produced by pump 22 remain fairly constant, at the level selected by the operator. As the fluid pressure increases as a function of load, as when the bicycle is driven uphill, for instance, the pressure in cylinder 42 will increase and force piston 44 against return spring 47, which in turn will move the pump housing in a direction decreasing the eccentricity of impeller 28 with respect to cavity 37. This decrease in eccentricity has the result of maintaining the fluid pressure at a constant value as the bicycle is driven uphill, thereby enabling the bicyclist to maintain a constant pedal pressure and a constant pedal rotation rate, the speed of the bicycle decreasing commensurately.

Because the desired pedal rotation rate or pedal pressure may vary from individual to individual, lever means such as control lever arm 18 are employed to adjust the pretension of return spring 47 acting between return spring bracket 48 and piston anchor bracket 45. As shown in FIG. 4, control lever 18 is pivotally connected by control lever pivot pin 19 to piston anchor bracket 45. As seen in FIGS. 1 and 7, control lever 18 extends upwardly to a ratchet plate 21, where the pretension of spring 47 can be adjusted by lifting the counterbalancing handle 20*a* and moving ratchet dog 20 along ratchet plate 21. Ratchet plate 21 can be fastened by screws and clamps to the bicycle frame as shown in FIG. 7 and can comprise a series of stacked and overlapping guide plates 21(*a*) without teeth alongside an indexing plate 21(*b*) with teeth, as shown in FIG. 7.

It should be noted that a variety of means can be employed to adjust the pretension of return spring 47 against return spring bracket 48. Control lever 18,

ratchet dog 20, and ratchet plate 21 illustrate merely one preferred embodiment.

As was mentioned above, the pressurized fluid produced by vane pump 22 can be utilized in a variety of hydraulic motors operably connected to rear wheel 12. However, as shown in FIG. 5, a vane-type motor 22' is well suited for this purpose and has certain advantages which will become apparent.

Vane motor 22' (FIGS. 5 and 6) includes the same basic elements as vane pump 22 but operates in an opposite fashion, being rotatably driven by the pressurized fluid applied. Vane motor 22' includes an impeller 28', a housing 23' made from plates 24(*a*)' and 24(*b*)' with spacer 26' interposed between said plates. Plates 24(*a*)' and 24(*b*)' and spacer 26' define a cavity 36' in which impeller 28' is disposed. Plates 24(*a*)' and 24(*b*)' have openings (not shown) similar to openings 25(*a*) and 25(*b*) in the corresponding plates in the vane pump. The openings through plates 24(*a*)' and 24(*b*)' receive the axle assembly 68 to which impeller 28' is fixedly attached.

A motor inlet opening (not shown) and motor outlet opening 66 are provided to receive pressurized fluid and expel unpressurized fluid from the motor, respectively. Vane motor 22' further includes vanes 33' which radially extend outwardly from vane slots 30' in impeller 28'. Vanes 33' are biased outwardly against the sides of cavity 36' by vane springs 34'. Vanes 33', impeller 28' and housing 23' define a plurality of chambers 36' which expand in volume as they move from about the four o'clock to about the eight o'clock position shown in FIG. 5 and contract in volume from the ten o'clock to about the two o'clock position as shown in Fig. as impeller 28' is rotated in the clockwise position. Chambers 36' which are expanding should be in fluid communication with the aforementioned motor inlet provided by motor inlet fitting 61. Manifold slot 31', comprising an arcuate groove in plate 24(*b*)', serves this function. Similarly, vane manifold 32' maintains chambers 36' which are contracting in volume in fluid communication with motor outlet 66 and motor outlet fitting 62.

The operation of vane motor 22' should be apparent at this point. Basically, the pressurized fluid entering through the motor inlet fills the chambers of expanding volume by means of vane manifold 31', thereby forcing impeller 28' to turn in the clockwise direction as shown in FIG. 5. As vanes 33' and chambers 36' reach a point where the volume of chambers 36' begin to contract, the chambers 36' come into fluid communication with motor outlet 66 through vane manifold 32', thereby permitting fluid to be forced out of the vane motor 22'.

The amount of work required to rotate motor impeller 28' will depend upon the degree of eccentricity of impeller 28' with respect to cavity 37'. The greater the eccentricity, the less work will be required to turn impeller 28' in cavity 37'. Of course, the eccentricity should always be maintained such that motor inlet opening 65 is maintained in fluid communication with those chambers 36' of expanding volume. Otherwise, the pump would turn in the direction opposite that shown in FIG. 5, and the fluid would be short-circuited (relieved) to the motor outlet 66. For a given fluid pressure, more work would be required to turn impeller 28' in cavity 37' if the eccentricity of impeller 28' with respect to cavity 37' is reduced. Again, motor inlet 65 should be in fluid communication with those chambers 36' which are expanding in volume as impeller 28' rotates.

Therefore, if the eccentricity of vane motor 22' is varied, the amount of work required to turn impeller 28' can be varied. A piston-cylinder arrangement disclosed previously in connection with the vane pump 22 could be used to vary the eccentricity of impeller 28' with respect to motor housing 23'. However, a spacer bar 51 can conveniently be used as well. As shown in FIG. 1, spacer bar 51 extends between pump housing 23 and motor housing 23' and maintains the two in fixed, spaced relationship with each other. Therefore, as the piston-cylinder arrangement on vane pump 22 causes vane pump housing 23 to move, spacer bar 51 will cause motor housing 23' to move as well. The length of spacer bar 51 should be selected such that impeller 28' will never contact the radially interior surfaces of spacer 26' and so that the eccentricity of impeller 28' in cavity 36' will be such that motor inlet 65 will be in fluid communication with chambers 36' of expanding volume and motor outlet 66 will be in fluid communication with chambers 36' of contracting volume.

Spacer bar 51 if properly sized will allow the simultaneous reduction of the pedal pressure required to operate vane pump 22 and the work required to operate vane motor 22'.

Motor housing 23' is suspended from a suspension stand 41' by clevis 38' and clevis pin 40(*a*)' by suspension bracket 39' and suspension pin 40(*b*)' in a manner previously disclosed.

In one specific example of a preferred embodiment, impellers 28, 28' are 4.75 inches in diameter and cavities 37, 37' are 5.125 inches in diameter. The center of pump housing 23 is placed 0.094 inches forward from the center of impeller 28, and pump housing 23 can be moved rearward to a point where its center is 0.032 inches forward of the center of impeller 28. Similarly, the center of motor housing 23' is placed 0.094 inches rearward from the center of impeller 28', and motor housing 23' is movable forward to a point where the center of motor housing 23' is 0.032 inches rearward from the center of impeller 28'.

When the housings are moved completely rearward, that is, the center of housing 23 is 0.032 inches forward from the center of impeller 28, there should be about 15 inches of travel for about one turn of crank 16 if wheel 12 is 24 inches in diameter. On the other hand, if the center of pump housing 23 is fully forward, that is, the center of pump housing 23 is 0.157 inches forward from the center of impeller 28, there should be about five turns of the wheel, or about 377 inches, for every turn of crank 16, provided rear wheel 12 is 24 inches in diameter. Of course, the above calculations assume rear housing 23' moves corresponding distances with respect to impeller 28' due to the interconnection of the housings by spacer bar 51.

Of course, there are an infinite number of settings between the two settings described above. Therefore, for a given pedal pressure selected by control lever 18 there is a wide range of speed possible with no manual shifting required. Furthermore, the changes between the various speeds will be gradual. Thus, there is no incremental change in either pedal pressure or speed as is characteristic of earlier hydraulic and sprocket mechanisms.

To ensure that little or no fluid will leak out of the hydraulic system of the present invention, annular gaskets 35(*a*) and 35(*b*) (FIG. 3) can be positioned between pump impeller 28 and housing 23, encircling openings 25(*a*) and 25(*b*) respectively. Advantageously, annular

grooves 35(c) and 35(d) can be provided in plates 24(a) and 24(b) around openings 25(a) and 25(b) respectively to receive such gaskets. Similar gaskets can be disposed between motor impeller 28' and plates 24(a)' and 24(b)' to prevent fluid from leaking from the motor. Any leakage of fluid will result in fluid being drawn from reservoir cup 55, which is in fluid communication with pump inlet opening 53.

The hydraulic system of the present invention can be installed on a standard bicycle frame without modification of the frame. However, the frame can be modified slightly to provide means of removing the rear tire without breaking the fluid circuit.

Referring to FIG. 5, one-half of a bifurcated rear wheel support is shown which includes frame elements 69, 70, and 71, and a flange 72 with a slot 73 therein for receiving a threaded rod 74 which extends through rear axle 68. The primary modification illustrated is the orientation of slot 73. In prior art bicycle frames, axle support slots such as slot 73 were oriented at an acute angle to the vertical with the mouth of the slot generally oriented toward the front of the bicycle. Such a slot would be unacceptable in the present design if easy removal of the rear tire is desired, since the prior art slot would require that the wheel be moved forward almost an inch. This would entail disconnecting spacer bar 51, and perhaps oil lines 59 and 60 as well if they were not made from a flexible material. Having slot 73 extend generally vertically downward permits the rear axle to be swung straight down (actually, on a long arc) out of the frame slot. To do so, it is preferable to remove return spring 47, so as to remove pressure from spacer bar 51, and machine screw 44 should also be removed, to disconnect piston 44 from bracket 45. Thus, if nut 75 shown in FIG. 6 is removed, threaded axle rod 74 can be slid downwardly until suspension stand pin 40(a)' comes into contact with the top of plate 72, which should provide enough clearance to remove the tire. As will be understood, the modification of the frame shown in FIG. 5 is also done on the other half of the bifurcated rear wheel support not shown.

The frame elements 69, 70, and 71 are shown with elements 70 and 71 at an angle with one another. In a conventional bicycle, the frame elements 70 and 71 would comprise one horizontal piece interconnecting plate 72 with crank housing 17. Having elements 70 and 71 at an angle to each other permits easy installation of motor outlet fittings 62, of motor inlet fittings 61, and of rear spacer bracket 67 which connects spacer bar 51 to motor housing 23'.

Of course, it is understood that the above disclosure is merely of particular examples of a preferred embodiment of the invention, and that various other embodiments as well as many changes and alterations may be made without departing from the underlying concepts and within the broader aspects of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a bicycle having a frame for supporting at least one drive wheel, pedals mounted on a drive crank for applying power to propel the bicycle, and a crank housing carried on said frame and having means for rotatably mounting said crank, the improvement comprising:

hydraulic motor means operably connected to said drive wheel to rotatably drive said wheel, said motor means having fluid inlet and outlet ports;

a vane-type hydraulic pump having inlet and outlet ports, a housing, and an impeller eccentrically positioned within said housing and operatively connected to said crank for rotation therewith;

fluid conduit means coupling the pump outlet port to the motor inlet port and coupling the pump inlet port to the motor outlet port; and

means for adjusting the eccentricity of said impeller in said housing as said fluid pressure changes in response to changed load, so as to maintain a constant pedal force for rotation of said crank and of said impeller under a range of load conditions, including:

a cylinder fixed in position with respect to said pump housing and in fluid communication with the pressure side of said pump;

a piston means movably received within said cylinder to move as the pressure in said cylinder changes, said piston means operatively connected to said bicycle frame so that said piston means forces said pump housing to move relative to said impeller as the cylinder pressure changes, thereby adjusting said eccentricity as a function of said pressure changes;

biasing means to bias said piston means and housing against movement as pressure increases; and

manual means to selectively adjust the force exerted by said biasing means against said piston means and housing to thereby raise or lower the amount of pressure required in said cylinder to change said eccentricity.

2. The improvement for a bicycle as defined in claim 1 wherein said piston means is secured to said crank housing of said frame by a first bracket attached to said crank housing, wherein said cylinder is attached to said pump housing, wherein said biasing means is disposed between said first bracket and a second bracket attached to said pump housing, and wherein said manual means comprises a lever pivotally attached to said first bracket, said biasing means being disposed to act upon the lever such that pivotal movement of said lever is applied to said biasing means and is transmitted thereby to said first bracket and said piston means.

3. A bicycle as defined in claim 2 which further comprises a pump housing suspension mechanism including a first suspension bracket attached to said crank housing, a second suspension bracket attached to said pump housing, and a suspension member pivotally attached to said suspension stand and to said suspension bracket such that said housing is pivoted on said suspension member by said piston and said cylinder means through said biasing means to move said housing relative to said impeller in a manner which changes said eccentricity.

4. A bicycle as defined in claim 3 which further comprises at least two stop means, one of said stop means for preventing pivotal movement of said housing in one direction beyond a first predetermined point, the other of said stop means for preventing pivotal movement of said housing in a second direction beyond a second predetermined point.

5. A bicycle as defined in claim 1 wherein said hydraulic motor means comprises a vane-type motor, said motor including a housing having inlet and outlet ports and having a generally cylindrical cavity therein in fluid communication with said ports, a generally cylindrical impeller eccentrically disposed within said cavity and having a diameter less than the diameter of said cavity, means for physically connecting said impeller with said

United States Patent [19]

Smith

[11] **Patent Number: 4,688,815**

[45] **Date of Patent: Aug. 25, 1987**

[54] **HYDRAULICALLY DRIVEN BICYCLE**

[75] Inventor: **William V. Smith, Memphis, Tenn.**

[73] Assignee: **Lectrolarm Custom Systems, Inc., Memphis, Tenn.**

[21] Appl. No.: **593,835**

[22] Filed: **Mar. 27, 1984**

[51] **Int. Cl.**[4] **B62M 19/00**

[52] **U.S. Cl.** **280/216**; 418/26; 418/27; 418/30; 418/31; 418/158; 418/159; 418/266; 418/268

[58] **Field of Search** 280/216, 259, 210, 212, 280/214; 180/76, 308; 272/73, 130; 418/266, 259, 268, 30, 29, 158, 159, 26, 27, 31

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Primary Examiner—Joseph F. Peters, Jr.
Assistant Examiner—Mitchell J. Hill
Attorney, Agent, or Firm—Dickstein, Shapiro & Morin

[57] **ABSTRACT**

A hydraulically driven bicycle frame with two axle members coupled to the bicycle frame and front and rear wheels mounted on such axles for rotation about the axis of the respective axle and a pair of pedals mounted on a pedal drive shaft coupled to the bicycle frame for rotation for applying manual power for operating the hydraulic system of the bicycle. The hydraulically driven bicycle has a hydraulic pump mechanism and a hydraulic drive mechanism. The hydraulic pump mechanism is operated by rotational movement of the pedal drive shaft. The hydraulic pump mechanism includes a pump housing having two sectional pump housing members that form a pump chamber between them. The two sectional pump housing members are capable of relative movement with respect to each other so that the pump chamber is capable of being varied in size for varying the flow of fluid through the pump mechanism. The hydraulic drive mechanism is driven by the fluid pump by the pump system and is coupled to one of the wheels of the bicycle for providing a rotational force to such wheel. The hydraulic drive mechanism includes a drive housing having two sectional drive housing members which form a drive chamber between them. The two sectional drive members are capable of relative movement with respect to each other so that the drive chamber is capable of being varied in size for varying the flow of fluid through the hydraulic drive mechanism. The hydraulic pump mechanism and the hydraulic drive mechanism are interconnected by fluid circulating tubes so that a closed hydraulic system is constructed on the bicycle.

46 Claims, 6 Drawing Figures

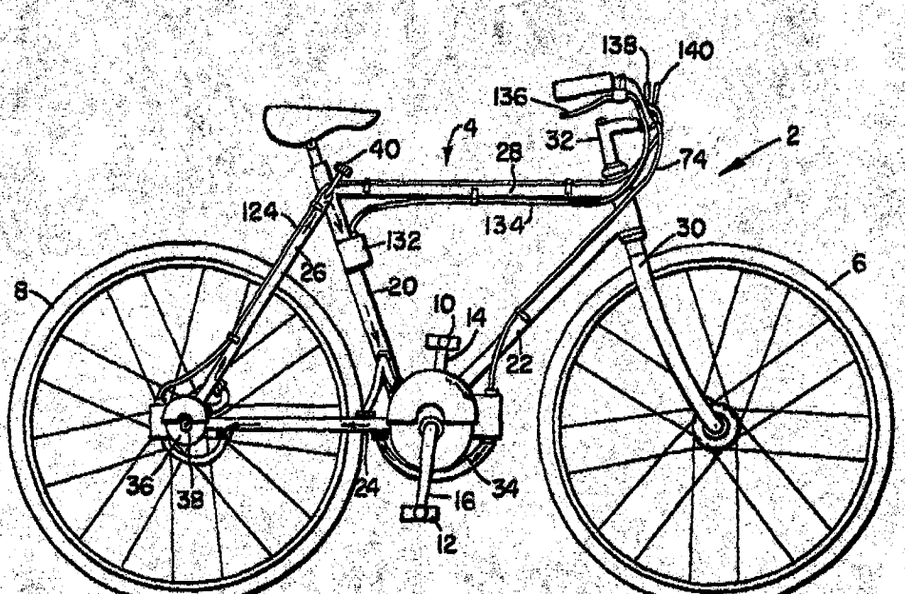

Fig. 1

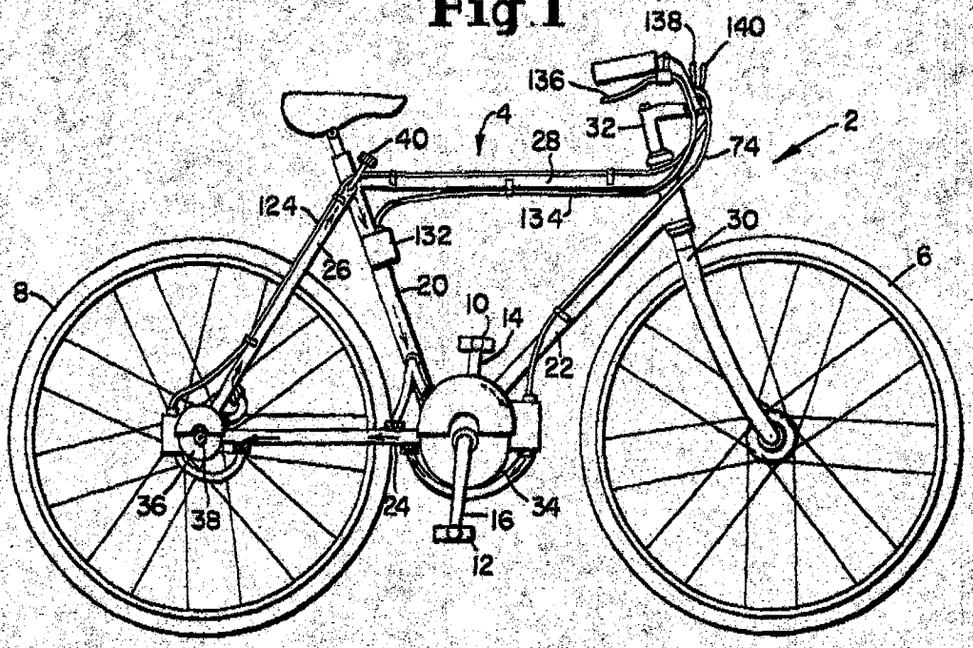

Fig. 2

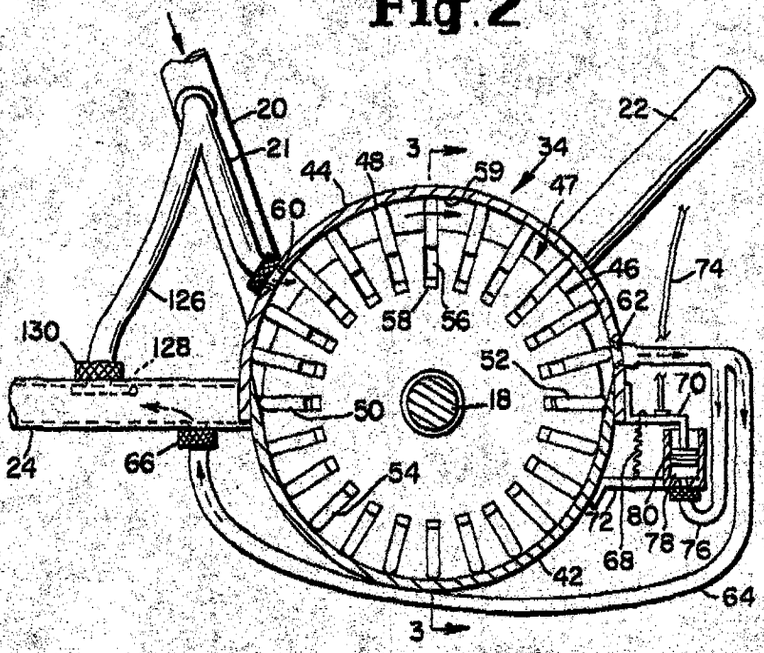

Fig. 3

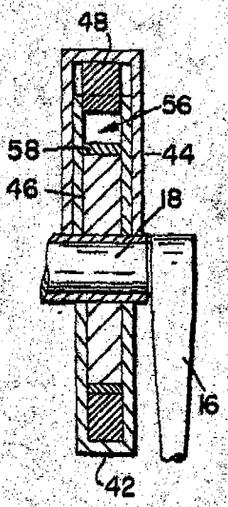

Fig. 4

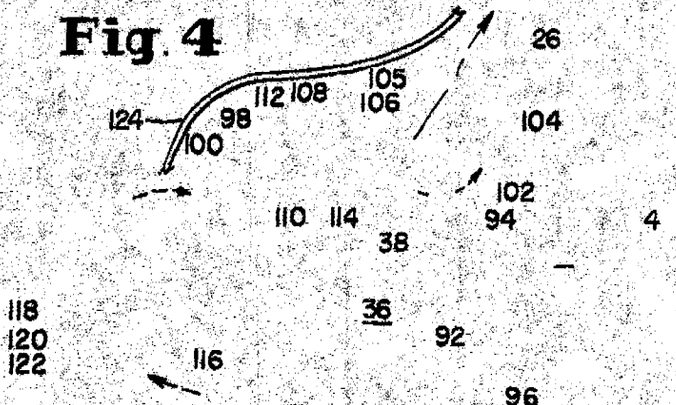

Fig. 5

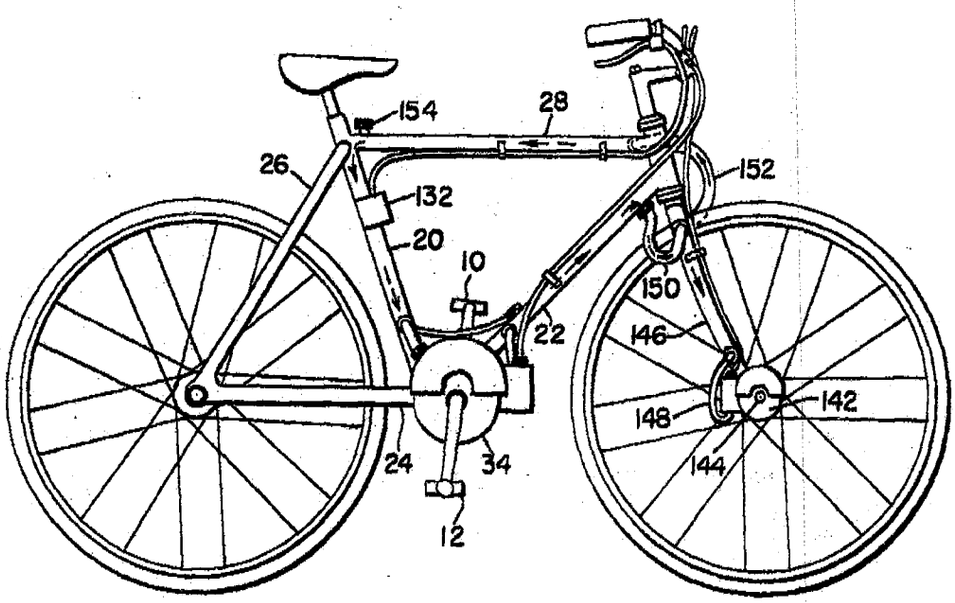
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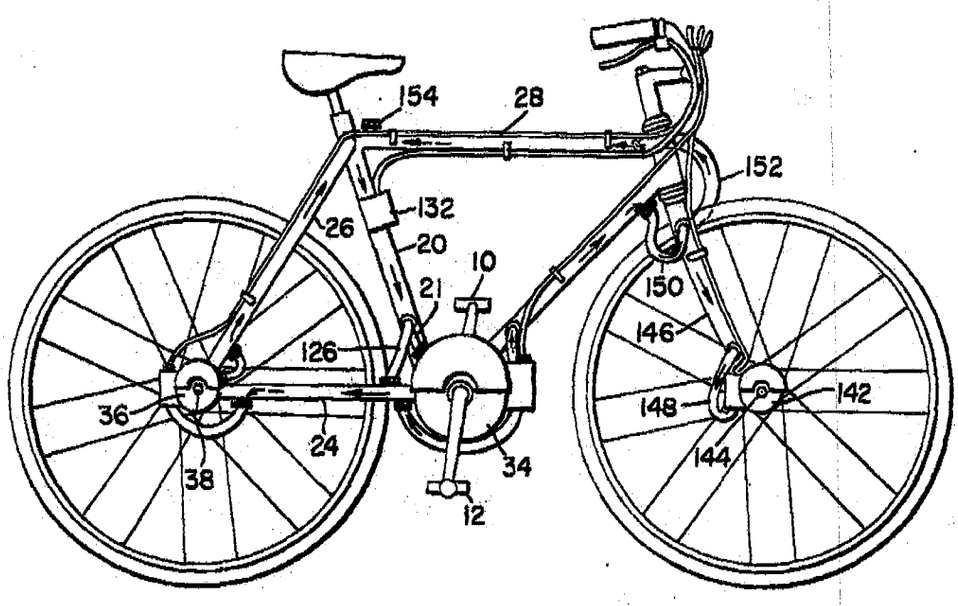
Fig. 6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HYDRAULICALLY DRIVEN BICYCLE

BACKGROUND OF THE INVENTION

The present invention relates to a hydraulically driven bicycle.

A wide variety of different types of two, three and four wheel manually powered hydraulically driven vehicles have been developed over the years. Each of these vehicles has depended upon power generated by the operator of the vehicle by rotating a set of pedals for causing a fluid to circulate through a closed hydraulic system. The circulating fluid is utilized for creating a drive force for powering one of the wheels of the vehicle. Examples of such hydraulically driven vehicles are shown in those patents discussed below.

U.S. Pat. No. 4,290,621 to Davey discloses a hydraulic system for a bicycle, which hydraulic system includes a multi-speed drive mechanism. The speed at which the bicycle is driven by the hydraulic mechanism disclosed in this patent can be varied by varying the volume of the fluid pumped to the hydraulic motor. The hydraulic motor is connected to the rear wheel of the bicycle for driving the rear wheel. The hydraulic system includes a multi-chambered gear pump which is powered by rotation of the pedals. Each of the chambers is provided with a valve recirculation line so that as the pump is operated, the fluid from each chamber can be either recirculated through the pump or directed to a hydraulic line leading to a multi-chambered hydraulic motor which is connected in driving engagement with the rear wheel of the bicycle.

U.S. Pat. No. 1,313,081 to Finney discloses a fluid drive mechanism for driving a two passenger vehicle. In the system disclosed by this patent, the fluid utilized can be either a hydraulic fluid or compressed air. Drive wheels are attached to the front and rear wheels of the vehicle. Each of the drive wheels is arranged within a casing. Each of the casings has an inlet opening and an outlet opening so that fluid can be pumped through the casing. As fluid moves through the casing, it engages a series of blades on the drive wheel which causes rotation of the drive wheel.

U.S. Pat. No. 3,811,704 to Gregoric discloses a hydraulically driven bicycle. The foot pedal of the bicycle disclosed by this patent is used for pumping a hydraulic fluid under pressure to a drive wheel for creating a torque force for providing drive power for the bicycle. The conduit for the drive system for the hydraulic fluid is formed in the frame of the bicycle. The hydraulic system operates to drive the rear wheel of the bicycle.

U.S. Pat. No. 3,850,448 discloses a hydraulic drive system for driving a bicycle and also discloses the use of a hydraulic system for providing a braking action for the bicycle. The force for driving and braking of the bicycle is determined by the direction in which the fluid is pumped within the hydraulic system disclosed in the patent. The fluid can be pumped in one direction for providing a forward drive force for the bicycle and the direction of flow of fluid can be reversed for providing a braking force to the bicycle. The fluid is pumped by a hydraulic pump mounted on the frame of the bicycle. The fluid is pumped to a rear wheel impeller housing and to a front wheel impeller housing. The fluid is pumped through pipes in the frame of the bicycle for driving the front and rear wheel impellers of the bicycle for providing the driving and braking forces to the bicycle.

U.S. Pat. No. 4,078,816 to Smith discloses a hydraulically driven two-wheeled pedicab. The hydraulic system disclosed by this patent includes a Wankel engine. The hydraulic fluid is pumped through the hydraulic system for driving this Wankel engine which in turn generates the drive force for propelling the pedicab.

U.S. Pat. No. 4,087,105 to Amarantos discloses a bicycle which is hydraulically driven with fluid circulated through the hydraulic system by rotation of the bicycle pedals. A throttle valve is placed within the hydraulic fluid flow line of the hydraulic system disclosed in this patent for controlling the flow of fluid discharged from the hydraulically driven motor. By closing this throttle valve, the motor is caused to act as a brake and slows down the movement of the bicycle.

Additional hydraulic drive systems for operator powered vehicles are disclosed in the following U.S. Pat. Nos. 2,793,876 to Allwes; No. 3,729,213 to Hudspeth et al.; No. 3,941,075 to Rupenian; No. 4,082,264 to Santos; No. 4,249,750 to Kantner; and, No. 4,347,700 to Kantner et al.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved manually powered hydraulically driven bicycle.

Another object of the present invention is to provide a hydraulically driven bicycle in which the effective ratio between the pump and drive mechanism can be varied by the operator of the bicycle.

A further object of the present invention is to provide a hydraulically driven bicycle having a hydraulic pump mechanism and a hydraulic drive mechanism in which the chambers of both mechanisms can be varied in size for varying the flow of fluid through such mechanisms.

Still another object of the present invention is to provide a hydraulically driven bicycle having a hydraulic pump mechanism and a hydraulic drive mechanism in which the chambers of both mechanisms can be varied in size for varying the flow of fluid through such mechanisms and each mechanism includes a rotatable cylinder having a plurality of extendable vanes that extend from such cylinder by a distance dependent upon the size of the chamber.

A still further object of the present invention is to provide an improved hydraulically driven bicycle in which the hydraulic drive mechanism can be located on either the front or rear wheel of the bicycle or two such mechanisms can be used for driving both the front and rear wheels of the bicycle.

Still another object of the present invention is to provide an improved hydraulically driven bicycle in which the drive mechanism can be utilized as a brake for braking the rotating bicycle wheel on which such drive mechanism is mounted.

These objectives are achieved by the manually powered hydraulically driven bicycle of the present invention. As with all bicycles, the bicycle of the present invention has a bicycle frame with two axle members coupled to the bicycle frame and front and rear wheels mounted on such axles for rotation about the axis of the respective axle and a pair of pedals mounted on a pedal drive shaft coupled to the bicycle frame for rotation for applying manual power for operating the bicycle. The hydraulically driven bicycle of the present invention also has a hydraulic pump mechanism and a hydraulic

drive mechanism such as set forth below. The hydraulic pump mechanism is operated by rotational movement of the pedal drive shaft. The hydraulic pump mechanism includes a pump housing having two sectional pump housing members that form a pump chamber between them. The two sectional pump housing members are capable of relative movement with respect to each other so that the pump chamber is capable of being varied in size for varying the flow of fluid through the pump mechanism. A rotatable pumping member pumps fluid through the pump chamber. The pedal drive shaft is coupled to this rotatable pumping member for driving such pumping member. The hydraulic drive mechanism is coupled to one of the wheels of the bicycle for providing a rotational force to such wheel. The hydraulic drive mechanism includes a drive housing having two sectional drive housing members which form a drive chamber between them. The two sectional drive members are capable of relative movement with respect to each other so that the drive chamber is capable of being varied in size for varying the flow of fluid through the hydraulic drive mechanism. A rotatable driving member is arranged to be rotated as fluid is circulated through the drive chamber. An output drive shaft is coupled to and rotated by the hydraulic driving member as fluid is circulated through the drive chamber. This output drive shaft is coupled to the wheel of the bicycle that is to be driven by the hydraulic system. The hydraulic pump mechanism and the hydraulic drive mechanism are interconnected by fluid circulating tubes so that a closed hydraulic system is constructed on the bicycle.

The rotatable pumping member includes a pump cylinder having a plurality of radially extending slots and a corresponding plurality of vanes arranged and movable within such slots in the pump cylinder. Each of the vanes is capable of having its outer end extend past the outer circumferential surface of the pump cylinder. As the cylinder is rotated, the vanes can be caused to extend out of the cylinder into the pump chamber so that the rotational movement of the cylinder pumps fluid through the pump chamber. The distance that each of the pump vanes extends past the circumferential surface of the pump cylinder during rotation varies in dependence upon the size of the pump chamber.

The two sectional pump housing members of the pump mechanism surround the pump cylinder. A first of these two sectional housing members is arranged juxtaposed to the pump cylinder. The second of the sectional pump housing members is movable with respect to the first sectional member and the pump cylinder for varying the distance between the second sectional member and the pump cylinder. This space between the second sectional member and the pump cylinder defines the pump chamber.

The pump vanes extend out of their respective slots as the pump cylinder is rotated so that the pump vanes are in contact with the second sectional pump housing member when the pump vanes are rotated through the pump chamber. After the pump vanes pass through the pump chamber, the first sectional pump housing member causes the pump vanes to be retracted back into their corresponding slots. The pump vanes remain in their slots in such retracted position as they are rotated past the first sectional pump housing member.

The pump vanes of the pump mechanism have at least a portion thereof formed of a magnetic material. The second sectional pump housing member has a layer of magnetic material on its inner surface facing the pump vanes. This layer of magnetic material magnetically attracts the pump vanes as the pump vanes are rotated through the pump chamber. This attraction force causes the pump vanes to extend out of their respective slots and for the outer ends of such pump vanes to be adjacent to the second sectional pump housing member as such extended pump vanes pass through the pump chamber. A spring is arranged within each of the slots in the pump chamber. This spring is positioned between the respective pump vane and the bottom of the slot for biasing the pump vane toward the sectional pump housing members.

The hydraulically driven bicycle of the present invention is provided with a hydraulic drive mechanism which drive mechanism is constructed in the same manner as the pump mechanism discussed above. This drive mechanism is arranged adjacent to either the front or rear wheel of the bicycle for generating a rotational force for driving such wheel. It also is possible to incorporate two hydraulic drive mechanisms with one such mechanism being located on each of the wheels of the bicycle so that both wheels of the bicycle are hydraulically driven. In addition, an operator controlled check valve can be arranged within the fluid circulating tube that is coupled to the output of the hydraulic drive mechanism for restricting the flow of fluid through the hydraulic drive mechanism so as to act as a brake by restricting the flow of fluid through the hydraulic drive mechanism and hence restricting the rotational movement of the drive cylinder and the corresponding wheel.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of a hydraulically driven bicycle in accordance with the present invention.

FIG. 2 is a front sectional view of the pump mechanism of the hydraulically driven bicycle shown in FIG. 1.

FIG. 3 is a partial sectional view along lines 3—3 of the pump mechanism shown in FIG. 2.

FIG. 4 is a front partial sectional view of the hydraulic drive mechanism of the hydraulically driven bicycle shown in FIG. 1.

FIG. 5 is a front elevational view of another embodiment of a hydraulically driven bicycle in accordance with the present invention in which the hydraulic drive mechanism is arranged on the front wheel of the bicycle.

FIG. 6 is a front elevational view of a further embodiment of the hydraulically driven bicycle of the present invention in which hydraulic drive mechanisms are located on both the front and back wheels of the bicycle.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A bicycle 2 constructed in accordance with the present invention is shown in FIG. 1. This bicycle has a frame 4 on which there is mounted a front wheel 6 and a rear wheel 8. Pedals 10 and 12 are coupled to a pedal driven shaft 18 (FIG. 2) through pedal mount arms 14 and 16, respectively, for enabling the operator of the bicycle to operate the hydraulically driven drive system of the bicycle.

The hydraulic system of the present invention includes a hydraulic pump system 34 and a hydraulic

D4

US005772225A

United States Patent [19]

Brackett

[11] **Patent Number: 5,772,225**

[45] **Date of Patent: Jun. 30, 1998**

[54] **HYDRAULIC BICYCLE WITH CONJUGATE DRIVE MOTORS**

[76] Inventor: **Douglas C. Brackett**, 2535 Mason Oaks Dr., Valrico, Fla. 33594

[21] Appl. No.: **629,368**

[22] Filed: **Apr. 8, 1996**

[51] **Int. Cl.**[6] **B62M 19/00**

[52] **U.S. Cl.** **280/216**; 280/259; 180/308; 60/468

[58] **Field of Search** 280/216, 215, 280/214, 236, 237, 259; 60/468; 180/367, 305, 307, 308

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Primary Examiner—Kevin Hurley
Attorney, Agent, or Firm—Sellitto & Associates, P.C.

[57] **ABSTRACT**

A device for transmitting power between mechanical movements which includes a fluid pump coupled to a first mechanical movement for pumping a fluid, a fluid motor coupled to a second mechanical movement and a manifold connecting the fluid pump and the fluid motor capable of conducting fluid output from the fluid pump to the fluid motor to drive the fluid motor and recirculate the fluid back to said fluid pump. Either the fluid pump and/or the fluid motor incorporates a conjugate drive motion translator. The power transmission is suitable for use on a bicycle replacing the typical gears and chain and preferably includes a shunt to permit the motor to override the pump, an apportionment valve to control the ratio of movement between a first and second mechanical movement, and a brake valve for stopping the second mechanical movement.

27 Claims, 6 Drawing Sheets

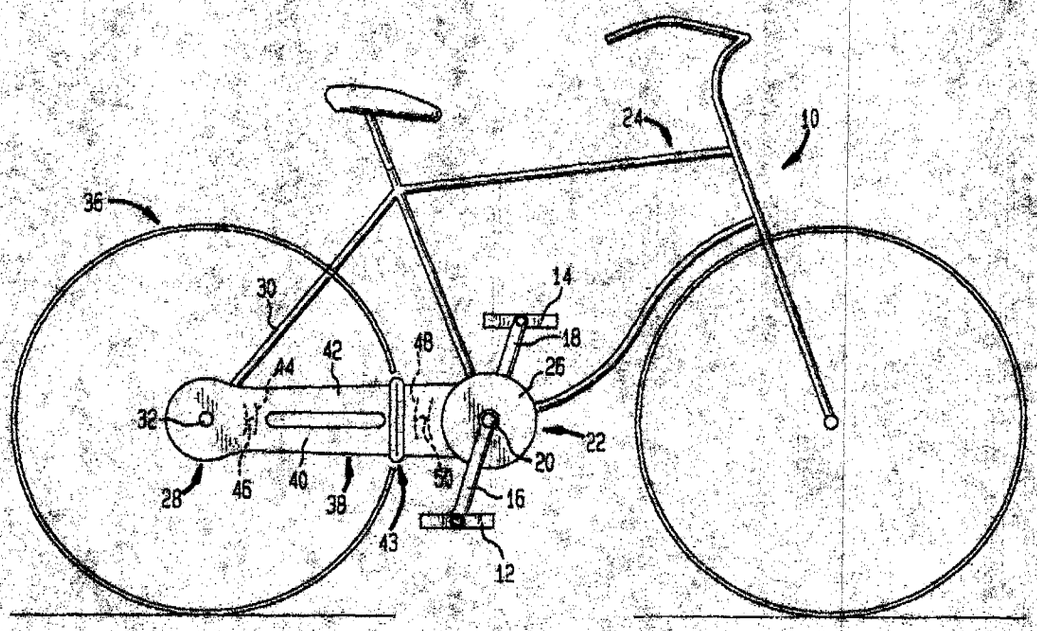


FIG. 6A

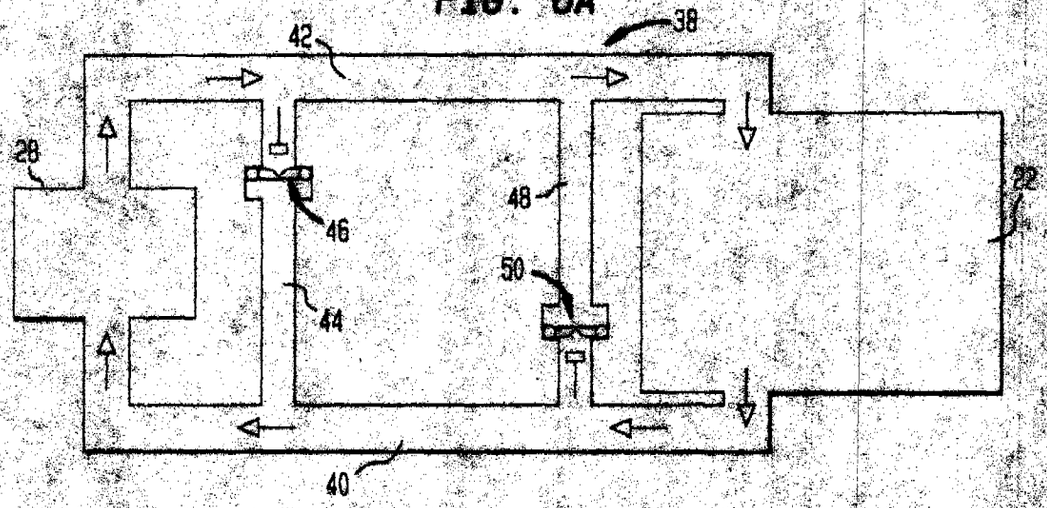


FIG. 6B

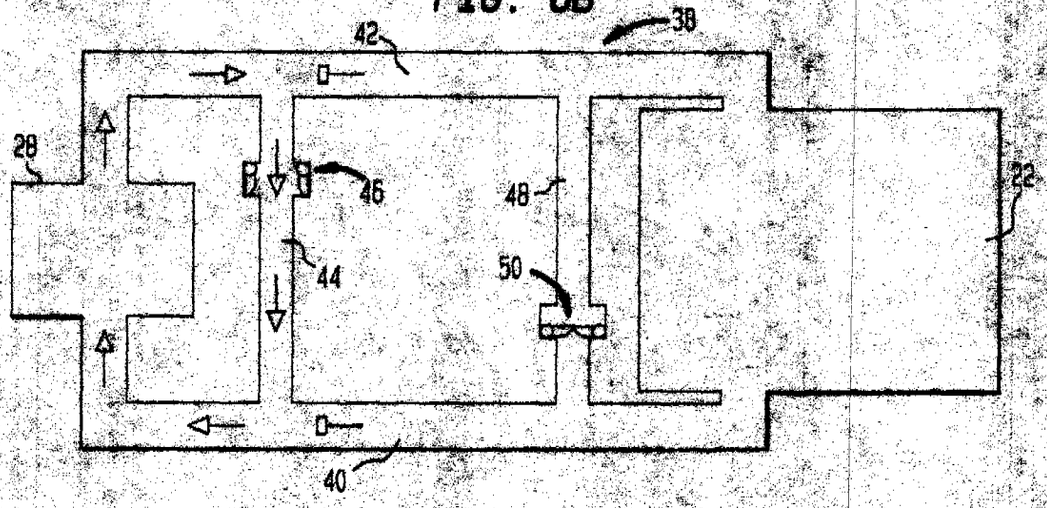
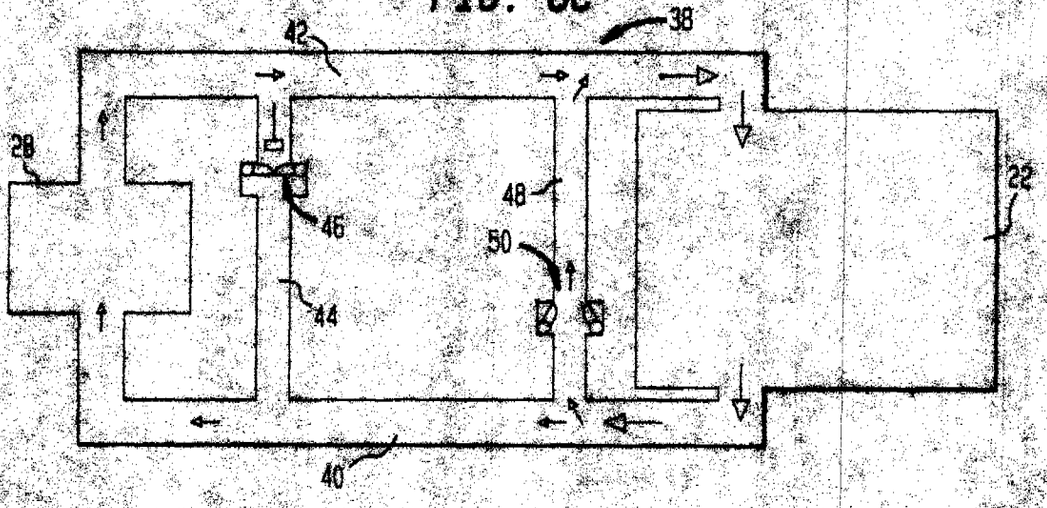


FIG. 6C



HYDRAULIC BICYCLE WITH CONJUGATE DRIVE MOTORS

FIELD OF THE INVENTION

The present invention relates to power and motion transmission apparatus, and more particularly to a transmission mechanism for transmitting power from the pedals of a bicycle to the rear wheel.

BACKGROUND OF THE INVENTION

Various transmission apparatus have been proposed over the years employing gears, clutches, chain drives, belts and the like. As applied to the problem of bicycle propulsion, the traditional mechanism for transmitting power from the rider to a motive wheel is a chain drive wherein a drive sprocket is attached to the pedals of a bicycle and a driven sprocket is attached to the rear wheel. A chain is engaged in the teeth of the sprockets such that rotation of the pedals in a first direction induces the rear wheel to turn. The driven sprocket is generally coupled to the rear wheel via a ratchet or one-way clutch such that the sprocket acts on the rear wheel in one direction of rotation only, i.e., the forward direction, but spins freely in the other direction. This one-way coupling of the drive sprocket to the motive or driven wheel permits the bicyclist to stop pedaling when coasting or braking. It has also become quite common for bicycles to incorporate gear change apparatus to select from a set of available gear ratios between the driven sprocket and the drive sprocket. This is normally accomplished by providing a nest of progressively larger driven sprockets at the rear wheel and a number of drive sprockets coupled to the pedals. Movable chain guides in conjunction with a chain tensioner allow the bicyclist to select which sprockets are utilized by positioning the drive chain over the correct sprocket pair via levers and cables.

While the traditional bicycle chain drive has served its purposes well over the years, it does have certain limitations of functionality and safety. For example, in order to reduce weight, chain drives are typically exposed, creating a safety risk to the rider in the form of entangling clothing in the chain and sprocket. Selectable ratio bicycle transmissions are prone to shifting to the wrong gear and to positioning the chain in an intermediate position between sprockets, leading to a surprising and dangerous slipping of the chain and the consequent unbalancing of the cyclist. Because the chain and sprocket require lubrication, they become a magnet for dust and dirt which impedes efficient power transmission, wears the chain and sprockets and frequently ruins clothing that contacts it by imparting a dirty, greasy stain.

It is therefore an object of the present invention to provide a transmission that reliably and efficiently transmits power from a first mechanical movement to a second. It is a further an object to provide a transmission which can be applied to a bicycle that is cleaner, safer and easier to use than a chain drive.

SUMMARY OF THE INVENTION

The problems and disadvantages associated with the conventional techniques and devices utilized to transmit power between mechanical movements are overcome by the present invention which includes a fluid pump coupled to a first mechanical movement for pumping a fluid, a fluid motor coupled to a second mechanical movement and a manifold connecting the fluid pump and the fluid motor. The manifold is capable of conducting fluid output from the fluid pump to the fluid motor to drive the fluid motor. Fluid is recirculated back to the fluid pump. Either the fluid pump and/or the fluid motor incorporates a conjugate drive motion translator.

BRIEF DESCRIPTION OF THE FIGURES

For a better understanding of the present invention, reference is made to the following detailed description of an exemplary embodiment considered in conjunction with the accompanying drawings, in which:

FIG. **1** is an elevational view of a bicycle in accordance with an exemplary embodiment of the present invention;

FIG. **2** is a plan view of the pedal engine/wheel motor with connecting manifold of the bicycle of FIG. **1**;

FIG. **3** is a cross-sectional view of the pedal engine/wheel motor of the bicycle of FIGS. **1** and **2**, taken along section line III-III and looking in the direction of the arrows;

FIG. **4** is an exploded view of the piston set, mating conjugate driver and crankpin of the pedal engine/wheel motor shown in FIG. **3**;

FIG. **5** is a cross-sectional view of the pedal engine/wheel motor of FIG. **2** taken along section line V—V and looking in the direction of the arrows;

FIGS. **6**A–**6**C are schematic views of the pedal engine/wheel motor and connecting manifold of FIGS. **1**–**5** in three different modes of operation, viz., minimum pedal engine-to-wheel motor turn ratio (**6**A), coast mode (**6**B) and at an intermediate turn ratio (**6**C); and

FIG. **7** is a schematic view of the present invention as shown in FIG. **6**C and further schematically depicting a brake.

DETAILED DESCRIPTION OF THE FIGURES

FIG. **1** shows a bicycle **10** having a pair of pedals **12**, **14** for receiving the feet of a rider. The pedals **12**, **14** are rotatably mounted on a pair of pedal cranks **16**, **18**, respectively, in a conventional manner. Unlike a traditional bicycle where the cranks **16**, **18** would be mounted to a drive sprocket shaft, in the present invention, the cranks **16**, **18** are mounted to the shaft **20** of a pedal engine **22**. The pedal engine **22** is a positive displacement pump for pumping fluids such as hydraulic fluid, oils and gases that is mounted to the bicycle frame **24** with the engine block **26** stationary and the shaft **20** free to rotate as controlled by the rotation of the pedals **12**, **14** by the rider. The method of mounting the engine **22** is conventional and in the manner of that by which internal combustion engines are mounted to the frames of mopeds and motorcycles. A wheel motor **28** of essentially the same general design as the pedal engine **22**, viz., that of a positive displacement pump, is mounted to the rear forks **30** of the bicycle frame **24**. The shaft **32** of the wheel motor **28** is stationary relative to the bicycle frame **24** and may be threaded on either end to approximate the configuration of a traditional rear sprocket shaft which is held onto the rear fork **30** by nuts which compress the forks inward against a land on the shaft **32**. The wheel motor block **34** (see FIG. **2**) is rotatable about the wheel motor shaft **32** in conjunction with the rear wheel **36**. The exterior of the wheel motor block **34** may be configured in the form of a spindle having a pair of spaced, drilled flanges with a plurality of holes for receiving the spokes of the rear wheel **36** or may be held fast to an independent wheel spindle or a solid wheel disk web by bolts or the like.

A manifold **38** is provided to carry the fluid pumped out of the pedal engine **22** to the rear wheel motor **28** to establish

a hydraulic connection for transmitting power from the pedals **12, 14** to the rear wheel **36**. As stated previously and as will be appreciated from FIGS. **3, 4** and **5**, the pedal engine **22** and the wheel motor **28** are both positive displacement pumps, such that the rotation of the pedals **12, 14** a selected number of degrees will correspond to a predetermined output volume of working fluid transmitted to the wheel motor **28** via a first conduit, viz., the feeder conduit **40**. In similar fashion, the reception of a given volume of fluid under pressure at the wheel motor **28** will generate a corresponding predetermined number of degrees of rotation of the motor block **34** and the rear wheel **36** to which it is coupled. Given that the hydraulic connection between the pedal engine **22** and the wheel motor **28** is to be maintained without interruption by contaminants in the working fluid, such as a fluid of different density, e.g., air in a system using hydraulic fluid, the wheel motor **28**, the manifold **38** and pedal engine **22** have all swept volumes thereof filled with fluid at all times. As a consequence, when the wheel motor **28** is rotated by the fluid output of the pedal engine **22**, a fluid output from the wheel motor **28** is induced which is redirected back to the input of the pedal engine **22** through a second conduit in the manifold, viz., return conduit **42**. Thus, the manifold **38** redirects fluid back from the wheel motor **28** to the pedal engine **22** in circuitous fashion such that the same working fluid is constantly recycled. Since the entire system is filled with fluid, Pascal's dictates that the fluid pressure will be equal on all surfaces within a closed volume. Accordingly, the work force will be divided between the pressure and suction side of the wheel motor.

Preferably, the interior contours and volumetric capacity of the manifold **38** are optimized using known hydraulic principles and methods to maximize flow therethrough and to prevent unnecessary fluid turbulence, friction and back pressure. The capacity of the manifold **38** is selected to accommodate the flow volume without appreciable back pressure. The manifold **38** may be cast of any light material such as plastic or aluminum, or may be formed from mandrel bent tubing of suitable volumetric capacity. The manifold **38** is connected to the inlet and outlet ports of the pedal engine **22** and wheel motor **28** in accordance with methods known to those in the art of hydraulic connections and fluid pumps. For example, the pedal engine **22** may be provided with inlet and outlet ports having a suitable surrounding surface for seating a compression gasket interposed between the manifold **38** and the engine **22**. Similarly O-ring seals and/or threaded fittings may be employed.

Alternatively, the manifold may be formed as a continuous casting or molding in continuity with the pedal engine **22** and/or wheel motor **28**. To facilitate changing the rear wheel, the manifold **38** may be provided with a flexible link **43** made of an elastomeric material that allows the manifold **38** to be bent such that the manifold **38** and/or wheel motor **28** swings clear of the frame **30** and/or rear wheel **36**.

As is known from traditional bicycle designs, it is highly desirable to have a mode of operation wherein the drive wheel can freewheel when overtaking the pedalling action of the rider, such as when the rider rests or coasts. This function may be performed by the present invention by including a first shunt manifold passage or coast shunt passage **44** (phantom view) that permits fluid recirculation into and out of the wheel motor **28** without fluid coupling to the pedal engine **22**. A one-way shunt valve **46** (phantom view) must be provided to control the passage of fluid through the coast shunt passage **44**. The flow direction that is enabled through the shunt valve **46** is from the return conduit **42** to the feeder conduit **40**. The shunt valve **46** may be any spring loaded or pressure activated valve, such as a spring loaded or pressure activated poppet valve, a reed valve or the like. In operation, when pedalling is stopped and the cycle continues to coast, the rotating wheel **36** causes the wheel motor **28** to pump fluid. Because the fluid output of the wheel motor **28** is not received by the pedal engine **22**, which is stationary, and because there is no new fluid supplied to the input side of the wheel motor **28**, pressure builds in the coast shunt passage **44** overcoming the closure pressure of the shunt valve **46** allowing fluid to pass through the coast shunt passage **44** and the local portion of the feeder conduit **40** leading to the inlet side of the wheel motor **28**.

The present invention also accommodates the desire to change drive ratios by providing a power shunt passage **48** (phantom view) connecting the feeder conduit **40** to the return conduit **42** and controlled by a power shunt valve **50**. The power shunt valve **50** controls the amount of fluid output from the pedal engine **22** that is shunted or recirculated back to the pedal engine **22** input rather than being directed to the input of the wheel motor **28**. By controlling the volume of fluid reaching the wheel motor **28** for a given number of degrees of pedal rotation, the ratio of degrees of pedal rotation to degrees of drive wheel rotation can be controlled. The power shunt passage **48** and power shunt valve **50** give the present invention the characteristics of an infinitely variable speed transmission. With the power shunt valve **50** closed, all of the fluid pumped out of the pedal engine **22** is directed by the feeder conduit **40** to the wheel motor **28** producing the highest number of revolutions per minute for the drive wheel **36**. As the shunt valve **50** is opened, a portion of the fluid output of the pedal motor **22** bleeds back through the power shunt passage **48** to the return conduit **42** on the intake side of the pedal engine **22**. Since a portion of the fluid output of the pedal engine **22** is recirculated without passing through the wheel motor **28**, the wheel motor **28** rotates at a lower rpm. For example, if the pedal engine **22** and the wheel motor **28** each displace one hundred cubic centimeters of fluid volume in one revolution and the power shunt valve **50** is closed, then one revolution of the pedal engine **22** would produce one revolution of the wheel motor **28**. For this same set of conditions, if the power shunt valve **50** is opened to allow one-quarter of the pedal engine **22** pump output to be recirculated back to its inlet side, then the wheel motor **28** will rotate only three quarters of a revolution.

As a second example, if the pedal engine **22** displaces one hundred cubic centimeters of fluid in one revolution and the wheel motor **28** displaces twenty-five cubic centimeters of fluid in one revolution with the power shunt valve **50** closed, then one revolution of the pedal engine **22** will result in four revolutions of the wheel motor **28**. Under the same conditions, if the power shunt valve **50** were opened to permit three quarters of the pedal engine **22** output to be recirculated to its input side, then one revolution of the pedal engine **22** will generate one revolution of the wheel motor **28**.

Both the coast shunt valve **46** and the power shunt valve **50** may be manually controllable, semi-automatic or fully automatic. For example, the coast shunt valve **46** could be actuated by a hand lever, be enabled by manual control, or automatically respond to pressure differentials by virtue of a spring's compressibility characteristics under a given pressure. Similarly, actuation of the power shunt valve **50** may be manual, enabled to occur (semiautomatic) or automatic under the control of a centrifugal governor or electronic control.

FIG. **2** shows a top view of pedal engine **22**, wheel motor **28** and manifold **38**.

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United States Patent [19]

Brackett

[11] Patent Number: 5,938,224

[45] Date of Patent: Aug. 17, 1999

[54] **HYDRAULIC BICYCLE WITH CONJUGATE DRIVE MOTORS AND VARIABLE STROKE CRANKSHAFT**

[76] Inventor: **Douglas C. Brackett**, 2535 Mason Oaks Dr., Valrico, Fla. 33594

[21] Appl. No.: **08/778,156**

[22] Filed: **Jan. 10, 1997**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/629,368, Apr. 8, 1996.

[51] **Int. Cl.**[6] **B62M 19/00**

[52] **U.S. Cl.** **280/216**; 280/259; 60/468; 74/50; 92/138

[58] **Field of Search** 280/214, 215, 280/216, 236, 237, 259; 60/468, 180/367, 305, 307, 308; 74/49, 50; 92/138, 237

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4,962,644	10/1990	Polacek .	
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Primary Examiner—Kevin Hurley

Attorney, Agent, or Firm—Selitto & Associates

[57] **ABSTRACT**

A device for transmitting power between mechanical movements which includes a fluid pump coupled to a first mechanical movement for pumping a fluid, a fluid motor coupled to a second mechanical movement and a manifold connecting the fluid pump and the fluid motor capable of conducting fluid output from the fluid pump to the fluid motor to drive the fluid motor and recirculate the fluid back to said fluid pump. Either the fluid pump and/or the fluid motor incorporates a conjugate drive motion translator. The power transmission is suitable for use on a bicycle replacing the typical gears and chain and preferably includes a shunt to permit the motor to override the pump, an apportionment valve to control the ratio of movement between a first and second mechanical movement, and a brake valve for stopping the second mechanical movement. Either the fluid pump and/or fluid motor may be of a variable output design incorporating a crankshaft of variable stroke, adjustable on-the-fly.

18 Claims, 21 Drawing Sheets

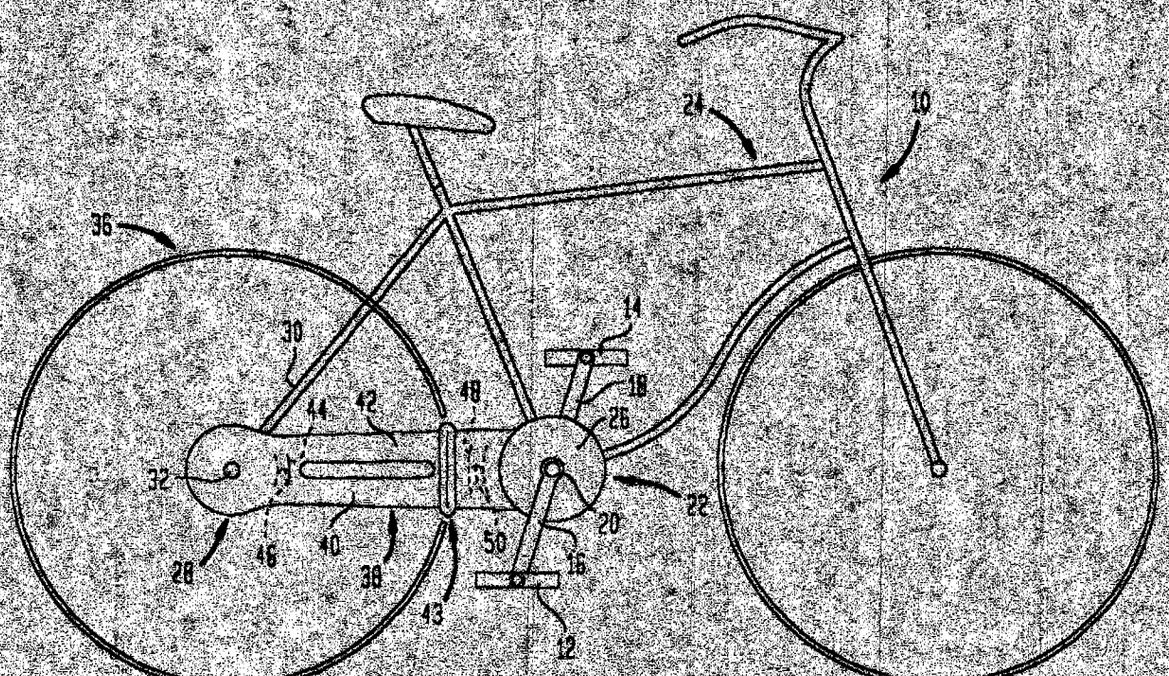


FIG. 6A

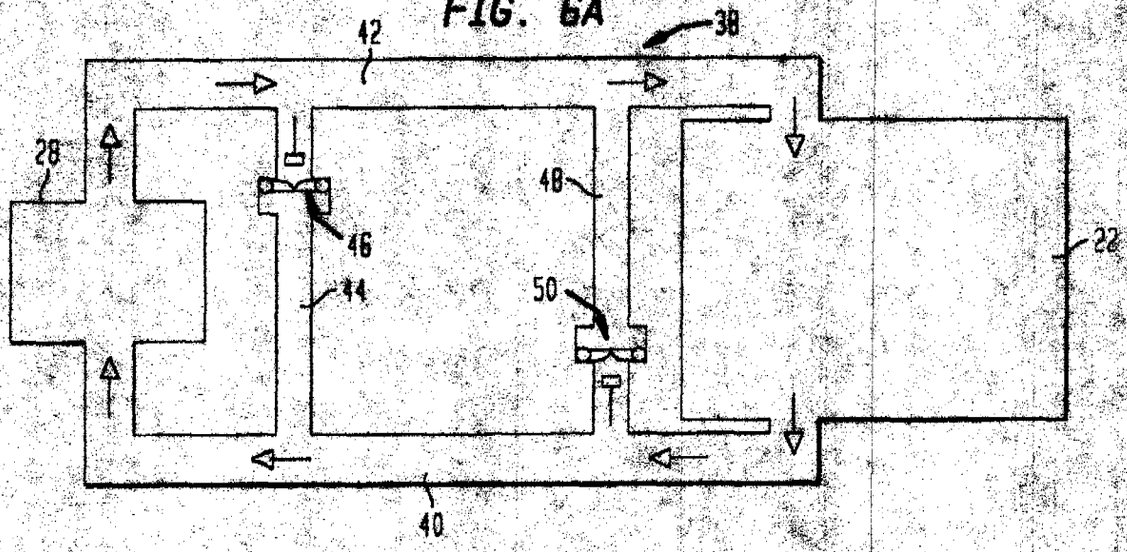


FIG. 6B

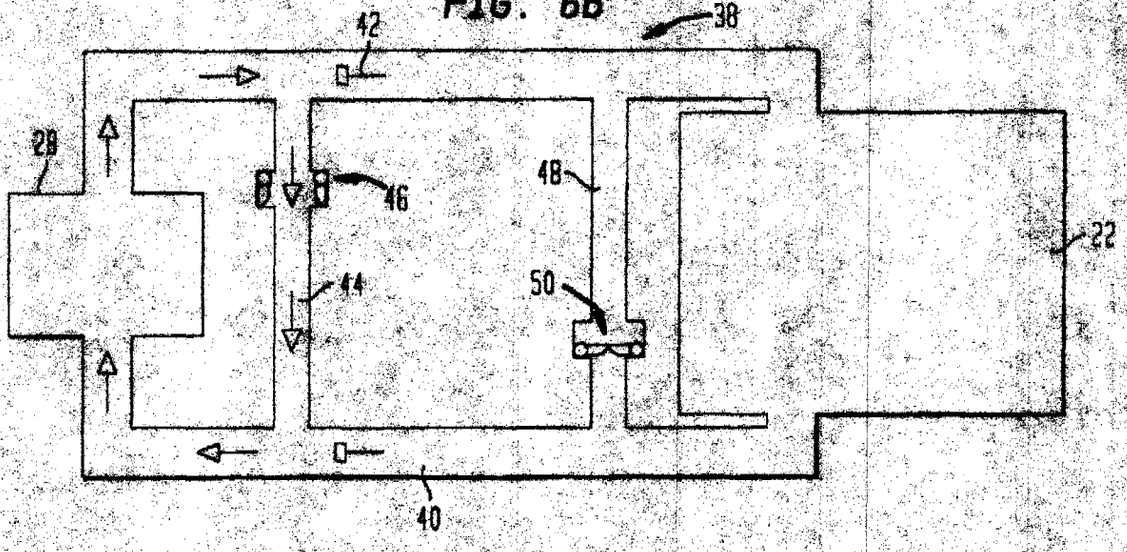
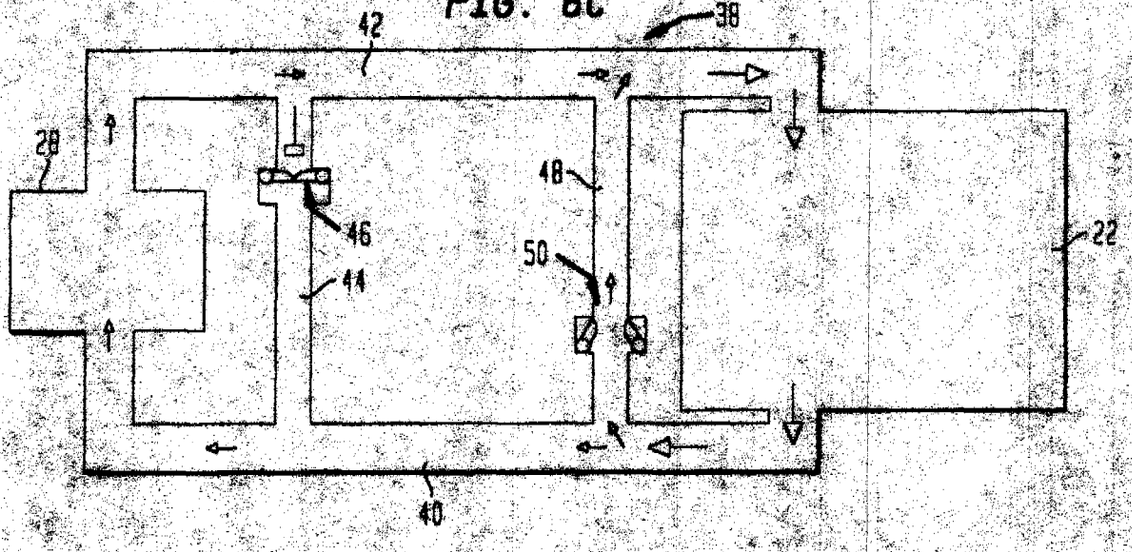


FIG. 6C



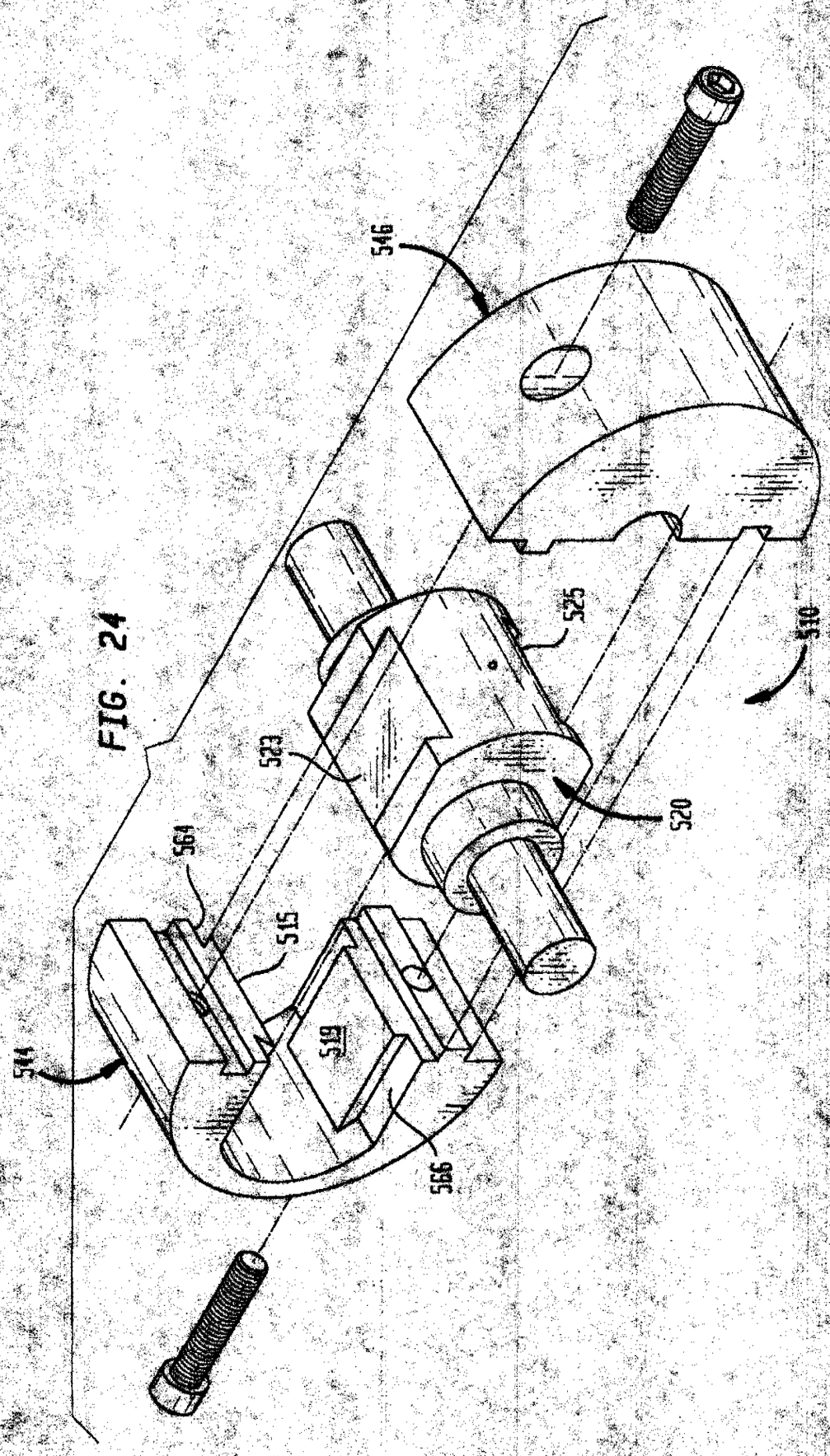


FIG. 24

HYDRAULIC BICYCLE WITH CONJUGATE DRIVE MOTORS AND VARIABLE STROKE CRANKSHAFT

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of application Ser. No. 08/629,368, filed Apr. 8, 1996.

FIELD OF THE INVENTION

The present invention relates to power and motion transmission apparatus, and more particularly to a transmission mechanism for transmitting power from the pedals of a bicycle to the rear wheel.

BACKGROUND OF THE INVENTION

Various transmission apparatus have been proposed over the years employing gears, clutches, chain drives, belts and the like. As applied to the problem of bicycle propulsion, the traditional mechanism for transmitting power from the rider to a motive wheel is a chain drive wherein a drive sprocket is attached to the pedals of a bicycle and a driven sprocket is attached to the rear wheel. A chain is engaged in the teeth of the sprockets such that rotation of the pedals in a first direction induces the rear wheel to turn. The driven sprocket is generally coupled to the rear wheel via a ratchet or one-way clutch such that the sprocket acts on the rear wheel in one direction of rotation only, i.e., the forward direction, but spins freely in the other direction. This one-way coupling of the drive sprocket to the motive or driven wheel permits the bicyclist to stop pedaling when coasting or braking. It has also become quite common for bicycles to incorporate gear change apparatus to select from a set of available gear ratios between the driven sprocket and the drive sprocket. This is normally accomplished by providing a nest of progressively larger driven sprockets at the rear wheel and a number of drive sprockets coupled to the pedals. Movable chain guides in conjunction with a chain tensioner allow the bicyclist to select which sprockets are utilized by positioning the drive chain over the correct sprocket pair via levers and cables.

While the traditional bicycle chain drive has served its purposes well over the years, it does have certain limitations of functionality and safety. For example, in order to reduce weight, chain drives are typically exposed, creating a safety risk to the rider in the form of entangling clothing in the chain and sprocket. Selectable ratio bicycle transmissions are prone to shifting to the wrong gear and to positioning the chain in an intermediate position between sprockets, leading to a surprising and dangerous slipping of the chain and the consequent unbalancing of the cyclist. Because the chain and sprocket require lubrication, they become a magnet for dust and dirt which impedes efficient power transmission, wears the chain and sprockets and frequently ruins clothing that contacts it by imparting a dirty, greasy stain.

It is therefore an object of the present invention to provide a transmission that reliably and efficiently transmits power from a first mechanical movement to a second. It is a further an object to provide a transmission which can be applied to a bicycle that is cleaner, safer and easier to use than a chain drive.

SUMMARY OF THE INVENTION

The problems and disadvantages associated with the conventional techniques and devices utilized to transmit power between mechanical movements are overcome by the present invention which includes a fluid pump coupled to a first mechanical movement for pumping a fluid, a fluid motor coupled to a second mechanical movement and a manifold connecting the fluid pump and the fluid motor. The manifold is capable of conducting fluid output from the fluid pump to the fluid motor to drive the fluid motor. Fluid is recirculated back to the fluid pump. In one embodiment, the fluid pump and/or the fluid motor incorporates a conjugate drive motion translator. In a second embodiment, the fluid pump and/or motor incorporates a variable stroke crankshaft, variable on the fly and during the operation of the device.

BRIEF DESCRIPTION OF THE FIGURES

For a better understanding of the present invention, reference is made to the following detailed description of an exemplary embodiment considered in conjunction with the accompanying drawings, in which:

FIG. **1** is an elevational view of a bicycle in accordance with an exemplary embodiment of the present invention;

FIG. **2** is a plan view of the pedal engine/wheel motor with connecting manifold of the bicycle of FIG. **1**;

FIG. **3** is a cross-sectional view of the pedal engine/wheel motor of the bicycle of FIGS. **1** and **2**, taken along section line III—III and looking in the direction of the arrows;

FIG. **4** is an exploded view of the piston set, mating conjugate driver and crankpin of the pedal engine/wheel motor shown in FIG. **3**;

FIG. **5** is a cross-sectional view of the pedal engine/wheel motor of FIG. **2** taken along section line V—V and looking in the direction of the arrows;

FIGS. **6A–6C** are schematic views of the pedal engine/wheel motor and connecting manifold of FIGS. **1–5** in three different modes of operation, viz., fully hydraulically engaged engine-to-wheel motor turn ratio (**6A**), coast mode (**6B**) and at partial hydraulic slip turn ratio (**6C**);

FIG. **7** is a schematic view of the present invention as shown in FIG. **6C** and further schematically depicting a brake.

FIG. **8** is a plan view of a crankshaft for use in the pedal engine/wheel motor of FIGS. **1–5**;

FIG. **9** is a side view of a crankshaft of FIG. **8**;

FIG. **10** is a front view of the crankshaft shown in FIGS. **8** and **9**;

FIG. **11** is a cross-sectional view of the crankshaft of FIG. **8** taken along section lines XI—XI and looking in the direction of the arrows;

FIG. **12** is the crankpin of FIG. **11** with a pair of active bearing member segments shown exploded away from the crankpin;

FIG. **13** is the crankpin and active bearing member segments of FIG. **12** in an assembled configuration and at a first crankpin bearing offset, namely, zero offset;

FIGS. **14–16** show the crankpin and active bearing member segments of FIG. **13** at three sequentially larger crankpin bearing offset positions;

FIGS. **17–19** show a second adjustable crankshaft for use in the present invention and at three stages of crankpin offset;

FIG. **20** is a plan view of a third adjustable crankshaft assembly constructed in accordance with an exemplary embodiment of the present invention;

FIG. **21** is a front view of the crankshaft assembly illustrated in FIG. **20**;

FIG. **22** is a plan view of a fourth adjustable crankshaft assembly constructed in accordance with an exemplary embodiment of the present invention;

FIG. **23** is a cross-sectional view of the crankshaft assembly illustrated in FIG. **22**, taken along the line XXIII—XXIII and looking in the direction of the arrows;

FIG. **24** is an exploded perspective view of a fifth adjustable crankshaft assembly constructed in accordance with an exemplary embodiment of the present invention;

FIG. **25** is a side view of the crankshaft assembly illustrated in FIG. **24**;

FIG. **26** is a front view of a crankshaft assembly as illustrated in FIG. **20** wherein the active bearing member travels along an arcuate path;

FIG. **27** is a front view of a crankshaft assembly as in FIG. **26** with the arcuate path of the active bearing member displaced eccentrically relative to the outer cylindrical surface of the active bearing member;

FIG. **28** is a front view of a crankshaft assembly as illustrated in FIG. **27** but incorporating a positioning piston and mating cylinder shown in phantom;

FIG. **29** is a front view of a sixth crankshaft assembly suitable for use in the present invention and utilizing a one-piece active bearing member;

FIG. **30** is a side view of the crankshaft assembly shown in FIG. **29**;

FIG. **31** is a side view of a seventh crankshaft assembly constructed in accordance with an exemplary embodiment of the present invention utilizing a composite active bearing member;

FIG. **32** is a front view of the crankshaft assembly of FIG. **31**;

FIG. **33** is a side view of an eighth crankshaft assembly in accordance with an alternative embodiment of the present invention;

FIG. **34** is a front view of the crankshaft assembly of FIG. **33**;

FIG. **35** is a partially schematic plan view of the internal components of the crankshaft assembly of FIGS. **33** and **34**;

FIG. **36** diagrammatically depicts an adjustable crankshaft in a conjugate drive system.

DERAILED DESCRIPTION OF THE FIGURES

FIG. **1** shows a bicycle **10** having a pair of pedals **12**, **14** for receiving the feet of a rider. The pedals **12**, **14** are rotatably mounted on a pair of pedal cranks **16**, **18**, respectively, in a conventional manner. Unlike a traditional bicycle where the cranks **16**, **18** would be mounted to a drive sprocket shaft, in the present invention, the cranks **16**, **18** are mounted to the shaft **20** of a pedal engine **22**. The pedal engine **22** is a positive displacement pump for pumping fluids such as hydraulic fluid, oils and gases that is mounted to the bicycle frame **24** with the engine block **26** stationary and the shaft **20** free to rotate as controlled by the rotation of the pedals **12**, **14** by the rider. The method of mounting the engine **22** is conventional and in the manner of that by which internal combustion engines are mounted to the frames of mopeds and motorcycles. A wheel motor **28** of essentially the same general design as the pedal engine **22**, viz., that of a positive displacement pump, is mounted to the rear forks **30** of the bicycle frame **24**. The shaft **32** of the wheel motor **28** is stationary relative to the bicycle frame **24** and may be threaded on either end to approximate the configuration of a traditional rear sprocket shaft which is held onto the rear fork **30** by nuts which compress the forks inward against a land on the shaft **32**. The wheel motor block **34** (see FIG. **2**) is rotatable about the wheel motor shaft **32** in conjunction with the rear wheel **36**. The exterior of the wheel motor block **34** may be configured in the form of a spindle having a pair of spaced, drilled flanges with a plurality of holes for receiving the spokes of the rear wheel **36** or may be held fast to an independent wheel spindle or a solid wheel disk web by bolts or the like.

A manifold **38** is provided to carry the fluid pumped out of the pedal engine **22** to the rear wheel motor **28** to establish a hydraulic connection for transmitting power from the pedals **12**, **14** to the rear wheel **36**. As stated previously and as will be appreciated from FIGS. **3**, **4** and **5**, the pedal engine **22** and the wheel motor **28** are both positive displacement pumps, such that the rotation of the pedals **12**, **14** a selected number of degrees will correspond to a predetermined output volume of working fluid transmitted to the wheel motor **28** via a first conduit, viz., the feeder conduit **40**. In similar fashion, the reception of a given volume of fluid under pressure at the wheel motor **28** will generate a corresponding predetermined number of degrees of rotation of the motor block **34** and the rear wheel **36** to which it is coupled. Given that the hydraulic connection between the pedal engine **22** and the wheel motor **28** is to be maintained without interruption by contaminants in the working fluid, such as a fluid of different density, e.g., air in a system using hydraulic fluid, the wheel motor **28**, the manifold **38** and pedal engine **22** have all swept volumes thereof filled with fluid at all times. As a consequence, when the wheel motor **28** is rotated by the fluid output of the pedal engine **22**, a fluid output from the wheel motor **28** is induced which is redirected back to input of the pedal engine **22** through a second conduit in the manifold, viz., return conduit **42**. Thus, the manifold **38** redirects fluid back from the wheel motor **28** to the pedal engine **22** in circuitous fashion such that the same working fluid is constantly recycled. Since the entire system is filled with fluid, Pascal's law dictates that the fluid pressure will be equal on all surfaces within a closed volume. Accordingly, the work force will be divided between the pressure and suction side of the wheel motor.

Preferably, the interior contours and volumetric capacity of the manifold **38** is optimized using known hydraulic principles and methods to maximize flow therethrough and to prevent unnecessary fluid turbulence, friction and back pressure. The capacity of the manifold **38** is selected to accommodate the flow volume without appreciable back pressure. The manifold **38** may be cast of any light material such as plastic or aluminum, or may be formed from mandrel bent tubing of suitable volumetric capacity. The manifold **38** is connected to the inlet and outlet ports of the pedal engine **22** and wheel motor **28** in accordance with methods known to those in the art of hydraulic connections and fluid pumps. For example, the pedal engine **22** may be provided with inlet and outlet ports having a suitable surrounding surface for seating a compression gasket interposed between the manifold **38** and the engine **22**. Similarly O-ring seals and/or threaded fittings may be employed.

Alternatively, the manifold may be formed as a continuous casting or molding in continuity with the pedal engine **22** and/or wheel motor **28**. To facilitate changing the rear wheel, the manifold **38** may be provided with a flexible link **43** made of an elastomeric material that allows the manifold **38** to be bent such that the manifold **38** and/or wheel motor **28** swings clear of the frame **30** and/or rear wheel **36**.

As is known from traditional bicycle designs, it is highly desirable to have a mode of operation wherein the drive

wheel can freewheel when overtaking the pedalling action of the rider, such as when the rider rests or coasts. This function may be performed by the present invention by including a first shunt manifold passage or coast shunt passage **44** (phantom view) that permits fluid recirculation into and out of the wheel motor **28** without fluid coupling to the pedal engine **22**. A one-way shunt valve **46** (phantom view) must be provided to control the passage of fluid through the coast shunt passage **44**. The flow direction that is enabled through the shunt valve **46** is from the return conduit **42** to the feeder conduit **40**. The shunt valve **46** may be any spring loaded or pressure activated valve, such as a spring loaded or pressure activated poppet valve, a reed valve or the like. In operation, when pedalling is stopped and the cycle continues to coast, the rotating wheel **36** causes the wheel motor **28** to pump fluid. Because the fluid output of the wheel motor **28** is not received by the pedal engine **22**, which is stationary, and because there is no new fluid supplied to the input side of the wheel motor **28**, pressure builds in the coast shunt passage **44** overcoming the closure pressure of the shunt valve **46** allowing fluid to pass through the coast shunt passage **44** and the local portion of the feeder conduit **40** leading to the inlet side of the wheel motor **28**.

The present invention also accommodates the desire to partially or wholly disengage the hydraulic drive by providing a power shunt passage **48** (phantom view) connecting the feeder conduit **40** to the return conduit **42** and controlled by a power shunt valve **50** (clutch valve). The power shunt valve **50** controls the amount of fluid output from the pedal engine **22** that is shunted or recirculated back to the pedal engine **22** input at a given pressure rather than being directed to the input of the wheel motor **28**. By controlling the volume of fluid reaching the wheel motor **28** for a given number of degrees of pedal rotation, the ratio of degrees of pedal rotation to degrees of drive wheel rotation can be controlled. The power shunt passage **48** and power shunt valve **50** therefore give the present invention some of the characteristics of an infinitely variable ratio transmission. With the power shunt valve **50** closed, all of the fluid pumped out of the pedal engine **22** is directed by the feeder conduit **40** to the wheel motor **28** producing the highest number of revolutions per minute for the drive wheel **36**. As the shunt valve **50** is opened, a portion of the fluid output of the pedal motor **22** bleeds back through the power shunt passage **48** to the return conduit **42** on the intake side of the pedal engine **22**. Since a portion of the fluid output of the pedal engine **22** is recirculated without passing through the wheel motor **28**, the wheel motor **28** rotates at a lower rpm. For example, if the pedal engine **22** and the wheel motor **28** each displace one hundred cubic centimeters of fluid volume in one revolution and the power shunt valve **50** is closed, then one revolution of the pedal engine **22** would produce one revolution of the wheel motor **28**. For this same set of conditions, if the power shunt valve **50** is opened to allow one-quarter of the pedal engine **22** pump output to be recirculated back to its inlet side, then the wheel motor **28** will rotate only three quarters of a revolution.

As a second example, if the pedal engine **22** displaces one hundred cubic centimeters of fluid in one revolution and the wheel motor **28** displaces twenty-five cubic centimeters of fluid in one revolution with the power shunt valve **50** closed, then one revolution of the pedal engine **22** will result in four revolutions of the wheel motor **28**. Under the same conditions, if the power shunt valve **50** were opened to permit three quarters of the pedal engine **22** output to be recirculated to its input side, then one revolution of the pedal engine **22** will generate one revolution of the wheel motor **28**.

Both the coast shunt valve **46** and the power shunt valve **50** may be manually controllable, semi-automatic or fully automatic. For example, the coast shunt valve **46** could be actuated by a hand lever, be enabled by manual control, or automatically respond to pressure differentials by virtue of a spring's compressibility characteristics under a given pressure. Similarly, actuation of the power shunt valve **50** may be manual, enabled to occur (semiautomatic) or automatic under the control of a centrifugal governor or electronic control. While the power shunt valve **50** provides turn ratio control at a given hydrostatic pressure, the shunt valve **50** does not provide maximum mechanical advantage or torque control. To achieve same, the present invention employs a variable output pump or motor as described below.

FIG. **2** shows a top view of pedal engine **22**, wheel motor **28** and manifold **38**.

FIGS. **3**, **4** and **5** show the internal components of a pedal engine **22** in accordance with the present invention. The wheel motor **28** may have the exact same configuration and for the purposes of the following description is assumed to be the same as the pedal engine **22**. Whereas many different types of positive displacement pumps can be employed as the pedal engine **22** and/or the wheel motor **28**, the embodiment of the present invention depicted in FIGS. **3**, **4** and **5** is that of a pump using a unique motion translator invented by the present inventor herein and entitled a "conjugate drive" type motion translator. A complete description of conjugate drive motion translators is provided in U.S. Pat. Nos. B1 5,259,256, 5,259,256, 5,351,567, 5,417,309, 5,445,039 and 5,456,159, such patents being incorporated herein by reference for their teachings regarding conjugate drives. Both the pedal engine **22** and the wheel motor **28** employ conjugate drive positive displacement pumps in the embodiment of the present invention depicted in FIGS. **3**, **4** and **5**.

The conjugate drive is a new, mechanical, linear-to-rotary or rotary-to-linear motion conversion device with considerable advantages over conventional connecting rod, scotch yoke, and other standard mechanisms. The conjugate drive is a compact design which has less inertia, bearing loads, and structural weight than standard mechanisms and uses a rigid structure to transfer forces through wave-shaped interface surfaces allowing for a pure rolling motion with continuous contact. The waved-shaped interface surfaces provide for a wide range of unique, highly flexible, dynamic piston motion controls. These motions allow the conjugate drive to optimize the input force and increase mechanical efficiencies. As a fluid pump, the conjugate drive can be effectively used as an alternative transmission for a typical bicycle. The conjugate drive bicycle transmission is, at minimum, comparable to the typical chain-drive bicycle transmission, and in most respects, is significantly better than the standard chain-drive. Those areas include: (1) equal or lighter weight; (2) equivalent cost; (3) decreased operational noise; (4) easier maintenance; (5) greater reliability; (6) greater mechanical efficiency in the real user environment; (7) exhibits improved biomechanical efficiency to optimize leg muscle power profile in training; (8) eliminates chain backlash and (9) provides a smooth, infinitely variable speed control shift for speed control.

As noted above, the relative volumetric capacity of the pedal engine **22** and wheel motor **28** will determine the ratios available for driving the bicycle. One can note that the pedal engine **22**/wheel motor **28** depicted in FIGS. **3** and **5** has four cylinders **52***a*, **52***b*, **54***a*, **54***b* with a block having a pair of skewed, perpendicularly oriented cylinder bores **52**, **54**. The cylinder bores **52**, **54** slideably receive a pair of mating double-ended piston assemblies **56**, **58** (shown in

phantom) therein. The double ended piston assemblies **56, 58** are composed of a pair of pistons **60, 62** and **64, 66** joined by a connective open web **68, 70**, respectively. While the piston assemblies are described as being composed of multiple parts for the purposes of explaining the invention, they may be formed as a single forging or casting, if desired. The webs **68, 70** each receive a corresponding pair of conjugate bearings **72, 74** and **76, 78**, respectively, affixed thereto. A crankpin **80** rotates with the shaft **20** at a fixed offset or throw. In the wheel motor **28**, the motor block **34** rotates about the crankshaft **32**, which is fixed. A pair of conjugate drivers **82, 84** and **86, 88** are disposed between the crankpin **80** and the conjugate bearings **72, 74** and **76, 78**, respectively.

FIG. **4** illustrates an embodiment of the present invention wherein the conjugate bearings **76** and **78** are formed monolithically in the web **70**. Pistons **64** and **66** may also be integrally formed with the web **70**.

As the crankpin is turned through each 360 degree rotation, the conjugate drivers **82, 84** and **86, 88** engage the conjugate bearings **72, 74** and **76, 78** transferring crankpin motion to the double-ended piston assemblies **56, 58**. For the purpose of explaining the present invention, however, it can be noted that the conjugate drive provides an efficient and durable rotary-to-linear motion interconverter that augments the pumping action of both the pedal engine **22** and the wheel motor **28**.

Given the cylinder configuration illustrated in FIGS. **3, 4** and **5**, it can be appreciated that each piston assembly **56, 58** will oscillate between a pair of extreme positions for each rotation of the crankshaft. Since the double ended piston assemblies **56, 58** divide each cylinder bore **52, 54** into a pair of cylinders, viz., **52***a*, **52***b* and **54***a*, **54***b*, respectively, having opposite directionality, the piston assembly position at the first extreme position corresponds to top piston position for the first cylinder and bottom piston position for the other. Conversely, at the other extreme position, the first cylinder is at bottom piston position and the other is at top piston position. In this sense, the cylinders **52***a*, **52***b*, **54***a*, **54***b* defined by each piston assembly are complementary, i.e., when one is on the intake stroke, the other is exhausting and vice versa. It is necessary that the output volume of the pedal engine equal the input volume because the system is closed and the volume of fluid output must be accommodated by the input stroke of its complementary cylinder. The same can be said of the wheel motor. While a four cylinder pedal engine is depicted, the number of cylinders can be any multiple of two.

FIGS. **6A–6C** show the operation of the present invention diagrammatically. The wheel motor **28** may have the exact same configuration as the pedal engine **22** and, for the purposes of the following description, both may be assumed to be identical.

A source of motive power actuates the engine **22**. In the bicycle embodiment shown in FIG. **1**, the source of power is the rider acting through the pedals **12, 14** and the pedal arms **16, 18**. Of course, it is not required that the power source be a human; an internal combustion, electric or steam engine could be employed. As a further alternative, a supplementary power source such as an electric motor, Stirling engine, compressed air cartridge, etc. coupled to a pump could be employed to assist a human in powering the vehicle. Whereas most conventional sources of power will communicate their power via a rotating output shaft, a reciprocating output, such as a piston drive shaft or a fluid under pressure would also be applicable for coupling the power source to the engine **22**. As with the power source, the engine **22** shown in the embodiment of FIG. **1** may have a rotating shaft for converting the rotary motion of the power source into motion of the fluid displacement apparatus constituting the engine **22**. It should be noted that the engine **22** has been denominated such due to its relationship to the fluid motor **28** because the engine **22** is the more active element, with the motor **28** responding to the output of the engine.

Given an engine **22** that is suitable for displacing fluid when actuated by a source of motive power P, the first mode of operation as shown in FIG. **6A** can be achieved. Namely, when valves **46** and **50** are closed, shunt passages **44** and **48** are blocked. Fluid output from the engine **22** is therefore directed in its entirety by feeder conduit **40** to the fluid motor **28**. The fluid passes through the motor **28** inducing a mechanical output which is coupled to an output mechanism, e.g., **36**, in the embodiment depicted in FIG. **1**, a wheel. While a wheel is depicted as the output mechanism, the present invention could be utilized to turn a shaft leading to a rear wheel differential, a propeller, or any other mechanism.

The relative volumetric capacities of the engine **22** and motor **28** determine the drive ratios available. Upon exiting the fluid motor **28**, the fluid is returned via the return conduit **32** to the inlet side of the engine **22** where it is again passed through the engine under the impetus of the power source. In the mode of operation depicted in FIG. **6A**, the engine **22** is turning the motor **28** at the lowest possible engine rpm-to-motor rpm ratio.

FIG. **6B** shows another mode of operation, wherein the motor **28** is overrunning the engine **22**. This can occur if the driven element, due to inertia or some other force, turns the motor **28** at a rate such that the motor fluid output exceeds that produced by the fluid engine **22**. As noted above, this condition occurs during operation of a bicycle when the operator stops pedaling and coasts. When motor **28** fluid displacement exceeds that of engine **22**, the feeder conduit **40** becomes depressurized and the return conduit **42** is pressurized. This pressure differential can be utilized to control a valve **46** through the shunt passageway **44** such that the fluid excess produced by the motor **28** can be conducted through the passageway **44** back to the feeder conduit **40** and into the motor **28** inlet. Without the shunting depicted in FIG. **6B**, the hydraulic linkage between the engine **22** and motor **28** could prevent the motor **28** from being actuated without a corresponding actuation of the engine **22**.

FIG. **6C** depicts a third mode of operation for the present invention wherein valve **50** controlling shunt passageway **48** is opened, allowing pressurized fluid to pass from the feeder conduit **40** to the depressurized return conduit **42** and into the intake side of the engine **22**. Since a portion of the fluid output of the engine **22** is diverted through shunt passageway **48**, the volume of fluid reaching the motor **28** is reduced, reducing the corresponding mechanical displacement of driven member **36**. In this manner, the ratio of engine **22** rpm-to-motor **28** rpm can be controlled, with the maximum valve **50** opening corresponding to the greatest engine **22** turn-to-motor **28** turn ratio.

In order to function as a pump, the engine **22** and the wheel motor **28** must be valved to the conduits of the manifold **38** such that a uni-directional flow is established, i.e., on the input stroke, the pedal engine must communicate with the return conduit **42**. On the output stroke, the pedal engine must be in fluid communication with the feeder

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United States Patent [19]

Chattin

[11] Patent Number: 6,032,968

[45] Date of Patent: Mar. 7, 2000

[54] **HYDRAULIC TRANSMISSION FOR BICYCLES**

[75] Inventor: **Jesse Chattin**, Tampa, Fla.

[73] Assignee: **Chattin Hydro-Cycle, Inc.**, Tampa, Fla.

[21] Appl. No.: **08/810,603**

[22] Filed: **Feb. 28, 1997**

[51] **Int. Cl.**[7] **B62M 1/10**

[52] **U.S. Cl.** **280/216**; 280/259; 418/205

[58] **Field of Search** 280/216, 215, 280/214, 259, 260; 180/305; 60/400–402, 419; 418/191, 205, 206.1; 417/231

[56] **References Cited**

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4,290,621	9/1981	Davey	280/216
4,684,143	8/1987	Sato	280/216
4,688,815	8/1987	Smith	418/159
5,387,000	2/1995	Sato	417/273

FOREIGN PATENT DOCUMENTS

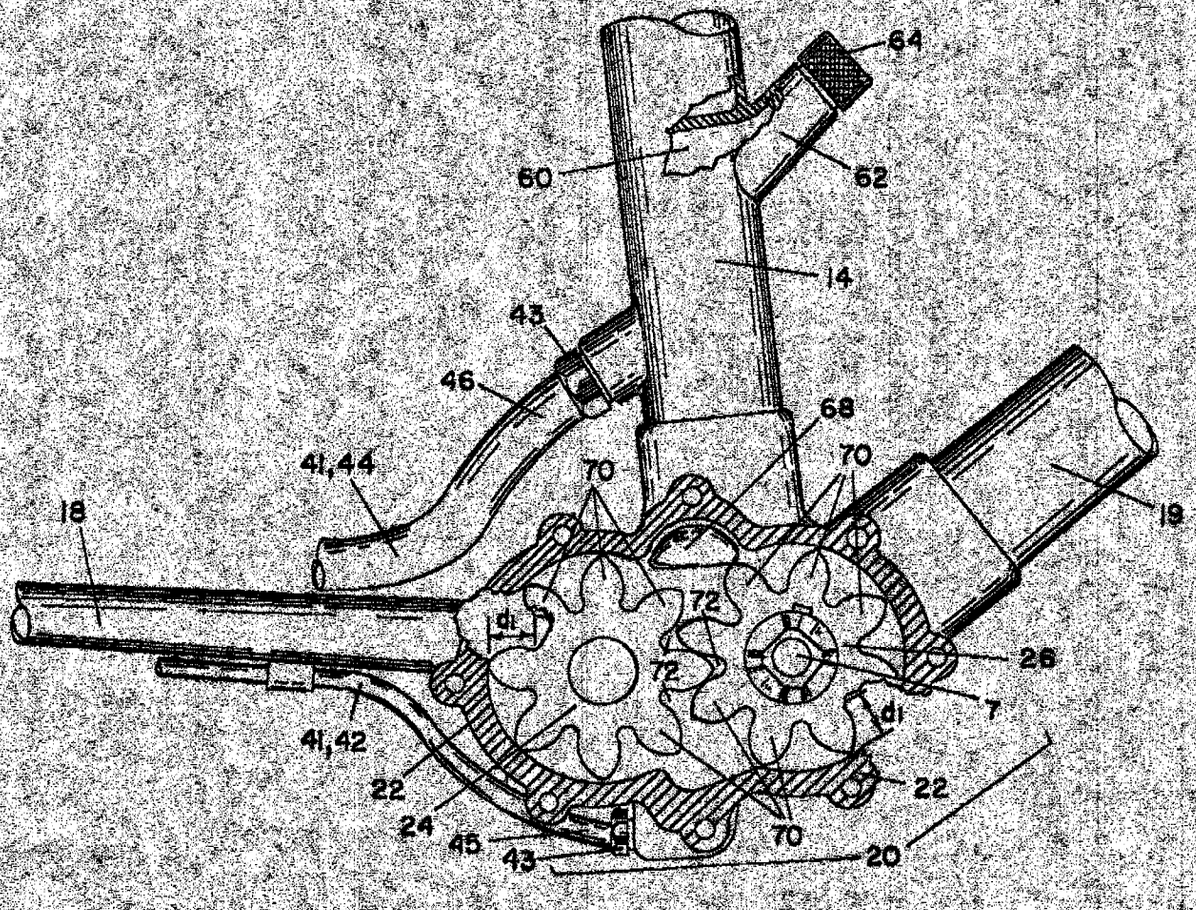
537981	5/1955	Belgium	280/216

Primary Examiner—Anne Marie Boehler
Attorney, Agent, or Firm—Stein, Schifino & Van Der Wall

[57] **ABSTRACT**

A drive mechanism for a bicycle comprising a pump unit driven by the rotation of the bicycle pedals, a hydraulic motor driven by the pump unit, a conduit system creating a closed hydraulic system for circulating hydraulic fluid between the pump unit and the hydraulic motor, and a pressure regulator for controlling the flow of hydraulic fluid from the pump unit to the hydraulic motor and thereby controlling the speed at which the bicycle is propelled. The pump unit has a first gear assembly having teeth with a face width w_1 and a whole depth d_1 and the hydraulic motor has a second gear assembly having teeth with a face width w_2 and a whole depth d_2. The teeth upon the respective gear assemblies mesh together to form inter-tooth pockets which facilitates hydraulic fluid transfer about the closed hydraulic system. The rotary motion relationship between the first and second gear assemblies of the present invention, as defined by their respective teeth, may vary from approximately 2.5:1 to approximately 18:1.

13 Claims, 5 Drawing Sheets



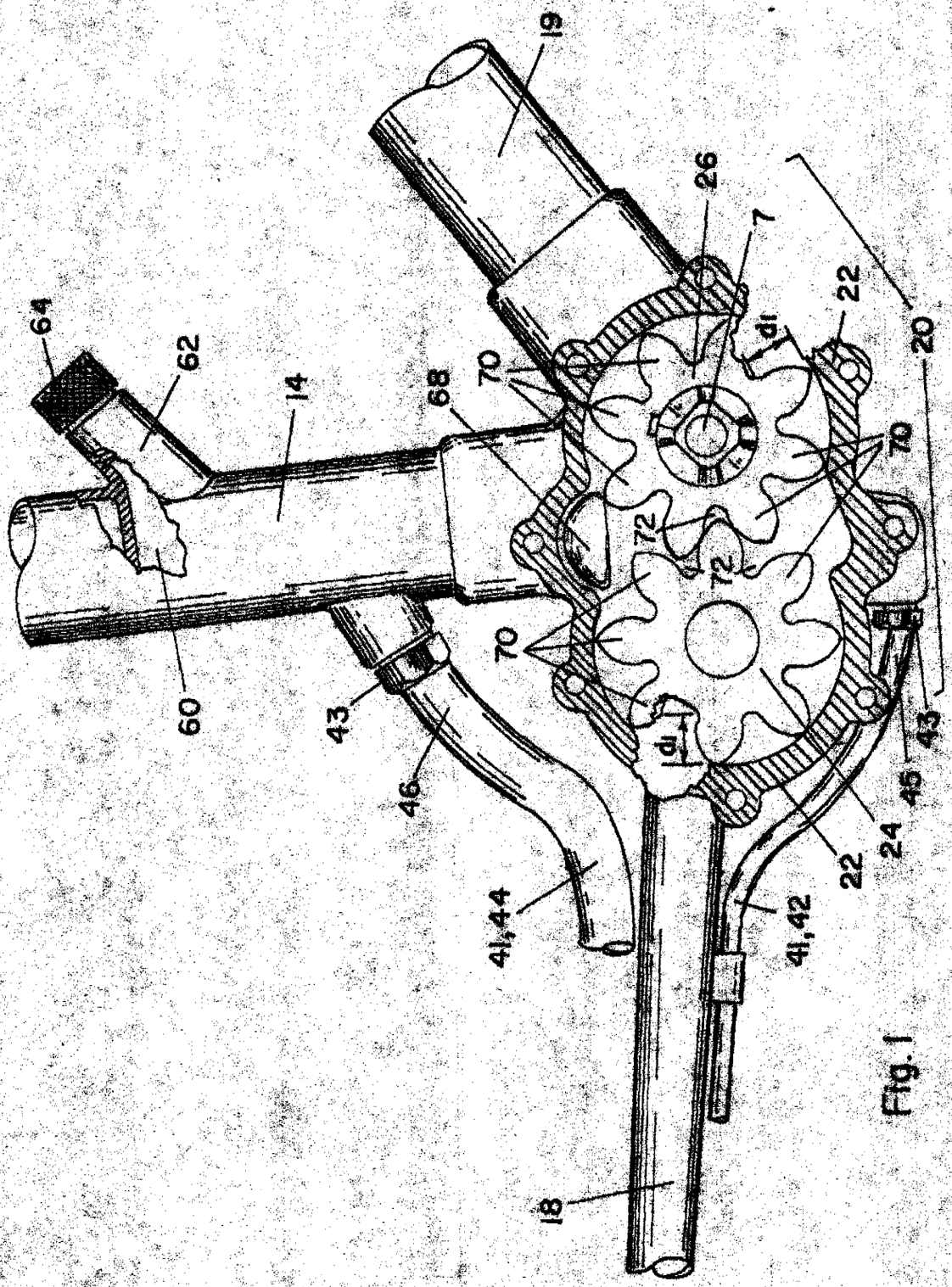


Fig. 1

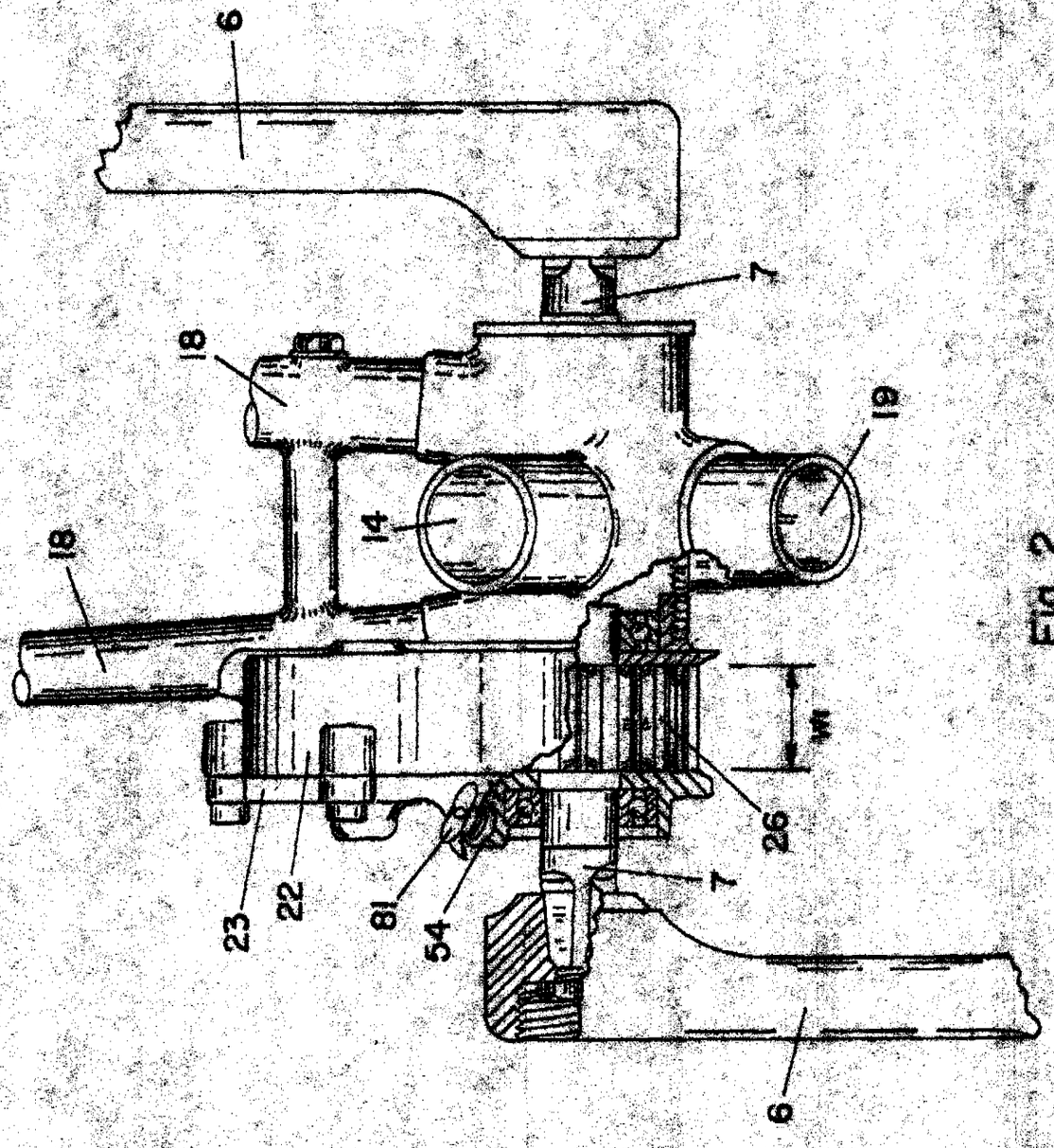


Fig. 2

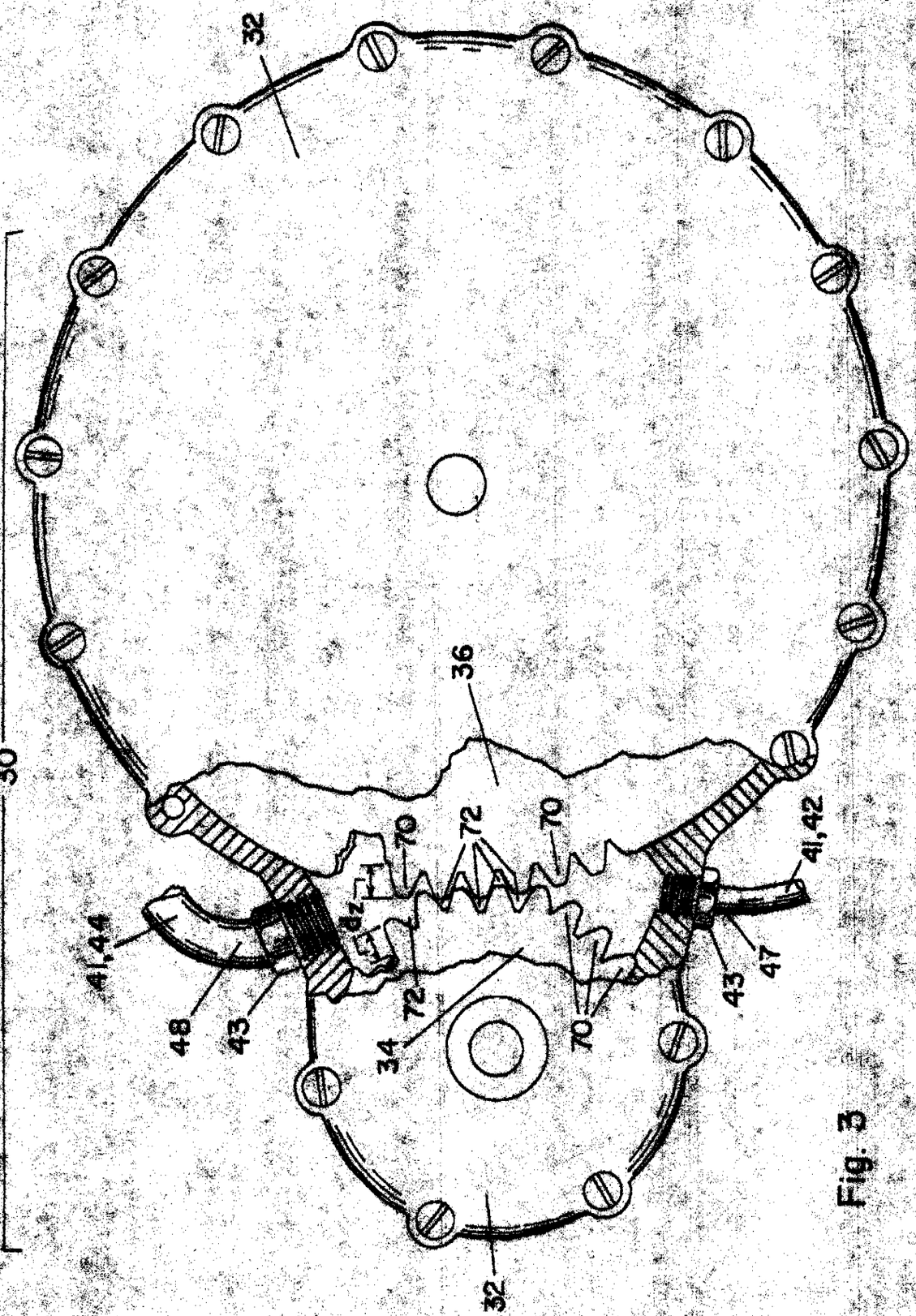


Fig. 3

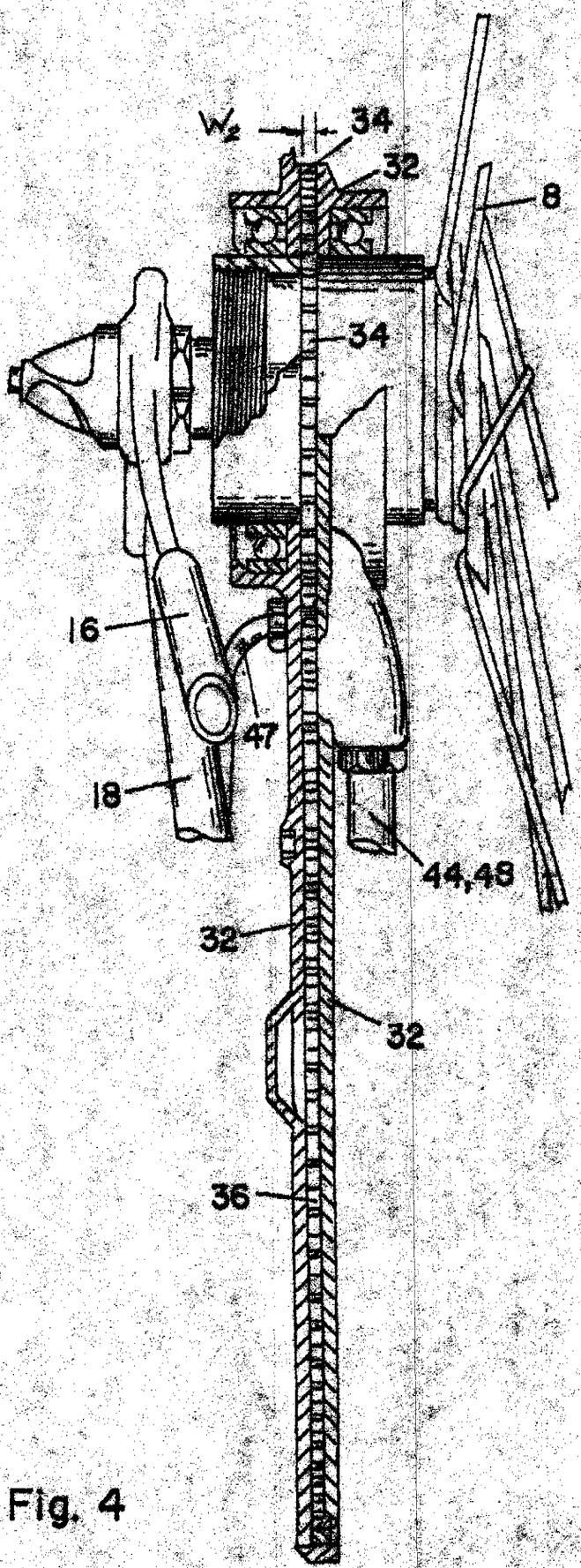


Fig. 4

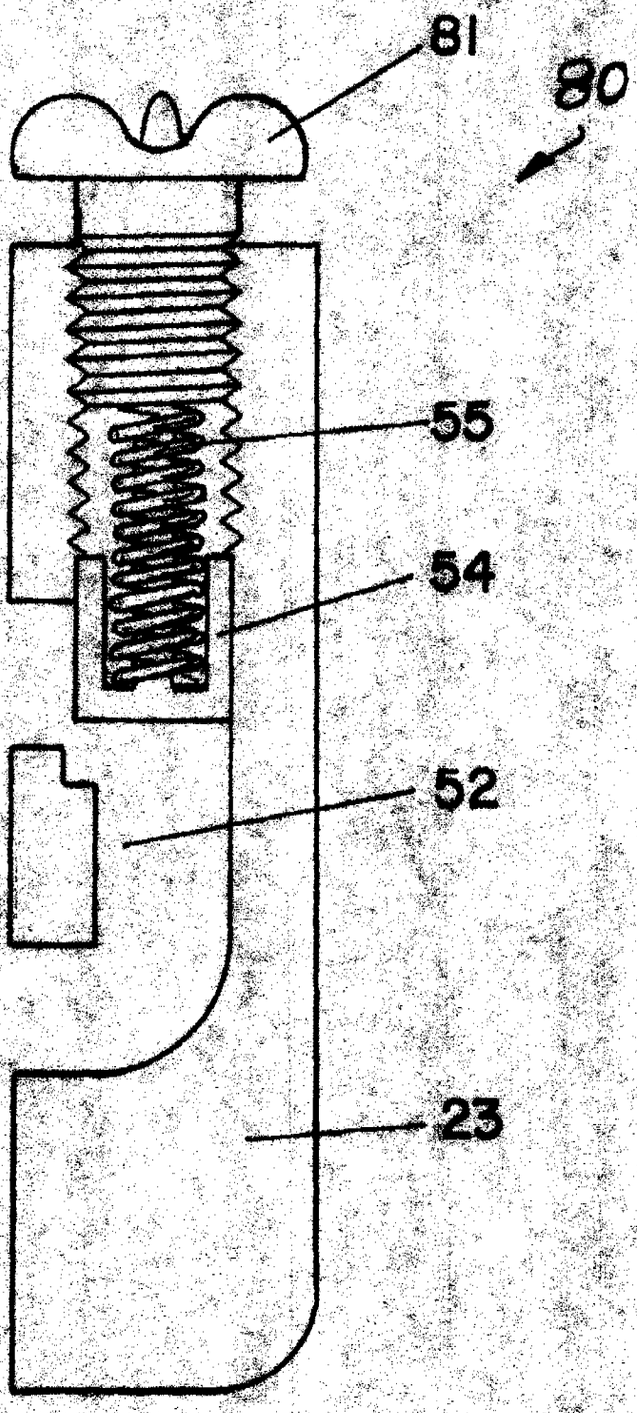


Fig. 5

HYDRAULIC TRANSMISSION FOR BICYCLES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to drive mechanisms for bicycles. This invention more particularly pertains to a hydraulic drive mechanism to propel a bicycle.

2. Description of the Background Art

Presently, most commercially available bicycles utilize a drive chain about a chain ring, driven by a crank axle and pedals, and a rear section gear cluster which is attached to the hub of the rear wheel to transmit power from the manually operated pedals to the rear wheel of the bicycle. For multi-speed bicycles, front and rear chain derailleurs cooperate with each other and in conjunction with a tensioning wheel to shift the drive chain from gear sprockets of varying diameters which results in the bicyclist being able to rotate the pedals at varying rates.

However, many hydraulic driven bicycles are known. For example, U.S. Pat. No. 4,249,750 to Kantner discloses a combination pump and motor for a hydraulic driven bicycle. Each pump and motor includes a plurality of fluid-pressure zones wherein one is a low pressure zone and another is a high pressure zone. Rotators in contact with one another, wherein one rotator has a smooth surface and another has a gear-like surface, transfer fluid from one zone to another zone. The rotators are arranged so that adjacent rotators are in contact and create a fluid-displacement path at the interface therebetween adjacent rotators. The Kantner patent discloses rotators in the pump having a 1:1 relationship with the rotators in the motor.

U.S. Pat. No. 4,688,815 to Smith teaches a hydraulic driven bicycle driven by a hydraulic pump and a hydraulic drive mechanism. The hydraulic pump has a pump chamber that may be varied in size for varying the flow of fluid through the pump mechanism. The drive mechanism has a drive chamber that also may be varied in size for varying the flow of fluid through the drive mechanism. However, this reference does not disclose a hydraulic drive means for propelling bicycles as disclosed by the present invention.

U.S. Pat. No. 4,290,621 to Davey discloses a bicycle employing a hydraulic multi-speed drive mechanism comprising a multi-chambered pump and a multi-chambered motor wherein selection of each chamber controls the amount of passing fluid and, hence, the speed of the bike is affected. Moreover, the patent to Davey discloses how to permit removal of the rear wheel from the bicycle without interrupting the hydraulic circuit. However, the present inventor believes the bicycle disclosed in the patent to Davey could not possibly work effectively because of the dimensional characteristics affecting the transmission of hydraulic fluid and, ultimately, the rotary motion of the complete hydraulic drive mechanism.

In response to these earlier hydraulic driven bicycles, it became clear that there is a need for an improved hydraulic drive mechanism. This device must provide for a smooth transition from a resting position to high speed without the usual shifting of gears as is encountered on conventional multi-speed bicycles.

In as much as the art consists of various types of bicycles, it can be appreciated that there is a continuing need for and interest in improvements to hydraulic driven bicycles, and in this respect, the present invention addresses these needs and interests.

Therefore, the principal object of this invention is to provide an improvement which overcomes the inadequacies of the prior art devices and provides an improvement which is a significant contribution to the advancement of hydraulic driven bicycles.

Another object of this invention is to provide a new and improved hydraulic drive means for bicycles which has all the advantages and none of the disadvantages of the earlier hydraulic driven bicycles.

Still another objective of the present invention is to provide a hydraulic bicycle that is lightweight and easily ridden.

Yet another objective of the present invention is to provide a hydraulic bicycle that is easily manufactured and assembled.

Still a further objective of the present invention is to provide a hydraulic bicycle capable of a smooth transition from a stationary position to a higher speed without the usual shifting of gears.

Yet a further objective is to provide a hydraulic drive mechanism that requires minimal maintenance for the biker.

An additional objective is to provide a pump that is powered by the conventional pedal and brake arrangement.

Another objective is to provide a drive mechanism for a bicycle having a frame comprising of a seat tube, seat stay and chain stay, a pedal means for applying manual power to propel the bicycle, a drive wheel rotatably supported on the frame, and a drive mechanism connected to the pedal means for rotating the drive wheel, an improved drive mechanism comprising a pump unit comprising a pump housing, a first gear assembly operationally disposed within the pump housing and driven by the rotation of the pedal means outside of the pump housing, the pump unit outwardly adjacent the seat tube and the chain stay; a hydraulic motor being supported on the frame, the hydraulic motor comprising a motor housing and a second gear assembly operationally disposed within the motor housing, the second gear assembly adapted to engage the drive wheel, the hydraulic motor outwardly adjacent the seat stay and the chain stay and driven by the hydraulic fluid pumped by the pump unit, the pump unit and the hydraulic motor having a rotary motion relationship in the range of approximately 2.5:1 up to approximately 18:1; conduit means coupled between the hydraulic motor and the pump unit for circulating hydraulic fluid through the pump unit and the hydraulic motor, the conduit means creating a closed hydraulic system; pressure regulator means in the closed hydraulic system for controlling the quantity of hydraulic fluid transmitted to the hydraulic motor when the pedal means is rotated; and a hydraulic fluid reservoir disposed above the pump unit, the conduit means coupled to and in fluid communication with the reservoir.

Even yet another objective is to provide a drive mechanism for a bicycle having a frame comprising of a seat tube, seat stay and chain stay, a pedal means for applying manual power to propel the bicycle, a drive wheel rotatably supported on the frame, and a drive mechanism connected to the pedal means for rotating the drive wheel, an improved drive mechanism comprising a pump unit comprising a pump housing and a first gear assembly, the first gear assembly comprising a pump idler gear and pump bull gear in rotational meshing contact with one another and operationally disposed within the pump housing, the pump bull gear driven by the rotation of the pedal means outside of the pump housing, the pump unit outwardly adjacent the seat tube and the chain stay; a hydraulic motor being supported on the frame, the hydraulic motor comprising a motor

housing and a second gear assembly, the second gear assembly comprising a smaller pinion gear and a larger idle gear in rotational meshing contact with one another and operationally disposed within the motor housing, the smaller pinion gear adapted to engage the drive wheel, the hydraulic motor outwardly adjacent the seat stay and the chain stay and driven by the hydraulic fluid pumped by the pump unit, the pump unit and the hydraulic motor having a rotary motion relationship configured by varying combinations of the first and second gear assemblies, the first and second gear assemblies having teeth meshing together to form inter-tooth pockets, the inter-tooth pockets facilitating hydraulic fluid transfer, the teeth of the first and second gear assemblies having a face width and a whole depth defining approximately a 12:1 rotary motion relationship; a conduit means for transmitting hydraulic fluid from the pump unit to the hydraulic motor and returning the hydraulic fluid from the hydraulic motor to the pump unit, the conduit means comprising of a small diameter conduit line for transmitting hydraulic fluid from the pump unit and a large diameter conduit line for returning hydraulic fluid from the hydraulic motor, the conduit means creating a closed hydraulic system; pressure regulator means for controlling the quantity of hydraulic fluid transmitted to the hydraulic motor when the pedal means is rotated, the pressure regulator means comprising a hydraulic fluid bypass in the pump unit, the hydraulic fluid bypass having a spring-loaded plunger interposed in the bypass; and a hydraulic fluid reservoir disposed within the seat tube and above the pump unit, the large diameter conduit line having a first end coupled to the reservoir and in fluid communication with the reservoir.

The foregoing has outlined some of the pertinent objects of the invention. These objects should be construed to be merely illustrative of some of the more prominent features and applications of the intended invention. Many other beneficial results can be obtained by applying the disclosed invention in a different manner or by modifying the invention within the scope of the disclosure. Accordingly, other objects and a more comprehensive understanding of the invention may be obtained by referring to the summary of the invention, and the detailed description of the preferred embodiment in addition to the scope of the invention defined by the claims taken in conjunction with the accompanying drawings.

SUMMARY OF THE INVENTION

The present invention is defined by the appended claims with the specific embodiments shown in the attached drawings. The present invention is directed to an apparatus that satisfies the need for an improved hydraulic drive mechanism for bicycles. For the purpose of summarizing the invention, the invention comprises a pump unit comprising of an internal gear assembly driven by the rotation of the pedals by the bicycle rider. A hydraulic motor also comprises of an internal gear assembly for driving the rear wheel of the bicycle. A conduit creating a closed hydraulic system, including the pump unit and the motor, transmits hydraulic fluid from the pump unit to the hydraulic motor, and returns the hydraulic fluid from the motor to the pump. A hydraulic fluid reservoir is disposed in the seat tube below the bicycle seat and above the pump unit. Finally, the present invention comprises a pressure regulator for controlling the quantity of hydraulic fluid transmitted to the hydraulic motor. Means are provided for adjusting the spring tension so as to adjustably control the amount of bypassing hydraulic fluid and, therefore, the hydraulic pressure about the closed system. When the biker initially starts off pedaling, the bike will increase speed with the increasing hydraulic pressure, as a result of the bicyclist's pedaling, and the hydraulic pressure rises up to a certain point where the spring loaded plunger raises to allow hydraulic fluid to bypass the rotating gears in the pump unit. Once the hydraulic fluid starts bypassing, the hydraulic pressure is prevented from rising any higher while the bicyclist continues to pedal faster. The speed of the bike is controlled by the amount of hydraulic fluid flow and the acceleration is controlled by the pressure of the hydraulic fluid.

An important feature of the present invention is that a variable rotary motion relationship, for facilitating hydraulic fluid transfer about the closed hydraulic system, exists between the pump unit and the hydraulic motor which enables the bicyclist to smoothly and easily attain a high speed from a stationary position. After extensive investigation and experimentation, the present inventor has discovered that the effective range of the rotary motion relationship of the present invention varies from approximately 2.5 up to and including approximately 18:1. The ratio for a particular bicyclist depends ultimately upon the age of the bicyclist and the intended purpose of the bike. In other words, a child would need a lower ratio of about 2.5:1 and a racing cyclist would prefer a higher ratio of about 18:1.

Generally, it is particularly preferable that the rotary motion relationship be approximately 12:1. Simply, the present invention depends on the relation of the rotating gears in the pump unit and hydraulic motor to generate hydraulic pressure and facilitate hydraulic fluid about the closed hydraulic system. Therefore, it can be readily seen that the present invention provides a means to propel a bicycle without the necessity of shifting. Thus, a hydraulic driven bicycle comprising the present invention would be greatly appreciated.

The foregoing has outlined rather broadly, the more pertinent and important features of the present invention. The detailed description of the invention that follows is offered so that the present contribution to the art can be more fully appreciated. Additional features of the invention will be described hereinafter. These form the subject of the claims of the invention. It should be appreciated by those skilled in the art that the conception and the disclosed specific embodiment may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more succinct understanding of the nature and objects of the present invention, reference should be directed to the following detailed description taken in connection with the accompanying drawings in which:

FIG. **1** is a side cross-sectional view of the pump unit of the present invention;

FIG. **2** is a top partial cross-sectional view of the pump unit of the present invention;

FIG. **3** is a side partial cross-sectional view of the hydraulic motor of the present invention;

FIG. **4** is a top cross-sectional view of the hydraulic motor of the present invention; and

FIG. **5** is side cross-sectional view of the cover plate of the pump housing.

Similar reference characters refer to similar parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, and in particular to FIGS. **1** and **4** thereof, a new and improved hydraulic drive mechanism embodying the principles and concepts of the present invention and generally designated by the reference number **10** will be described. The drive mechanism **10** is designed to replace the conventional chain drive utilized on most commercially available bicycles. Otherwise, the bicycle is a conventional bicycle utilizing pedals operated manually by the cyclist to drive the rear drive wheel.

The present invention comprises of a pump unit **20** which pumps hydraulic fluid, as a result of the bicyclist's rotation of the pedals **6**, a hydraulic motor **30** mounted on the rear of the bike frame for driving the drive wheel **8**, a hydraulic conduit system **42, 44** circulating hydraulic fluid back and forth between the pump unit **20** and the hydraulic motor **30**, a pressure regulator means **52, 54** for controlling the quantity of hydraulic fluid transmitted to the hydraulic motor, and a hydraulic fluid reservoir **60** in the seat tube **14**.

As shown in FIG. **1**, the pump unit **20** comprises a pump housing **22** and a first gear assembly **24, 26**. It is preferable that the pump unit **20** be made of steel, aluminum or other suitable material. The first gear assembly comprises a pump idler gear **24** and a pump bull gear **26** in rotational meshing contact with one another and operationally disposed within the pump housing **22**. The pump housing **22** further comprises a cover plate **23**, shown in FIG. **2**, which provides access to the interior of the pump unit **20**. The pump bull gear **26** is driven by the rotation of pedals **6**, by the bicyclist, outside of the pump housing **22**. FIG. **2** illustrates the pump unit **20** outwardly adjacent the seat tube **14** and the chain stay **18**. The pedals **6** have crank arms which are connected to each end of a shaft **7** passing through the pump unit **20**. The pump bull gear **26** is secured to the shaft **7** and the pump idler gear **24** is supported by a stub axle.

As shown in FIGS. **3** and **4**, the hydraulic motor **30** comprises of a motor housing **32** and a second gear assembly **34, 36**. It is preferable that the hydraulic motor **30** be made of steel, aluminum or other suitable material. The second gear assembly comprises a smaller pinion gear **34** and a larger idle gear **36** in rotational meshing contact with one another and operationally disposed within the motor housing **32**. It is preferable to have a gear **36** larger than the gear **34** because the larger the gear **36** the more leverage that is created. Therefore, a multiplication of force is directed to the drive wheel **8**. The motor housing **32** includes a cover plate to provide access to the interior of the hydraulic motor **30**. The smaller pinion gear **34** is adapted to engage the drive wheel **8**. The hydraulic motor **30** is outwardly adjacent the seat stay **16** as well as the chain stay **18** and is driven by the hydraulic fluid pumped by the pump unit **20**.

A hydraulic conduit system **42, 44** is coupled between the pump unit **20** and the hydraulic motor **30** for circulating hydraulic fluid through the pump unit **20** and the hydraulic motor **30**. The hydraulic conduit system transmits hydraulic fluid from the pump unit **20** to the hydraulic motor **30** and then returns the hydraulic fluid from the hydraulic motor **30** to the pump unit **20**. The conduit system **42, 44** creates a closed hydraulic system **41** whereby operation of the pump unit **20** causes the hydraulic fluid to circulate through the pump unit **20** and the hydraulic motor **30**. It is preferred that one weight hydraulic fluid be used in the closed hydraulic system **41** because it is thin. In other words, the thicker the fluid, the harder it is for a cyclist to pump it.

As illustrated in FIGS. **1** and **3**, the conduit system comprises of a small diameter conduit line **42** for transmitting hydraulic fluid from the pump unit **20** and a large diameter conduit line **44** for returning hydraulic fluid from the hydraulic motor **30**. A first end **46** of the large diameter conduit line **44** is coupled in fluid communication to the reservoir **60** and a second end **48** of the large diameter conduit line **44** is coupled in fluid communication with the hydraulic motor **30**. As for the small diameter conduit line **44**, a first end **45** of the small diameter conduit line **42** is coupled in fluid communication with the pump unit **20** and a second end **47** is coupled in fluid communication with the hydraulic motor **30**.

It is preferred that a small diameter line, in comparison to a larger diameter line which is to be used to transmit hydraulic fluid from the pump unit **20** to the hydraulic motor **30**, be used in the present invention so that the hydraulic fluid coming back to the pump unit **20** comes back slowly and, therefore, will not have any significant back pressure upon the pump unit **20**. In other words, the larger diameter line is a low pressure line and the smaller diameter line is a high pressure line. In one version of the present invention, couplings **43** are coupled to each end of the conduit lines **42** and **44** which thread into the pump and motor housings **22, 32** and the reservoir **60**, respectively, thereby securing the conduit lines **42** and **44** so that hydraulic fluid may be circulated through the closed hydraulic system **41**.

As shown in FIG. **1**, the hydraulic fluid reservoir **60** is disposed above the pump unit **20**. The hydraulic conduit system **42, 44** is coupled to and in fluid communication with the reservoir **60**. Preferably, the reservoir **60** is disposed in the seat tube **14** such that the reservoir **60** is then over the top of the pump unit **20**. Below the reservoir **60** is an inlet **68**, as shown in FIG. **1**, which allows fluid to flow into the pump unit **20**. Also, the reservoir **60** includes a fill means **62** coupled in fluid communication with the reservoir **60**. The fill means **62** allows for the reservoir **60** to be filled with hydraulic fluid. The fill means **62**, in one embodiment of the present invention, comprises a closure means **64** for selectively opening and closing the fill means **62**. As illustrated in FIG. **1**, an internally threaded cap **64** may be threadably engaged over a fill tube **62**.

The present invention further comprises a pressure regulator means **52, 54** in the closed hydraulic system **41** for controlling the quantity of hydraulic fluid transmitted to the hydraulic motor **30** when the pedals **6** are rotated. The pressure regulator means comprises a hydraulic fluid bypass **52** in the pump unit **20**. The bypass **52** has a spring-loaded plunger **54** interposed in the bypass **52**. The spring tension of the spring-load plunger **54** is adjustable so that the amount of bypassing hydraulic fluid bypassing the closed hydraulic system **41** may be controlled. Preferably, the plunger **54** is hollow on one end with the spring **55** inside as shown in FIG. **5**.

When the bicyclist is in the stationary position, the pressure about the closed hydraulic system **41** is zero. Then when the bicyclist starts off pedaling, the bike will increase speed with the increasing hydraulic pressure in the closed system **41**. The hydraulic pressure will increase up to a point at which is set by selecting a spring-loaded plunger **54** of a specific tensile strength. Beyond this point, hydraulic fluid bypasses the rotating gears in the pump unit **20**. When the pressure drops, as a result of the decreased speed of the bike, the spring-loaded plunger **54** blocks further bypassing of hydraulic fluid.

The present invention may further comprise a manually adjustable control means **80** coupled to the pressure regulator means **52** for adjusting the pressure in the closed