The Evolution of Bicycle Shifting Systems

RPI Bicycle Engineering Symposium
Fall 2015
Larry Ruff, RPI
The Evolution of Bicycle Shifting Systems

• Introduction
  – The bicycle industry has always had a large number of small companies and “garage” inventors
  – It would be tough to cover everything that has been done in the time of this talk
  – A great reference: “The Dancing Chain” by Berto, Shepherd and Henry
  – Also: www.disraeligears.co.uk
The Evolution of Bicycle Shifting Systems

• Talk Outline
  – The Early Days
  – Internally Geared Hubs
  – Rear Derailleur Systems
  – Front Shifting Methods
  – Shift Levers
  – Automatic Shifting
  – Made in the USA
  – Air, Electric, Wireless, Hydraulic
  – Where is it Going?
The Evolution of Bicycle Shifting Systems

• The Early Days
  – Can’t even begin to cover everything!
    • 2 speed high wheeler hub/crankset: 1870
    • Double chain ring: 1868
    • Epicyclic gearing: first British patent 1878
    • 4 speed belt drive (like a lathe!): 1897
Flip-Flop Hub: 1890? In France
Retro-Direct Gearing: First Patented in 1869 by Barberon and Meunier
The Evolution of Bicycle Shifting Systems

• Internally Geared (Epicyclic) Hubs
  – The British really focused on these while the French focused more on derailleur systems
    • British: Muddy roads
    • British: Derailleurs are “untidy”
    • French: Beauty of seeing it work
    • French: Hub gears are “friction boxes”
    • French: Derailleurs allow lower gears
The Evolution of Bicycle Shifting Systems

• Epicyclic Hubs in Britain in 1909
  – Crabbe 2 Speed
  – James 2 Speed
  – Stanley 2 Speed
  – Eadie 2 Speed
  – Griffin 2 Speed
  – Villiers 2 Speed
  – Centaur 2 Speed
  – Simplex 2 Speed
The Evolution of Bicycle Shifting Systems

• Epicyclic Hubs in Britain in 1909
  – Sturmey Archer 3 Speed
  – BSA 3 Speed
  – Stanley 3 Speed
  – Micrometer 3 Speed
  – Sunbeam 3 Speed
  – Optimus 3 Speed
  – Seabrook 3 Speed
  – Crabbe-Simplex 3 Speed
<table>
<thead>
<tr>
<th>Dynohubs</th>
<th>Dynamo Hubs</th>
<th>P.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>580 (W)</td>
<td>8 Speed Hubs</td>
<td>P.8</td>
</tr>
<tr>
<td>C50</td>
<td>5 Speed Hubs</td>
<td>P.11</td>
</tr>
<tr>
<td>540</td>
<td>4 Speed Hubs</td>
<td>P.14</td>
</tr>
<tr>
<td>C30</td>
<td>Rotary 3 Speed Hubs</td>
<td>P.17</td>
</tr>
</tbody>
</table>
The Evolution of Bicycle Shifting Systems

The Evolution of Bicycle Shifting Systems

• Rear Derailleur Systems
  – First patent by Jean Loubeyre of Paris: 1895
  – 1920’s started to see more practical derailleurs
  – 1930’s: “The Golden Age”
  – Linear derailleurs
  – Parallelogram derailleurs
  – Slant parallelogram derailleurs
1934 Simplex
Tour de France
1936 Super Champion
1951? Simplex 303
Linear
Cyclo-Benelux
1950’s

Linear
Campagnolo Corsa
Not Sure What to Call It!
Parallelogram
Parallelogram
Slant Parallelogram
The Evolution of Bicycle Shifting Systems

• Front Shifting Methods
  – First front derailleur? by Jeanperrin: 1895
  – Linear action front derailleur
  – Parallelogram front derailleur
  – Browning: 1985
  – Expandable chainwheel: 1901
  – Front/bottom bracket gearing: 1870
Below: Fig. 9.22. The 1957 Simplex front derailleur had a cam to move the cage. Simplex' Italian factory made it for a year.

Above: Fig. 9.24. The 1958 LJ 203 cable-operated plunger-type front derailleur copied the Campagnolo Gran Sport. It had an alloy body. In 1962, it became the AV 223 with a Delrin body.
Figure 4: Position of hinged pawl (either straight, up, or down) controls position of swinging sector.

Figure 7: Selector assembly in position on seat tube (upper drawing). Triangular cam and reset cam control the path of the pawl. Lower drawing shows critical alignment between pawl and cams.
Figure 3: Selector assembly (at arrow) mounted on seat tube in place of front derailleur. Two cap screws allow for lateral adjustment. Note shift control cable at left, and shaved teeth on inner chainring at right. Also note safety tab on swing sector, needed to prevent another upshift when chain is on the large ring and an upshift is selected by the control lever.
Expandable Chainwheel
Schlumpf 2 Speed
Pinion
9-18 Speed
The Evolution of Bicycle Shifting Systems

• Shift Levers
  – Down tube, top tube, seat tube, stem, bar end, thumb, twist, trigger, integrated

• Modern Integrated
  – Campagnolo
  – Shimano
  – SRAM
  – Microshift
integrated brake/shift levers

grip-twist shifters

down tube shifters

trigger shifters

bar-end shifters
Exploded Campagnolo Ergopower lever—nine-speed
(ten-speed has a different bottom bushing and washer, but is otherwise the same)

- lever body
- G-springs
- G-spring carrier
- index gear
- thumb lever
- pivot pin
- spring
- pivot post nut
- brake lever
- finger lever
- ratchet ring
- compensation spring
- plastic bottom cover plug
- rubber lever hood
The Evolution of Bicycle Shifting Systems

• Automatic Shifting
  – Autobike
  – GT Autostream
  – Shimano Nexus
The Evolution of Bicycle Shifting Systems

• Made in the USA
  – Paul Components: 1995
  – Precision Billet: 1994
  – White Industries LMDS: 1997
  – Joe’s: 1998
The Evolution of Bicycle Shifting Systems

• Air, Electric, Wireless and Hydraulic
  – Mavic
    • Zap: 1994
    • Mektronic: 1999
  – Shimano
    • Airlines: 2000
    • DI2
  – Campagnolo EPS
  – FSA
  – SRAM
  – Rotor
Hydraulic Drive Proposal from 1988............50 pounds!
FSA Electronic
Rotor Hydraulic
The Evolution of Bicycle Shifting Systems

• Where is it Going?
  – More speeds? Shimano did 14 speeds in 1999
  – Other wireless or wired?
  – Back to hub gears for commuting and touring
    • Can eliminate chain
  – ???
A plurality of sprockets are essentially mounted together, wherein a spacing between each pair of adjacent sprockets is less than a distance of at least one of the plurality of sprockets. In another embodiment of the invention, a plurality of sprockets are essentially mounted together, wherein a spacing between each pair of adjacent sprockets is less than or equal to approximately 2.5 millimeters. In yet another embodiment of the present invention, at least ten sprockets are essentially mounted together to form a first free sprocket surface facing partially downward, a second free sprocket surface facing partially upward, and a second free sprocket surface in line with an equal or smaller diameter of the sprocket where the spacing between the first free sprocket surface and the second free sprocket surface is less than or equal to approximately 30 millimeters.
The Evolution of Bicycle Shifting Systems

• What’s on Display?
  – A disassembled Sturmey Archer AW Hub
  – Derailleurs from the 50’s to today
  – Disassembled Shimano STI and Campagnolo Ergo levers
  – A bike with Mavic Zap
  – A bike with Mavic Mektronic