Title: OPERATING MECHANISM FOR CONVERTIBLE TOP WITH MOVABLE REAR BOW AND ONLY TWO OPERATING CYLINDERS

Abstract: A convertible top operating mechanism includes a bi-directional hydraulic pump (54) which is selectively connected to top-operating hydraulic cylinders (30, 30°) and tonneau-operating hydraulic cylinders (50, 50°) by a two-way, 5-condition control valve (56) to selectively raise and lower the top and tonneau. A mechanical linkage connects with a spring (28) during operation of the top operating cylinders (30, 30°) when fully extended and initially retracting to move the rear bow (26) to enable tonneau operation and to seal the top on the tonneau.
OPERATING MECHANISM FOR CONVERTIBLE TOP WITH MOVABLE REAR BOW AND ONLY TWO OPERATING CYLINDERS

5 TECHNICAL FIELD

This invention relates to automobile convertible tops and, more particularly, to an operating mechanism for a convertible top having a movable rear bow.

10 BACKGROUND OF THE INVENTION

Many convertible tops designed for high-end sports or other two-seat vehicles employ a movable rear or 5-bow. The rear bow is secured to the tonneau cover after the top is raised. The rear bow is thereafter raised to enable opening of the tonneau cover to permit lowering of the top, after which the tonneau cover is closed. This system eliminates the need for a separate boot cover and presents a more aesthetically pleasing vehicle in both the top raised and lowered positions.

15 Power tops that utilize a movable rear bow normally provide a pair of cylinders to operate the top, and require manual operation to raise and lower the rear bow or provide an additional pair of cylinders to operate the rear bow.

20 There is a need for a convertible top operating mechanism which uses only a single pair of power operators to operate both the top and the rear bow.
SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a convertible top operating mechanism which uses only a single pair of power operators to operate both the top and the rear bow.

This invention is an improvement on the invention disclosed in U.S. Patent No. 5620226, the disclosure of which is incorporated herein by reference.

In one aspect this invention comprises a convertible top operating mechanism which includes a bi-directional hydraulic pump which is selectively connected to top-operating hydraulic cylinders and tonneau-operating hydraulic cylinders by a two-way, 5-condition control valve to selectively raise and lower the top and tonneau. A mechanical linkage connects the top-operating cylinders with a movable rear bow and is co-operable with a spring during operation of the top-operating cylinders when fully extending and initially retracting to move the rear bow to enable tonneau operation and to seal the top on the tonneau.

In another aspect, this invention comprises a vehicle having a convertible top movable between a lowered position stored in a storage well and a raised position, said storage well having a cover movable between open and closed positions, said top comprising a pair of spaced linkages each comprising a plurality of pivotally-interconnected side rails including a rear rail, a plurality of spaced transverse bows, including a rear bow pivotally attached to the rear rails
for independent raising and lowering movement relative to the rear rail to enable movement of the cover, interconnecting the linkages to support a fabric top, and a power operator connected to each rear rail that is extensible to raise and retractable to lower the top. A top operating mechanism includes a drive pin is mounted on each rear rail. A slotted clevis having a drive abutment is mounted on the end of each actuator and embracing the drive pin, while a spring provides a lowering bias to the rear rail.

A drive link pivotally mounted on each clevis is engageable with the drive pin during extension of the power operators to raise the top. A drive surface on each rear bow is engageable by the drive abutment to raise the rear bow, and a cam surface on the rear rail is engageable with the drive link when the top is raised to pivot the drive link out of engagement with the drive pin to enable the drive abutment to engage the drive surface to raise the rear bow upon further extension of the power operators.

The power operators are hydraulic cylinders that are controlled by a 5-way (or condition), 2-position control valve which operate a bi-directional hydraulic pump. This valve is connected to both top-operating hydraulic cylinders and to a pair of tonneau-operating hydraulic cylinders.

In a first position, both ends of the top cylinders are connected to both sides of the pump, while one end of the tonneau cylinders are connected to one side of the pump, and the other tonneau cylinder ends are blocked. When the pump is inoperative (condition 1), this allows the top to float, but secures the tonneau against movement.

In this valve position, operation of the pump in one direction will extend the top cylinders only (condition 2) to raise the top; it will pressurize
one side of the tonneau cylinders, but they cannot move since the exhaust side is blocked. Pump operation in the other direction will retract the top cylinders only (condition 3) to lower the top; the tonneau cylinders are connected to exhaust, but cannot move since the pressure side is blocked.

In a second position, both ends of the tonneau cylinders are connected to both sides of the pump, while one end of the top cylinders are connected to one side of the pump and the other top cylinder ends are blocked. If this position were used when the pump is inoperative, the tonneau would be unpressured and float, while the top would be secured against movement; however this condition is not utilized.

In the second valve position, pump operation in one direction will extend the tonneau cylinders only (condition 4) to raise the tonneau. Operation of the pump in the other direction will retract the tonneau cylinders only (condition 5) to lower the tonneau. In both condition 4 and 5, the blockage of one end of the top cylinders prevents their movement.

These and other objects and features of this invention will become more readily apparent upon reference to the following detailed description of a preferred embodiment, as illustrated in the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 – 7 are detail views of a portion of a convertible top showing a top operator according to this invention, illustrating a sequence of operation;
Figs. 8 – 10 are enlarged views of a drive link utilized in the top operator of this invention; and

Figs. 11 – 15 are schematic diagrams of a hydraulic system according to this invention, illustrating the sequence of operations for operating the top and tonneau.

DESCRIPTION OF THE PREFERRED EMBODIMENT

This invention is directed to a top and tonneau operating system for the convertible top of a vehicle, such as more fully illustrated in U.S. Patent No. 5620226. Figs. 1 – 7 show a portion of one side of a convertible top linkage. A vehicle body bracket 20 pivotally mounts a rear rail 22 that includes a bracket 24 that pivotally mounts a movable rear or #5 bow 26 that is movable relative to rear rail 22 between raised and lowered positions. A coil spring 28 biases rear bow 26 in an illustrated clockwise direction to lowered position.

Top-operating hydraulic cylinders 30, 30' (shown schematically in Figs. 11 – 15) each has a cylinder rod 32 that mounts a clevis 34, best seen in Figs. 8 – 10. Clevis 34 includes a slot 36 that receives a drive pin 38 mounted on rear rail 22. Clevis 34 mounts a roller 40 which serves as a drive abutment. A drive link 42 is pivotally mounted on clevis 34 for movement into (Figs. 1, 2, 7, 8 and 9) and out of (Figs. 3, 4, 5, 6 and 10) a position engaging drive pin 38. When drive link 42 engages drive pin 38, it traps pin 38 against the outer end of slot 36 such that extension and retraction of cylinder rod 32 will pivot rear rail 22 to raise and lower the convertible top.

The mechanical arrangement of cylinder 30 is such that rod 32 need be only partially extended (such as to a midpoint) to fully raise the top. At the top raised position, drive link engages a cam member 44 (Fig. 2) mounted on rear
rail 22 which pivots drive link 42 out of driving engagement with drive pin 38 (Fig. 3). Upon further extension of rod 32, cam member 44 merely slides along pin 38, which slides along slot 36. This further extension of rod 32 engages roller 40 with a cam drive surface 46 on rear bow 26 which raises rear bow 26 (Fig. 4) against the bias of spring 28. Thus mechanical linkage 34 – 46 and spring 28 operate rear bow 26 at the ends of hydraulic cylinder operation to automatically raise and lower rear bow 26.

In the top raised position, rear bow 26 rests atop the vehicle top storage compartment cover, or tonneau (not illustrated), which covers the top storage well (not shown), where it is latched. All of this is well-known and forms no part of this invention. The raising of rear bow 26 just described allows the tonneau to be opened by rods 50, 50' of cylinders 52, 52' (Figs. 11 - 15). When the tonneau is open, the rods 32, 32' of cylinders 30, 30' are partially retracted to the midpoint (Figs. 5, 6), which allows spring 28 to lower rear bow 26. At this point drive link 42 disengages cam member 44.

Referring now to Figs. 11 – 15, cylinders 30, 30' and 52, 52' are supplied with hydraulic pressure fluid by a motor-driven bi-directional hydraulic pump 54 through a control valve 56, which is remotely operated either manually (electrically), or automatically by a microcontroller (one-button operation). Valve 56 is spring biased to the Figs. 14, 15 position, and is moved to the Figs. 11 – 13 position by a solenoid 58. Valve 56 has five ports 60, 62, 64, 66, 68. Ports 60 and 66 are connectable to one side 70 of pump 54, while ports 62 and 68 are alternately connectable to the other side 72 of pump 54. Port 62 is a blind port.

The hydraulics of the top operating system illustrated have five conditions during raising and lowering of the top:
In Condition 1 of Fig. 11, valve 56 is deactuated and biased to its leftward position. Pump 54 is inoperative and the top floats, as fluid can flow between cylinder ends through pump 54, while the tonneau is locked by blockage of the cylinder rod ends. This is the normal position with the vehicle top either raised or lowered and relieves any hydraulic stress on the system.

Fig. 12 illustrates Condition 2, with pump side 70 pressurized to extend cylinders 30, 30’. If the top were lowered, the cylinders would start from a fully retracted position and this would raise the top and then raise rear bow 26.

Fig. 13 illustrates Condition 3, with the pump 54 reversed to pressurize pump side 72 to retract cylinders 30, 30’ and lower the top. Initial movement of the cylinders will operate to raise rear bow 26.

Fig. 14 illustrates Condition 4, with valve 56 actuated and pump side 72 pressurized to extend cylinders 52, 52’ to open the tonneau.

Fig. 15 illustrates Condition 5, with valve 56 actuated and pump 54 reversed to pressurize pump side 70 to retract cylinders 52, 52’ to close the tonneau.

Operation of the top operating mechanism will now be described during the raise/lower cycle of the convertible top. The hydraulics will initially be in Condition 1 when the top is lowered. Valve 56 allows all cylinders to float.

Valve 56 is then moved to the Fig. 14 position to enable pump 54 to operate cylinders 50, 50’ and open the tonneau (Condition 4). When the tonneau is opened, valve 56 is moved to the Fig. 12 position to partially extend cylinders 30, 30’ and raise the top (Condition 2). Valve 56 is then moved to the Fig. 15 position enable reversed pump 54 to retract cylinders 50, 50’ and close the tonneau (Condition 5). Valve 56 is then moved back to the Fig. 12 position.
enable reversed pump 54 to fully extend cylinders 30, 30', which operates mechanical linkage 34 – 46 to enable spring 28 to lower rear bow 26 into engagement with the tonneau, where it may be latched by means not illustrated. The vehicle may optionally include an interlock (not illustrated) which prevents top operation when the vehicle is moving). Valve 56 then returns to the Fig. 11 position (Condition 1).

When it is desired to lower the top, valve 56 is initially moved to the Fig. 12 position to partially retract cylinders 30, 30' and actuate mechanical linkage 34 – 46 to raise rear bow 26 against the bias of spring 28. Valve 56 is then moved to the Fig. 14 position to extend cylinders 50, 50' and open the tonneau (Condition 4), whereafter it is moved to the Fig. 13 position to fully retract cylinders 30, 30' and lower the top (Condition 3). When the top is lowered, valve 56 is moved to the Fig. 15 position to close the tonneau (Condition 5). Valve 56 then returns to the Fig. 11 position (Condition 1).

Thus the mechanical linkage 34 – 46 and spring 28 of this invention operate rear bow 26 at the ends of hydraulic cylinder operation to automatically raise and lower rear bow 26 without the need of the conventional additional hydraulic cylinders. The 2-way 5-position valve 56 of this invention provides an efficient hydraulic operation of the cylinders, and combines with the mechanical linkage to provide a simple, inexpensive, yet efficient and effective convertible top control mechanism.

While only a preferred embodiment has been described and shown, obvious modifications are contemplated within the scope of this invention. The following sample claim is intended to cover only one aspect of this invention, and the scope thereof is not intended to be construed as limiting the actual scope of the invention.
CLAIMS

What is claimed is:

1. A top operating mechanism for moving a vehicle convertible top between a lowered position stored in a storage well and a raised position, said storage well having a cover movable between open and closed positions, said top comprising a pair of spaced linkages each comprising a plurality of pivotally-interconnected side rails including a rear rail, a plurality of spaced transverse bows, including a rear bow pivotally attached to the rear rails for independent raising and lowering movement relative to the rear rail to enable movement of the cover, interconnecting the linkages to support a fabric top, and a power operator connected to each rear rail that is extensible to raise the top and retractable to lower the top, said top operating mechanism characterized by

   a drive pin mounted on each rear rail,
   a slotted clevis having a drive abutment mounted on the end of each actuator and embracing the drive pin,
   a spring providing a lowering bias to the rear rail,
   a drive link pivotally mounted on each clevis and engageable with the drive pin during extension of the power operators to raise the top,
   a drive surface on each rear bow engageable by the drive abutment to raise the rear bow, and
   a cam surface on the rear rail engageable with the drive link when the top is raised to pivot the drive link out of engagement with the drive pin to enable the drive abutment to engage the drive surface to raise the rear bow upon further extension of the power operators.

2. The top operating mechanism of claim 1, wherein the power operators are hydraulic cylinders and further characterized by a 5-way, 2-
position control valve, which selectively connects a bi-directional hydraulic pump with the top-operating hydraulic cylinders.

3. The top operating mechanism of claim 2, including a pair of tonneau-operating hydraulic cylinders, and further characterized by the control valve selectively connecting the hydraulic pump with the tonneau-operating hydraulic cylinders.

4. A top operating mechanism for moving a vehicle convertible top between a lowered position stored in a storage well and a raised position, said storage well having a cover movable between open and closed positions, said top comprising a pair of spaced linkages each comprising a plurality of pivotally-interconnected side rails including a rear rail, a plurality of spaced transverse bows, including a rear bow pivotally attached to the rear rails for independent raising and lowering movement relative to the rear rail to enable movement of the cover, interconnecting the linkages to support a fabric top, and a hydraulic cylinder connected to each rear rail that is extensible to raise the top and retractable to lower the top, said top operating mechanism characterized by a mechanical linkage connecting each power operator with the rear bow for raising the rear bow when the hydraulic cylinder is moved to fully extended condition, and for lowering the rear bow when the hydraulic cylinder is initially retracted from its fully extended condition, and

including a 5-position control valve, which a bi-directional hydraulic pump with the top-operating hydraulic cylinders.

5. The top operating mechanism of claim 4, including a pair of tonneau-operating hydraulic cylinders, and further characterized by the control valve selectively connecting the hydraulic pump with the tonneau-operating hydraulic cylinders to control operation of the tonneau-operating hydraulic
cylinders, the top-operating and tonneau-operating hydraulic cylinders, the bi-directional pump and the control valve comprising a hydraulic system.

6. The top operating mechanism of claim 5, further characterized by the hydraulic system having a first neutral condition, a second condition for raising the top, a third condition for lowering the top, a fourth condition for opening the tonneau, and a fifth condition for lowering the tonneau.

7. The top operating mechanism of claim 6, further characterized by the top-operating cylinders being extended during the second condition and being retracted during the third condition, and the mechanical linkage is activated at the end of the second condition to lower the rear bow and at the beginning of the third condition for raising the rear bow.
Fig. 2

46 44
CAM FOR MECHANICAL LINK
INTERNATIONAL SEARCH REPORT

INTERNATIONAL application No.
PCT/US00/29261

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : B60J 7/08
US CL. : 296/117
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 296/117, 115, 107.08, 136, 76

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category #</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X, P</td>
<td>US 5,998,948 A (Lange et al.) 07 December 1999, entire document.</td>
<td>1</td>
</tr>
<tr>
<td>Y, P</td>
<td>US 5,620,226 A (Sautter, Jr.) 15 April 1997, see entire document.</td>
<td>2.4</td>
</tr>
<tr>
<td>X, P</td>
<td>US 6,048,021 A (Sautter, Jr.) 11 April 2000, Figures 1-8.</td>
<td>1</td>
</tr>
<tr>
<td>Y, P</td>
<td>US 6,115,965 A (Jennings) 12 September 2000, Figures 2-7.</td>
<td>2.7</td>
</tr>
<tr>
<td>Y, P</td>
<td>US 6,024,403 A (Ritter et al.) 15 February 2000, Figures 2-7.</td>
<td>2.7</td>
</tr>
<tr>
<td>Y</td>
<td>US 5,467,596 A (Yui) 21 November 1995, Figures 1 and 12.</td>
<td>2.7</td>
</tr>
<tr>
<td>A, E</td>
<td>US 6,150,781 A (Hollerbach) 21 November 2000, Figure 1.</td>
<td>2.7</td>
</tr>
<tr>
<td>A</td>
<td>US 5,067,768 A (Fischbach) 26 November 1991.</td>
<td>1.7</td>
</tr>
</tbody>
</table>

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier application or patent published on or after the international filing date
  "L" document which may throw doubts on priority claims or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered neither novel nor can it be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report
JAN 19 2001

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703)305-3230

Authorized officer
D. Glenn Dayson

Telephone No. (703) 308-1113

Form PCT/ISA/210 (second sheet) (July 1998)
Continuation of B. FIELDS SEARCHED Item 3: EAST (search terms: clevis, spring, pin, link, cam, drive, vehicle; and bi-directional, pump, control, valve)