DECLARATION OF JUNE ANN MUNFORD

1. My name is June Ann Munford. I am over the age of 18, have personal knowledge of the facts set forth herein, and am competent to testify to the same.

2. I earned a Master of Library and Information Science (MLIS) from the University of Wisconsin-Milwaukee in 2009. I have over ten years of experience in the library/information science field. Beginning in 2004, I have served in various positions in the public library sector including Assistant Librarian, Youth Services Librarian and Library Director. I have attached my Curriculum Vitae as Appendix CV.

3. During my career in the library profession, I have been responsible for materials acquisition for multiple libraries. In that position, I have cataloged, purchased and processed incoming library works. That includes purchasing materials directly from vendors, recording publishing data from the material in question, creating detailed material records for library catalogs and physically preparing that material for circulation. In addition to my experience in acquisitions, I was also responsible for analyzing large collections of library materials, tailoring library records for optimal catalog

search performance and creating lending agreements between libraries during my time as a Library Director.

4. I am fully familiar with the catalog record creation process in the library sector. In preparing a material for public availability, a library catalog record describing that material would be created. These records are typically written in Machine Readable Catalog (herein referred to as "MARC") code and contain information such as a physical description of the material, metadata from the material's publisher, and date of library acquisition. In particular, the 008 field of the MARC record is reserved for denoting the date of creation of the library record itself. As this typically occurs during the process of preparing materials for public access, it is my experience that an item's MARC record indicates the date of an item's public availability.

5. Typically, in creating a MARC record, a librarian would gather various bits of metadata such as book title, publisher and subject headings among others and assign each value to a relevant numerical field. For example, a book's physical description is tracked in field 300 while title/attribution is tracked in field 245. The 008 field of the MARC record is reserved for denoting the creation of the library record itself. As this is the only date reflecting the inclusion of said materials within the library's collection, it is my experience

that an item's 008 field accurately indicates the date of an item's public availability.

6. I have reviewed Exhibit CI-1006, "He Mows Grass in Air-Conditioned Comfort" as published in *Farm Show*, May-June 2003.

7. Attached hereto as Appendix MHS01 is a true and correct copy of the MARC record for *Farm Show* as held by the Minnesota Historical Society. I secured this record myself from the library's public catalog. The MARC record contained within Appendix MHS01 accurately describes the title, author, publisher, and ISSN number of *Farm Show.* The 'Location Items' field of this record visible on page 2 indicates this collection includes the May-June 2003 edition of *Farm Show* containing "He Mows Grass in Air-Conditioned Comfort".

8. Attached hereto as Appendix MHS02 is a true and correct copy of "He Mows Grass in Air-Conditioned Comfort" as published in *Farm Show* as held by the Minnesota Historical Society. These scans were secured from the library's collection. In comparing Exhibit CI-1006 to Appendix MHS02, it is my determination that Exhibit CI-1006 is a true and correct copy of "He

Mows Grass in Air-Conditioned Comfort" as published in *Farm Show* May-June 2003.

9. The 008 field of the MARC record in Appendix MHS01 indicates the date of record creation. The 008 field of Appendix MHS01 indicates the Minnesota Historical Society first acquired this journal as of February 20, 1990 and held new issues of the journal in perpetuity until 2005. Considering this information, it is my determination that *Farm Show* May-June 2003 and therefore "He Mows Grass in Air-Conditioned Comfort" was made available to the public by the Minnesota Historical Society shortly after its initial release in May-June 2003.

10. I am familiar with the Internet Archive, a digital library formally certified by the State of California as a public library. Among other services that the Internet Archive makes available to the general public is the Wayback Machine, an online archive. The Internet Archive's Wayback Machine service archives webpages as of a certain capture date to track changes in the web over time. The Internet Archive has been in operation as a nonprofit library since 1996 and has hosted the Wayback Machine service since its inception in 2001. During my time as a librarian, I frequently used the Internet Archive's Wayback Machine for research and instruction purposes.

This includes teaching instructional classes on using the Wayback Machine to library patrons and using the Wayback Machine to research reference inquiries that require hard-to-find online resources. I consider the Internet Archive's recordskeeping to be as rigorous and detailed as other formal library recordskeeping practices such as MARC records, OCLC records and Dublin Core.

11. Attached hereto as Appendix IA01 are screen captures of the Internet Archive Wayback Machine record for http://www.farmshow.com/view_issue.php?i_id=67&vol=27&number=3&year=2003. I secured these screen captures myself from https://web.archive.org/web/20111121195914/http://www.farmshow.com/view_issue.php?i_id=67&vol=27&number=3&year=2003.

12. Appendix IA01 is a screen capture of a web page entitled "Farm Show – Volume 27, Issue 3, 2003 – Instant Download Available" as hosted on the *Farm Show* website. This page was captured as of November 21, 2011. This page advertises the May-June 2003 issue of *Farm Show* as being available for purchase as a PDF.

13. Attached hereto as Appendix IA02 are screen captures of the Internet Archive Wayback Machine record for http://www.farmshow.com/a_issue.php?volume=27&issue=3. I secured these captures myself from https://web.archive.org/web/20130501000000*/http://www.farmshow.com/a_issue.php?volume=27&issue=3.

14. Appendix IA02 is a screen capture of a web page entitled "Farm Show – Volume 27, Issue 3, 2003 – All Stories in this Issue" as hosted on the *Farm Show* website. This page was captured as of September 19, 2013. This page includes a full table of contents for the May-June 2003 issue of *Farm Show* and clearly includes "He Mows Grass in Air-Conditioned Comfort" within this table of contents. This page also advertises the May-June 2003 issue of *Farm Show* as being available for purchase as a PDF.

15. I have reviewed Exhibit CI-1005, a document entitled *Service Manual: Groundsmaster 5900 & 5910* as published by Toro.

16. Attached hereto as Appendix IA03 are screen captures of the Internet Archive Wayback Machine record for http://toro.com/customercare/commercial/education/pdf/08159sl.pdf. I

secured these screen captures myself from https://web.archive.org/web/20100203203155/http://toro.com/customercare/commercial/education/pdf/08159sl.pdf.

17. Appendix IA03 is a PDF copy of *Service Manual: Groundsmaster 5900 & 5910* as published on the Toro website as of February 3, 2010. In comparing *Service Manual: Groundsmaster 5900 & 5910* to Exhibit CI-1005, it is my determination that Exhibit CI-1005 is a true and correct copy of *Service Manual: Groundsmaster 5900 & 5910.* As the Internet Archive first captured *Service Manual: Groundsmaster 5900 & 5910* as of February 3, 2010 it is my determination that *Service Manual: Groundsmaster 5900 & 5910* was first made available to the public as of February 3, 2010 if not earlier via the original Toro website.

18. I have been retained on behalf of the Petitioner to provide assistance in the above-illustrated matter in establishing the authenticity and public availability of the documents discussed in this declaration. I am being compensated for my services in this matter at the rate of $200.00 per hour plus reasonable expenses. My statements are objective, and my compensation does not depend on the outcome of this matter.

19. I declare under penalty of perjury that the foregoing is true and correct. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: 6/27/2024



June Ann Munford

APPENDIX CV

June A. Munford
Curriculum Vitae

Education

University of Wisconsin-Milwaukee - MS, Library & Information Science, 2009
Milwaukee, WI

- Coursework included cataloging, metadata, data analysis, library systems, management strategies and collection development.
- Specialized in library advocacy, cataloging and public administration.

Grand Valley State University - BA, English Language & Literature, 2008
Allendale, MI

- Coursework included linguistics, documentation and literary analysis.
- Minor in political science with a focus in local-level economics and government.

Professional Experience

Researcher / Expert Witness, October 2017 – present
Freelance ● Pittsburgh, Pennsylvania & Grand Rapids, Michigan

- Material authentication and public accessibility determination. Declarations of authenticity and/or public accessibility provided upon research completion. Experienced with appeals and deposition process.

- Research provided on topics of public library operations, material publication history, digital database services and legacy web resources.

- Past clients include Alston & Bird, Arnold & Porter, Baker Botts, Fish & Richardson, Erise IP, Irell & Manella, O'Melveny & Myers, Perkins-Coie, Pillsbury Winthrop Shaw Pittman and Slayden Grubert Beard.

Library Director, February 2013 - March 2015
Dowagiac District Library ● Dowagiac, Michigan

- Executive administrator of the Dowagiac District Library. Located in

Southwest Michigan, this library has a service area of 13,000, an annual operating budget of over $400,000 and total assets of approximately $1,300,000.

● Developed careful budgeting guidelines to produce a 15% surplus during the 2013-2014 & 2014-2015 fiscal years while being audited.

● Using this budget surplus, oversaw significant library investments including the purchase of property for a future building site, demolition of existing buildings and building renovation projects on the current facility.

● Led the organization and digitization of the library's archival records.

● Served as the public representative for the library, developing business relationships with local school, museum and tribal government entities.

● Developed an objective-based analysis system for measuring library services - including a full collection analysis of the library's 50,000+ circulating items and their records.

November 2010 - January 2013
Librarian & Branch Manager, Anchorage Public Library ● Anchorage, Alaska

● Headed the 2013 Anchorage Reads community reading campaign including event planning, staging public performances and creating marketing materials for mass distribution.

● Co-led the social media department of the library's marketing team, drafting social media guidelines, creating original content and instituting long-term planning via content calendars.

● Developed business relationships with The Boys & Girls Club, Anchorage School District and the US Army to establish summer reading programs for children.

June 2004 - September 2005, September 2006 - October 2013
Library Assistant, Hart Area Public Library
Hart, MI

● Responsible for verifying imported MARC records and original MARC

cataloging for the local-level collection as well as the Michigan Electronic Library.

● Handled OCLC Worldcat interlibrary loan requests & fulfillment via ongoing communication with lending libraries.

Professional Involvement

Alaska Library Association - Anchorage Chapter
- Treasurer, 2012

Library Of Michigan
- Level VII Certification, 2008
- Level II Certification, 2013

Michigan Library Association Annual Conference 2014
- New Directors Conference Panel Member

Southwest Michigan Library Cooperative
- Represented the Dowagiac District Library, 2013-2015

Professional Development

Library Of Michigan Beginning Workshop, May 2008
Petoskey, MI
- Received training in cataloging, local history, collection management, children's literacy and reference service.

Public Library Association Intensive Library Management Training, October 2011
Nashville, TN
- Attended a five-day workshop focused on strategic planning, staff management, statistical analysis, collections and cataloging theory.

Alaska Library Association Annual Conference 2012 - Fairbanks, February 2012
Fairbanks, AK
- Attended seminars on EBSCO advanced search methods, budgeting, cataloging, database usage and marketing.

Depositions

2019 ● Fish & Richardson

Apple v. Qualcomm (IPR2018-001281, 39521-00421IP, IPR2018-01282 and 39521-00421IP2)

2019 ● Erise IP

Implicit, LLC v. Netscout Systems, Inc (Civil Action No. 2:18-cv-53-JRG)

2019 ● Perkins-Coie

Adobe Inc. v. RAH Color Technologies LLC (Cases IPR2019-00627, IPR2019-00628, IPR2019-00629 and IPR2019-00646)

2020 ● O'Melveny & Myers

Maxell, Ltd. v. Apple Inc. (Case No. 5:19-cv-00036-RWS)

2021 ● Pillsbury Winthrop Shaw Pittman LLP

Intel v. SRC (IPR2020-1449)

2022 ● Perkins-Coie

Realtek v. Future Link (IPR2021-01182)

2023 ● Fish & Richardson

Neuroderm Ltd. v. Abbvie, Inc (Case No. PGR2022-00040)

2023 ● Fish & Richardson

Nearmap US Inc. v. Pictometry International Corp. (IPR2022-00735)

2023 ● Fish & Richardson

Samsung Electronics v. MemoryWeb LLC (Case No. 39843-0136PS1)

2023 ● Pillsbury Winthrop Shaw Whitman LLP

Gravel Rating Systems v. Costco Wholesale Corp. (Civil Action No. 4:21-cv-149-ALM)

Limited Case and Clientele History

Alston & Bird

- Ericsson

  v. Collision Communications (IPR2022-01233)

- Nokia

  v. Neptune Subsea, Xtera (Case No. 1:17-cv-01876)

- Universal Electronics Inc

  v. Roku Inc (IPR2022-00818)

Arnold & Porter

- Ivantis

  v. Glaukos (Case No. 8:18-cv-00620)

- Samsung

  v. Jawbone (Case No. 2:21-cv-00186)

Benesch Friedlander Coplan & Aronoff

- Voyis

  v. Cathx (Case No. 5:21-cv-00077-RWS)

Erise I.P.

- Apple
  - v. Ericsson Inc. (IPR2022-00715)
  - v. Future Link Systems (IPRs 6317804, 6622108, 6807505, and 7917680)
  - v. INVT (Case No. 20-1881)
  - v. Navblazer LLC (IPR2020-01253)
  - v. Qualcomm (IPR2018-001281, 39521-00421IP, IPR2018-01282, 39521-00421IP2)
  - v. Quest Nettech Corp (Case No. 2:19-cv-00118-JRG)
  - v. Telefonaktiebolaget LM Ericsson (IPR2022-00275)
- Fanduel
  - v. CGT (Case No. 19-1393)
- Garmin
  - v. Phillips North America LLC (Case No. 2:19-cv-6301-AB-KS)
- Netscout
  - v. Longhorn HD LLC (Case No. 2:20-cv-00349)
  - v. Implicit, LLC (Civil Action No. 2:18-cv-53-JRG)
- Sony Interactive Entertainment LLC
  - v. Bot M8 LLC (IPR2020-01288)
  - v. Infernal Technology LLC (Case No. 2:19-CV-00248-JRG)
- Unified Patents

v. GE Video Compression (Civil Action No. 2:19-cv-248)

Fish & Richardson

- Apple

  v. AliveCor (3:21-cv-03958)

  v. LBS Innovations (Case No. 2:19-cv-00119-JRG-RSP)

  v. Koss Corporation (IPR2021-00305)

  v. Masimo (IPR 50095-0012IP1, 50095-0012IP2, 50095-0013IP1, 50095-0013IP2, 50095-0006IP1, 50095-0135IP1)

  v. Neonode (Case No. 21-cv-08872-EMC)

  v. Qualcomm (IPR2018-001281, 39521-00421IP, IPR2018-01282, 39521-00421IP2)

- Dell

  v. Neo Wireless (IPR2022-00616)

- Dish Network

  v. Entropic Communications, LLC (Case No. 2:2023-CV-01043)

  v. Realtime Adaptive Streaming (Case No. 1:17-CV-02097-RBJ)

  v. TQ Delta LLC (Case No. 18-1798)

- Evapco Dry Cooling

  v. SPG Dry Cooling (IPR2021-00688)

- Genetec

  v. Sensormatic Electronics (Case No. 1:20-CV-00760)

- Huawei

v. Bell Northern Research LLC (IPR2019-01174)

- Kianxis

  v. Blue Yonder (Case No. 3:20-cv-03636)

- LG Electronics

  v. Bell Northern Research LLC (Case No. 3:18-cv-2864-CAB-BLM)

- Metaswitch

  v. Sonus Networks (IPR2018-01719)

- Microsoft

  v. Throughputer Inc (IPR2022-00757)

- Mom Enterprises

  v. Ddrops Company (Case No. 1:22-cv-00332)

- MLC Intellectual Property

  v. MicronTech (Case No. 3:14-cv-03657-SI)

- Nearmap Inc

  v. EagleView Technologies (IPR2022-01009)

- Neuroderm Ltd.

  v. Abbvie, Inc (Case No. PGR2022-00040)

- Realtek Semiconductor

v. Future Link (IPR2021-01182)

- Quectel
  - v. Koninklijke Philips (Case No. 1:20-cv-01710)

- Samsung
  - v. Aire Technology (IPR2022-00877)
  - v. Bell Northern Research (Case No. 2:19-cv-00286-JRG)
  - v. Communication Technologies Inc (IPR2022-01221)
  - v. Jawbone Innovations (IPR2022-00865)
  - v. MemoryWeb LLC (IPR2022-00885)
  - v. Dodots Licensing Solutions (IPR2023-00701)
  - v. Telefonaktiebolaget LM Ericsson (IPR2021-00615)

- Texas Instruments
  - v. Vantage Micro LLC (IPR2020-01261)

- Xilinx
  - v. Sentient Sensors LCC (Case No. 1:22-cv-00173)

Irell & Manella

- Curium

O'Melveny & Myers

- Apple
  - v. Maxell (Case No. 5:19-cv-00036-RWS)

- Micron Technology Inc.

  v. Besang Inc (IPR2023-00900)

- Samsung

  v. Daedalus Prime LLC (1335 Investigation)

Perkins-Coie

- Heru Industries

  v. The UAB Research Foundation (IPR2022-01148)

- Intel Corporation

  v. BitMICRO (Case No. 5:23-cv-00625)

- Realtek Semiconductor

  v. Future Link (IPR2021-01182)

- Twitter Inc

  v. VOIP-Pal.com (Case No. 3:20-cv-02397-JD)

- TCL Industries

  v. Koninklijke Philips NV (IPR2021-00495, IPR2021-00496 and IPR2021-00497)

Pillsbury Winthrop Shaw Pittman

- Intel

  v. FG SRC LLC (Case No. 6:20-cv-00315)

- Gravel Rating Systems

v. Costco (Case No. 4:21-cv-149)
v. Lowe's Home Centers (Case No. 4:21-cv-150)
v. T-Mobile USA (Case No. 4:21-cv-152)
v. Kohl's Inc. (Case No. 4:21-cv-258)
v. Under Armor (Case No. 4:21-cv-356)

Quinn Emanuel

- Wolfspeed

  v. The Trustees of Purdue University (Case No. 1:2021-cv-00840)

Stern, Kessler, Goldstein & Fox

- Preliminary Research

Sheppard, Mullin, Richter & Hampton LLP

- Cadence Design Systems Inc.

  v. Semiconductor Design Technologies (Case No. 3:23-cv-01001)

APPENDIX MHS01

```
leader  01244nas  2200361Ia 4500
001     990016527550104294
005     20190124171827.0
007     hd fu---bucu
008     900220c19779999mnuuu p a     0   a0eng d
022     ##$a0163-4518
035     ##$a(MnHi)001652755SYS01-Aleph
035     ##$a(OCoLC)ocm21096782
035     9#$a21096782
040     ##$cMHS
049     ##$aMHSF $aMHS9 [(Current issues)]
099     ##$a237 $9LOCAL
245     00$aFarm show $hmicroform
260     00$aLakeville, Minn. : $bFarm Show,
300     ##$av. : $bill. ; $c41 cm.
310     ##$aBimonthly
500     ##$a"For everyone in agriculture interested in latest new products."
500     ##$aDescription based on: Vol. 1, no. 2 (1977); title from caption.
533     ##$aMicrofilm. $b[Saint Paul, Minn.] : $cMinnesota Historical Society, $d[1980- . $eon microfilm reels ; 35 mm.
570     ##$aEditor-publisher: H.M. Johnson.
650     #0$aAgricultural machinery $vPeriodicals.
650     #0$aAgricultural implements $xPeriodicals.
700     10$aJohnson, Harold M.
776     0#$tFarm show $w(OCoLC)3676332 $9LOCAL
780     05$tAg world $x0190-4515 $w(OCoLC)2251068 $9LOCAL
967     98$d19900215 $cSK $9LOCAL
967     99$c1 $v1-2 $9LOCAL
967     99$c1 $v3-4 $9LOCAL
967     99$c1 $v5-8 $nA917 $9LOCAL
```

JOURNAL
Farm show
1977

Available at Gale Family Library Periodicals Storage (FOLIO (Current issues)) and other locations >

TOP
SEND TO
LINKS
LOCATION
DETAILS
VIRTUAL BROWSE

Send to

PERMALINK | EMAIL | EXPORT BIBTEX | CITATION | PRINT | REFWORKS | ENDNOTE | EASYBIB | EXPORT RIS

Links

MARC >

Location

Optional sign in available to save your results. Contact the library for assistance. Sign in

BACK TO LOCATIONS

LOCATION ITEMS

Gale Family Library
Available , Microfilm ; 237
from:1-2 1977-1978 until:26-29 2002-2005

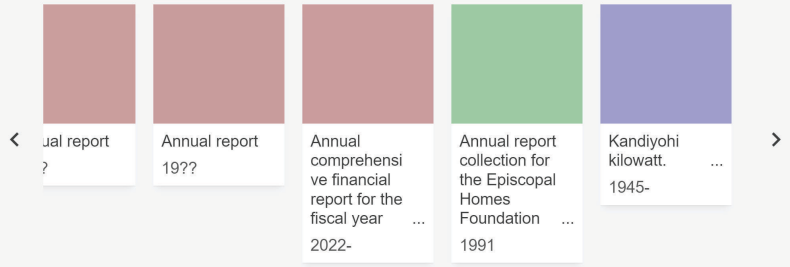
237 copy 00001 v.26-29(2002-2005)	Item in place
237 copy 00001 v.22-25(1998-2001)	Item in place
237 copy 00001 v.17-21(1993-1997)	Item in place
237 copy 00001 v.13-16(1989-1992)	Item in place
237 copy 00001 v.9-12(1985-1988)	Item in place
237 copy 00001 v.5-8(1981-1984)	Item in place
237 copy 00001 v.3-4(1979-1980)	Item in place
237 copy 00001 v.1-2(1977-1978)	Item in place

Details

Call Number / Location	237
Title	Farm show
Creation Date	1977
Related titles	Earlier title : Ag world >
	Earlier title : Ag world >

	Available in other form: Farm show
Publisher	Lakeville, Minn. : Farm Show
Format	v. : ill. ; 41 cm.
Note	"For everyone in agriculture interested in latest new products." Description based on: Vol. 1, no. 2 (1977); title from caption.
Subject	Agricultural machinery -- Periodicals Agricultural implements -- Periodicals
Contributor	Johnson, Harold M.
Genre	Periodicals.
Frequency	Bimonthly
Reproduction Note	Microfilm. [Saint Paul, Minn.] : Minnesota Historical Society, [1980- . on microfilm reels ; 35 mm.
MMS ID	990016527550104294
Other System Identifier	(OCoLC)ocm21096782
Source	Library Catalog

Virtual Browse



Tags

ADD YOUR OWN TAGS

APPENDIX MHS02

GIVE FARM SHOW
FOR FATHERS DAY!
GIFT SUBSCRIPTIONS
CD-ROMS SEE ENCLOSED
ORDER FORM FOR DETAIL
OR CALL 1-800-834-9665

**********3-DIGIT 551
0064126 12 1 99 P-57 P51
LIBRARY - SERIALS UNIT
MINNESOTA HISTORICAL SOCIETY
345 KELLOGG BLVD W
SAINT PAUL MN 55102-1903

3 0322 00070 8968

FARM SHOW®

For everyone in agriculture interested in latest new products and ideas. Carries no advertising!

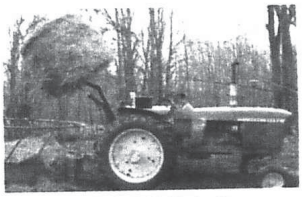
Vol. 27, No. 3, 2003
$5.00

"Made It Myself" Ideas Born In Farm Shops

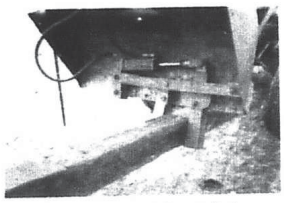
To Subscribe, Call 1-800-834-9665 (Or Use Order Form On Page 44)



"Tag-Along" Loader Boom
(Page 18)



3-Pt. High-Lift Bale Spear
(Page 19)



Bucket-Mounted Post Gripper
(Page 43)



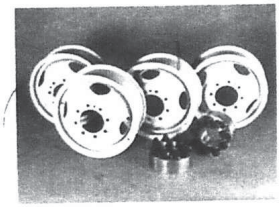
Swather Fitted With Forklift
(Page 18)



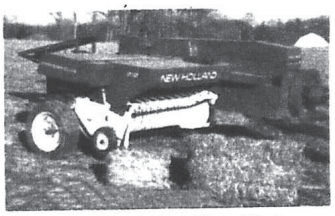
Skid Steer Controlled From Outside Cab
(Page 43)



Bucket For ATV's, Garden Tractors
(Page 44)

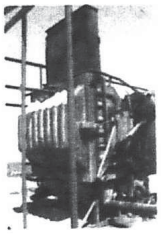


Turn Your Pickup Into A "Dually"
(Page 25)



Reworked Machine Makes Mini Bales
(Page 19)

Big Bale Burner Turns Waste Into Fuel
(Page 20)





Low-Cost Culvert Feed Bunks
(Page 2)



26 Years Of Great Ideas!
(See page 15)

IN THIS ISSUE: Ag World®

2 Dome Building Ready For Market
3 State-Of-The-Art Self-Propelled Sprayer
4 Bin Windows Help Check Grain Level
8 Aqua Farm Ties Fish To Greenhouse
10 New Ways To Fill Center Pivot Tracks
11 Latest New Accessories For ATV's
35 Make Your Own Electricity For Free
37 "Vet" Needles Used On Grease Gun
33 How To Buy A Great Used Combine



New domes come with multi-color tarps and are available in diameters of 30, 38, 42, and 50 ft.



Silver Stream owners Daryl Enns and Dave Arnold recently demonstrated the strength of the new building by hanging a full-sized pickup from the center hub.

Domed "Hoop" Building Ready For Market

That first-ever hoop-type domed building that we told you about last summer (Vol. 26, No. 4) is now ready for market.

Silver Stream Shelters is well known to FARM SHOW readers for its innovative wood-hoop structures and metal truss designs (Vol. 25, No. 2). Company owners Darryl Enns and Dave Arnold say their latest new creation is totally unique to the industry.

"We invented a new hub which mounts at the peak of the building, joining conventional trusses to create a circular structure that's unlike anything on the market," says Enns.

The building comes in 30, 38, 42, and 50-ft. dia. sizes.

"We feel this building design will be ideal for cattle handling, grain storage, salt and sand storage, and even machinery storage. It might also work great as an indoor training facility for horses, as well as for many other uses that we haven't even thought of yet," says Enns. "It's a relatively inexpensive way to add extra storage to your farm and it also makes a great conversation piece."

The new domed building can be covered with multi-colored tarps. Doors up to 12 ft. wide are set up between the arches.

A 30-ft. dia. dome building sells for just over $5,000. Silver Stream wants to get a few of the buildings out and work with the owners on optional design features so they'll sell the first buildings at $3,150 for a 30-ft. and $4,170 for a 38-ft.

Enns notes that in addition to the new domes, the company has a limited supply of wood frame and metal truss hoop buildings at a special price for FARM SHOW readers. For $2,995 you can get a 30 by 72-ft. building, including a 12.5-oz. tarp with a 15-year warranty.



Secret to design of new domed building is the new center hub which joins conventional hoop-type trusses together.

Contact: FARM SHOW Followup, Silver Stream Shelters, Box 1448, Altona, Manitoba R0B 0B0 Canada (ph toll-free 877 547-4738 or 204 324-4592; website: www.silverstreamshelters.com).

Vol. 27, No. 3, 2003

Harold M. Johnson
Founder & Publisher Emeritus

Editor/Publisher - Mark Newhall
Senior Editor - Bill Gergen
Contributing Editors - Mick Lane, C.F. Marley
Office Manager - Anne Lash
Circulation - Peg Nagel, Shelly Mende, Mary Lunde

FARM SHOW (ISSN #01634518) is published bimonthly (6 times a year) for $19.95 per year ($30.95 in Canada and foreign countries) by Farm Show Publishing, Inc., P.O. Box 1029, 20088 Kenwood Trail, Lakeville, Minn. 55044. Periodicals postage paid at Lakeville, Minn., and Shakopee, Minn. POSTMASTER: Send address changes to FARM SHOW, P.O. Box 1029, Lakeville, Minn. 55044 (ph 952 469-5572; fax 952 469-5575). email: Circulation@FARMSHOW.com. Website: www.FARMSHOW.com. Single copy price is $5.00 ($7.00 in Canada). Publication No. 469490 GST No. 131272023 Publication Agreement #40032660

FARM SHOW does not accept advertising and focuses exclusively on new products and product evaluations.

FARM SHOW does not charge for new products or services featured in the magazine. Anyone with a new product or service of interest to farmers - whether inventor, manufacturer, marketer, distributor or whatever - is invited to contact FARM SHOW regarding possible publication.

FARM SHOW Publishing, Inc., has not tested or used any of the ideas or products described in its publications. FARM SHOW Publishing, Inc., does not promote, recommend or endorse the use of the ideas or products described in its publications. FARM SHOW Publishing, Inc., disclaims any and all responsibilities and liabilities in the event of personal injury, death, property damage or losses as the result of the use or application of any such ideas or products. Anyone applying or using such ideas or products does so at his, her or their own risk.

Printed in U.S.A. All rights reserved, including the right of reproduction, in whole or in part, without written permission.

May-June, 2003

Low-Cost "Culvert Feed Bunks"

"They didn't cost much and should last a lifetime," says Rusty Faubion, Blockton, Iowa, who turned 36-in. dia. concrete culverts into fenceline feed bunks.

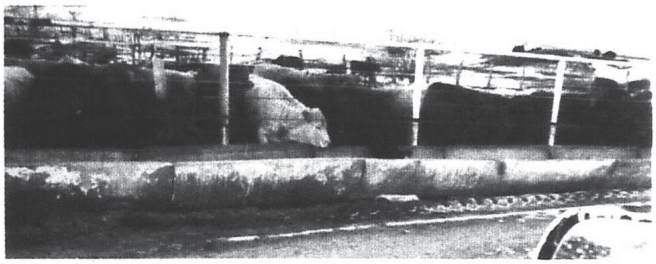
The culverts were given to him after a highway was rebuilt in front of his house. They're 6 ft. long and are designed to interlock tightly together. Faubion used a big cement saw to cut each culvert in half lengthwise. The culverts were then placed end to end alongside a home-built cable fence.

"It was a lot of work but the effort was worth it," says Faubion. "All together I made about 176 ft. of bunks. I borrowed the cement saw from a construction company and paid $119 for a new blade. The culverts are 4 in. thick and have. rebar spaced 2 in. apart at the top and bottom. It took about 20 minutes to make each cut.

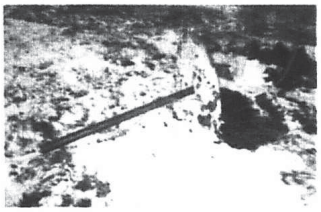
"The bunks are free-standing and won't tilt. They hold a lot of feed."

Faubion says a lot of counties across the country are switching from cement road culverts to plastic and steel. "You can often get concrete culverts cheap," he says.

To make it easy to clean old feed out of the bunks, Faubion welded a round steel disc to a 6 1/2-ft. long piece of steel pipe. A length of chain bolts to the end of the pipe. To clean out the bunk, he hooks the chain onto the bucket on his front-end loader and then drives alongside the bunks.



Rusty Faubion made these fenceline feed bunks out of old 36-in. dia. concrete culverts.





To make it easy to clean old feed out of bunks, he welded a steel disc to a 6 1/2-ft. long piece of steel pipe (above). A big cement saw was used to cut each culvert in half lengthwise. The culverts were then placed end-to-end alongside a cable fence.

Contact: FARM SHOW Followup, Russell Faubion Jr., Rt. 2, Box 69, Blockton, Iowa 50836 (ph 641 788-3761 or 712 542-7006).



Robert Judice built this zero turn riding mower. It has an air conditioned cab and a 5-ft. deck that automatically raises or lowers according to mowing conditions.

He Mows Grass In Air-Conditioned Comfort

"I built this zero turn riding mower equipped with a 5-ft. deck two years ago. It has air conditioning and a deck that automatically raises or lowers according to mowing conditions," says Robert Judice, New Iberia, La.

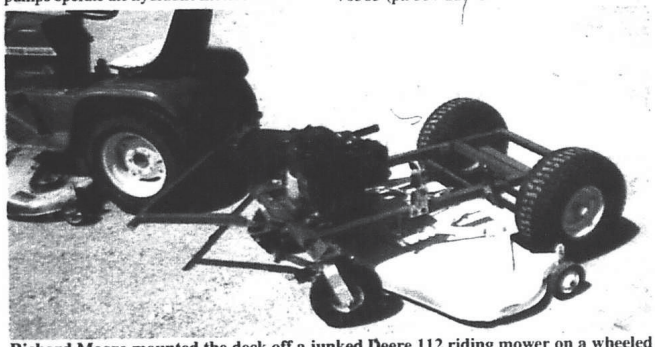
The mower is powered by a 34 hp Kubota diesel engine and is all hydraulic-driven. It rides on 15-in. wheels on front and smaller golf cart wheels on back. Each of the front wheels is driven by a separate Charlin motor. The deck is offset about 10 in. to the left side, allowing Judice to get close to a ditch or building. The right side of the deck is even with the right front wheel.

He used 1/8-in. thick sheet metal to build the cab. The hood came off an old International Harvester 2 plus 2 tractor. The frame is built from 2 by 3-in. sq. tubing. A hydraulic reservoir is located under the left fender. The fuel tank is under the right. The cab is insulated with the same type of insulation material used in tractors. The seat is a boat seat that hinges backward. The diesel engine, which originally had been used to operate a water pump, powers three hydraulic pumps that are hooked together. Two of the pumps operate the hydraulic motors that drive the front wheels, and the third powers a motor that belt-drives the mower blades. All of the pumps are located under the cab's floorboard, which lifts up for easy access.

The machine is equipped with a unique "blade sensor". It works on the pressure side of the hydraulic motor that drives the deck and powers a cylinder that raises and lowers the deck. The sensor allows the deck to lower automatically, depending on the length of the grass being cut. When it reads that the pressure on the deck cylinder is too high, it backs oil up into the cylinder, which then raises the deck slightly to relieve the pressure.

"I really like the air conditioned cab. It gets so cold inside the cab that the windows fog up," says Judice. "The evaporator coil is off an old Ford car and is located in back, just above the rear window. The compressor and condenser came off a Subaru car. I was told that the engine runs a little hot, so instead of locating the condenser in front of the radiator, I mounted it on the side of the cab. I use an electric fan to cool the condenser."

Contact: FARM SHOW Followup, Robert Judice, 5317 Daspit Road, New Iberia, La. 70563 (ph 337 229-6375 or 337 229-8180).



Richard Moore mounted the deck off a junked Deere 112 riding mower on a wheeled frame. He uses a Tecumseh 10 hp engine to power the trailing deck.

Deck Doubles Cutting Width

Mowing his 2 1/2-acre lawn takes half as long since Richard Moore, Colby, Kansas, added a second mower deck behind his 1970 John Deere 112 lawn tractor.

He was happy with the variable speed transmission on his 112 tractor and the way the 41-in. deck left his lawn looking manicured, but he felt he needed something bigger.

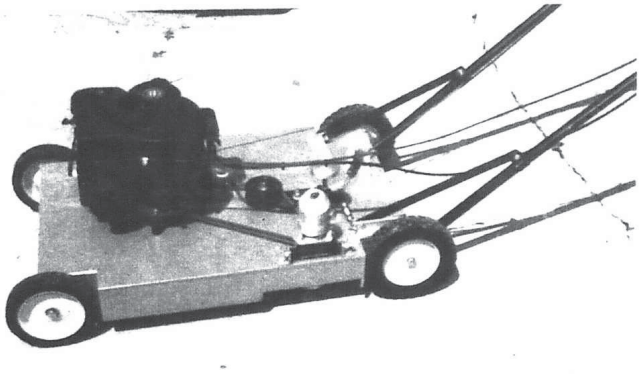
He found a junked 1968 112 at a local lawn mower shop. "The deck was in good shape, so I bought the tractor for $75," he says.

Rather than trying to fix the junker and run two tractors, Moore made a trailer to hold the second mower deck to pull behind his tractor. He stripped the front wheels and spindles off the junked 112 and used those on the back of his trailer, which he made from square steel tubing. He mounted a couple of new caster wheels on front of his trailer.

Then he devised a way to mount the deck from the junked tractor on the trailer, using the lever and mechanical lift mechanism from the old tractor. He used a 10 hp Tecumseh engine to power the trailing deck.

He says the most difficult part was adapting the deck lift linkage from the old tractor to the trailing unit. "I scratched my head a lot over that, but a friend was able to help me figure it out," he says.

Contact: FARM SHOW Followup, Richard Moore, 1886 County Road 15, Colby, Kan. 67701 (ph 785 462-3280; fax 785 462-8322).



"It lets me mow my lawn without leaving a thin strip of grass next to building foundations, etc.," says Marty Garrett about the trimmer he added to the left side of his mower.

Mower Has Built-In Grass Trimmer

Marty Garrett, Louisville, Ill., thought it would be neat to have a lawn mower equipped with a built-in grass trimmer. He couldn't buy one, so he built one.

"The trimmer extends about 2 in. beyond the left side of the mower. It lets me mow my lawn without leaving a thin strip of grass next to sidewalks, building foundations, and flowerbeds," says Garrett.

The trimmer consists of a vertical shaft and bearing that goes through the deck, and to which is attached a Teflon spool that holds the trimming line which is located underneath the deck. The rotating spool is belt-driven by the same engine that drives the blade. An idler pulley, connected by cable to a lever on the handlebars, is used to engage or disengage the spool.

Garrett used 1/8-in. thick sheet metal to build the 21-in. wide deck. The blade is powered by a 3 1/2 hp Briggs & Stratton gas engine.

"It does a nice, clean job and works great around trees and flowerbeds as well as sidewalks and building foundations," says Garrett. "We tested this in a cemetary that had been mowed but had growth around the stones that was 5 or 6 in. high. This whacked that off like no one's business. Whenever I need more line I just shut the engine off and pull more line out."

Garrett is looking for a manufacturer.

Contact: FARM SHOW Followup, Marty Garrett, 845 Garden St., Louisville, Ill. 62858 (ph 618 665-4508).

Side-Mount Mower Built Out Of Cub Cadet Tractor

"It lets me cut a 9-ft. swath, saving a lot of mowing time," says Dwight Davis, Hope Hull, Alabama, who built a "wing" lawn mower out of a Cub Cadet tractor equipped with a home-built 5-ft. deck. He pulls it alongside his 1976 Power King garden tractor, which has a 4-ft. deck.

Davis removed the front axle, rear end, and operator's platform from the Cub, leaving only the tractor's frame and 12 1/2 hp engine. He mounted the tractor on a new frame made out of 2-in. sq. tubing.

He used 1 1/2-in. angle iron and 1/8-in. thick sheet metal to build the deck, which is equipped with three 20-in. blades. The deck is reinforced with 3/8-in. thick steel plate and 2-in. channel iron where the spindles mount. It's supported by four 10-in. caster wheels.

The frame that the Cub mounts on attaches to the Power King with three adjustable length, 1/2-in. dia. steel rods. The rods are threaded at one end, allowing Davis to easily adjust the distance between the two mowers. The rods attach to clevis pins that allow the attached mower to flex up and down.

The Cub's electric clutch is used to control the blades, which are belt-driven off the engine crankshaft.

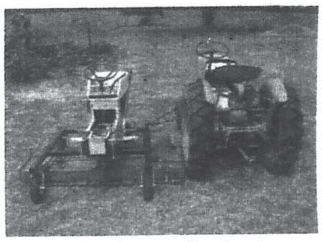
"It works just as good as I had hoped it would and has reduced my mowing time by more than half," says Davis.

"I left the fuel tank, starting system, and charging system intact on the Cub frame. The only thing I added to the tractor was a frame to hold the battery.

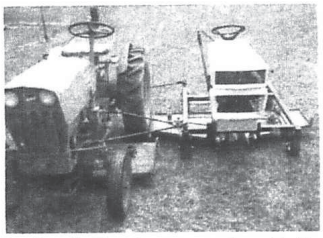
"It handles real well. At first I was afraid the wing mower would pull the tractor to the side, but it hasn't been a problem. The wing mower is positioned right next to the tractor where it's easier to see than if it trailed behind.

"To operate the two mowers, I first start the Cub and use the electric clutch on it to engage the blades. Then I start the Power King and turn on the pto to engage the blades. The decks overlap 2 in. The four caster wheels allow the Cub mower to move in any direction with the Power King. When needed, I can quickly remove three clevis pins and use the Power King by itself."

Contact: FARM SHOW Followup, Dwight Davis, 6073 Felder Rd., Hope Hull, Alabama 36043 (ph 334 286-6175; email: dpdavis@starband.net).



"It has reduced my mowing time by more than half," says Dwight Davis, who built a "wing" lawn mower out of a Cub Cadet tractor equipped with a 5-ft. deck.



Davis pulls the wing mower alongside his Power King garden tractor, which has a 4-ft. deck. Four caster wheels allow the wing mower to move in any direction with the Power King.

Hat Collection Reaches 54,386

When we first met Buckey Legried, back in 1997, his cap collection was already among the world's largest at 24,000. He has since expanded the collection to an incredible 54,386 caps, which makes it by far the largest in the world.

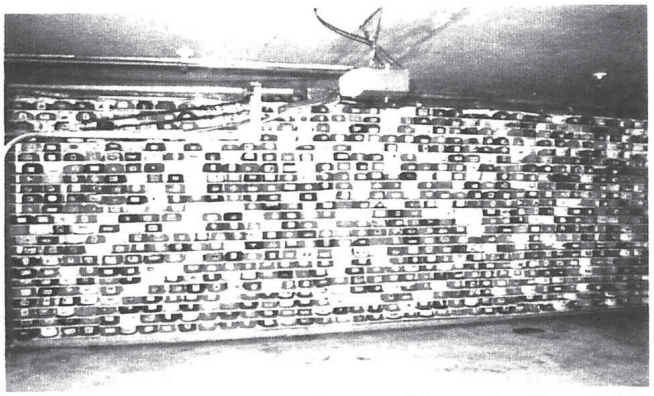
According to a recent report in *Minnesota Farm Guide* (www.minnesotafarmguide.com), Legried has about 2,000 caps on display in his garage and basement. The rest are in storage, 24 caps per box or about 2,000 boxes.

He has caps from Brazil, Denmark, Japan, Korea, Norway, China, Sweden and Venezuela, and many other countries. He has at least one John Deere cap from each state and all of the Canadian provinces except New Foundland. It's not easy to keep up with new Deere caps, says Legried. "Deere comes out with a new cap design many times throughout the year. They have so many different lines of equipment and operate in so many areas of the world that I don't even try to keep track of every new cap they come out with."

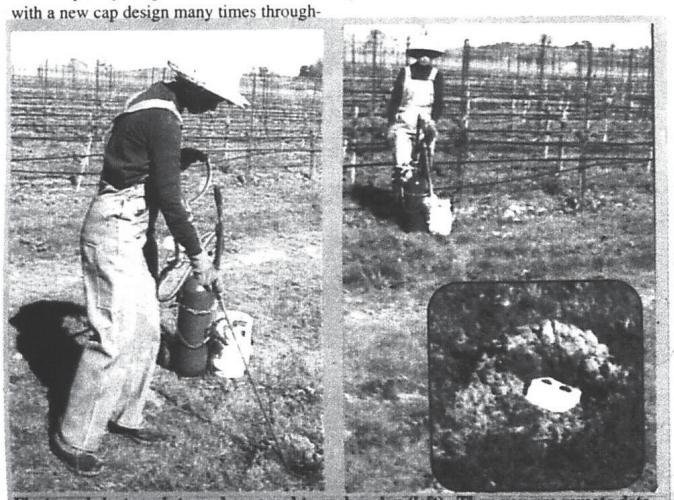
Legried keeps many of his caps on display in his basement, which has shelves on both sides. One side has nothing but Deere caps. The other side has caps with the Deere dealer's name, town and state. Other caps are stored in two 48-ft. semi-trailers.

"A lot of people know about my collection and I still get phone calls from people who want to give me caps," says Legried. He recently sent in his application to Guinness World Records for the world's largest cap collection."

Contact: FARM SHOW Followup, Buckey Legried, 45394 20th St., Frost, Minn. 56033 (ph 507 878-3315; fax 507 878-3125).



Legried keeps some caps on display in his basement. Others are stored in a pair of 48-ft. semi-trailers.



First you inject gas into underground tunnel or den (left). Then you use remote detonator to ignite gas (right). The resulting explosion kills by concussion.

Remote-Controlled "Blaster" Kills Underground Pests

The idea of blasting gophers and other underground pests with an explosion of propane has been around for many years. But the possible danger of the procedure has kept some people away.

A new underground blaster called Safekrush is said to eliminate any risk of blasting yourself. Like other units on the market, it has a wand that you use to inject propane and oxygen into underground tunnels. But instead of a detonator that fits on the end of the wand, it has a remote-controlled electronic detonator that you activate with a wireless remote from a safe distance away.

The manufacturer says the new system appeals to farm women who don't normally like setting traps, using poison bait, or standing right over a tunnel while it's blown up. "Our new system works great on nearly any underground pest including gophers, moles, muskrats, ground squirrels, prairie dogs, badgers, and woodchucks," says company representative John Rogers. He notes that a full foot of the flame-proof wand can be inserted into he den for improved ignition of the gasses. "The injection unit is much lighter than other systems and you get additional equipment for about half the price. In addition, Safekrush comes with helpful aids, such as the Wind Guard and a flameproof tarp for treating Voles, which is normally a very difficult rodent to control."

The patent pending system includes an injection wand, the remote control detonation device, two pressure control valves, and a mobile cart for pulling it around. It sells for $1,170 plus $25 S&H.

Oxygen and propane are mixed as they're injected into the underground tunnels. The gasses rapidly spread throughout the tunnel complex and then expand at a rate of 5,000 ft. per second after detonation, killing all animals at once by concussion. Unlike traps, which kill one at a time, you can wipe out an entire colony in minutes, notes Rogers.

Any size oxygen and propane tanks can be used with the system.

Contact: FARM SHOW Followup, Occidental Nuisance Wildlife Control Company, P.O. Box 920, Forestville, Calif. 95436 (ph 707 824-0903; www.safekrush. com).



Westendorf's new "auto dump" loaders quick-tach to any brand ATV, garden tractor, or lawn tractor up to 20 hp.

"Auto Dump" Bucket For ATV's, Garden Tractors

Putting a loader on an ATV or garden tractor, or lawn tractor is an idea whose time has come, says Westendorf Mfg.

The "auto dump" loaders quick-tach to any brand or model ATV, garden tractor, or lawn tractor up to 20 hp, with or without a 3-pt. hitch. The bucket mounts on front of an ATV or lawn tractor and can be either front or rear-mounted on garden tractors. Models are available to raise the bucket 3, 4, or 5 ft. high.

The bucket operates off the machine's battery and bolts to its frame. A single switch is used to raise, dump, and reset the bucket.

A "clam shell" bucket for hauling grass clippings and leaves is also available.

"We offer a wide variety of attachments for the bucket," says Matt Westendorf. "It can be removed in less than five minutes by removing three pins. The bucket's mounting brackets don't interfere with belly-mounted mowers, so you don't have to remove the mower in order to use the bucket."

The company has also introduced a new forklift, blade, and boom designed for its add-on 3-pt. hitch called the Power Point Converter. "The blade hinges in the middle so you can use it as a flat blade or a V-plow," says Westendorf. "The forklift can be used to move pallets and boxes, etc. The boom can be used to move engines, etc. We also offer extended lift poles that can be used to move picnic tables and garbage bins, etc.," he notes.

The auto-dump bucket and mounting brackets sell for about $500. The Power Point Converter sells for about $600.

Contact: FARM SHOW Followup, Westendorf Mfg. Co. Inc., Box 29, Onawa, Iowa 51041 (ph 712 423-2762; fax 712 423-1460; website: www.westendorfmfg.com).

How To Subscribe To FARM SHOW

(New & Renewal)

Yes! I want to be first to learn about latest new products. Please sign me up for FARM SHOW. I understand I can cancel at any time and receive a full refund if not satisfied.

☐ Check here to renew.

United States	Canada
☐ $19.95 for 1 yr.	☐ $30.95 (Can.) for 1 yr.
☐ $37.95 for 2 yrs.	☐ $58.95 (Can.) for 2 yrs.
☐ $51.95 for 3 yrs.	☐ $79.95 (Can.) for 3 yrs.

☐ My check ($_____) is enclosed. *(Add 7% GST in Can.)*

Name _____

Address _____

City _____ State /Prov. _____ Zip _____

Make check payable to FARM SHOW.
Clip and mail this coupon to:
FARM SHOW, P.O. Box 1029, Lakeville, Minn. 55044
Or phone toll-free 800 834-9665
VISA & Mastercard accepted.

APPENDIX IA01

https://web.archive.org/web/20110601000000*/http://www.farmshow.com/view_issue.php?i_id=67&vol=27&number=3&year=2003 May 7, 2024

INTERNET ARCHIVE SIGN UP | LOG IN UPLOAD Search

ABOUT BLOG PROJECTS HELP DONATE CONTACT JOBS VOLUNTEER PEOPLE

DONATE

INTERNET ARCHIVE WayBackMachine

Explore more than 866 billion web pages saved over time

http://www.farmshow.com/view_issue.php?i_id=67&vol=27&number=38

Calendar · Collections · Changes · Summary · Site Map · URLs

Saved **3 times** between November 21, 2011 and September 5, 2013.

001 2002 2003 2004 2005 2006 2007 2008 2009 2010 **2011** 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024

JAN

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

FEB

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28					

MAR

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

APR

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

MAY

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

JUN

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

JUL

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

AUG

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

SEP

			1	2	3	
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

OCT

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

NOV

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	**21**	22	23	24	25	26
27	28	29	30			

DEC

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Note

This calendar view maps the number of times **http://www.farmshow.com/view_issue.php?i_id=67&vol=27&number=3&year=2003** was crawled by the Wayback Machine, *not* how many times the site was actually updated. More info in the FAQ.

FAQ | Contact Us | Terms of Service (Dec 31, 2014)

The Wayback Machine is an initiative of the Internet Archive, a 501(c)(3) non-profit, building a digital library of Internet sites and other cultural artifacts in digital form. Other projects include Open Library & archive-it.org.

Your use of the Wayback Machine is subject to the Internet Archive's Terms of Use.

https://web.archive.org/web/20111121195914/http://www.farmshow.com/view_issue.php?i_id=67&vol=27&number=3&year=2003 May 7, 2024

INTERNET ARCHIVE WayBackMachine http://www.farmshow.com/view_issue.php?i_id=67&vol=27&number=3&year=2003 Go OCT NOV 21 2011 AUG 2010 2013
3 captures 21 Nov 2011 - 5 Sep 2013
About this capture

November 21, 2011 • 1-800-834-9665

STORE

Books
Back Issue DVD-ROM
DVDs
Back Issues

Instant Issue Downloads
Send Us Your Ideas
Free Issue
Free Classifieds
Search Back Issues

Farm Show - Volume 27, Issue 3, 2003

FARM SHOW Magazine » Farm Show - Volume 27, Issue 3, 2003

Instant Download Available!



A Sampling Of Stories Featured in this Issue

[View All Stories From This Issue - Abbreviated]

- Tag-A-Long Loader Made On Truck Frame
- Scaled-Down New Holland Baler Makes "Mini Bales"
- External Controls Make Skidsteer More Useful
- 3-Pt. High-Lift Bale Spear
- Bracket-Mounted Post Gripper
- Owatonna Mower Fitted With Forklift
- "Auto Dump" Bucket For ATV's, Garden Tractors

Price:

Instant PDF Download - $3.95 ADD TO CART

CLICK HERE TO VIEW PREVIOUS ISSUES
GET A FREE ISSUE
FARM SHOW ON DVD-ROM BUY NOW $39.95

FARM SHOW Magazine
P.O. Box 1029
Lakeville, Minnesota 55044-1029
1-800-834-9665

Subscribe
Free Issue
Farm the WWW
Tell A Friend

FIND US ONLINE
facebook
Become a fan

GIVE A GIFT SUBSCRIPTION

©2011 Farm Show - All Rights Reserved. Contact Us | Terms of Use

PayPal. VISA DISCOVER SECURE SHOPPING 128 bit encryption

APPENDIX IA02

https://web.archive.org/web/20130501000000*/http://www.farmshow.com/a_issue.php?volume=27&issue=3 May 7, 2024

INTERNET ARCHIVE SIGN UP | LOG IN UPLOAD Search

ABOUT BLOG PROJECTS HELP DONATE CONTACT JOBS VOLUNTEER PEOPLE

DONATE

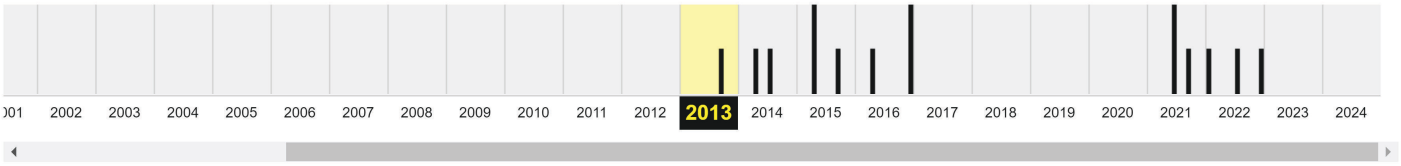
INTERNET ARCHIVE WayBackMachine

Explore more than 866 billion web pages saved over time

http://www.farmshow.com/a_issue.php?volume=27&issue=3

Calendar · Collections · Changes · Summary · Site Map · URLs

Saved **15 times** between September 19, 2013 and December 2, 2022.



JAN

	1	2	3	4	5	
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

FEB

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

MAR

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

APR

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

MAY

		1	2	3	4	
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

JUN

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

JUL

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

AUG

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

SEP

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

OCT

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

NOV

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

DEC

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Note

This calendar view maps the number of times **http://www.farmshow.com/a_issue.php?volume=27&issue=3** was crawled by the Wayback Machine, *not* how many times the site was actually updated. More info in the FAQ.

FAQ | Contact Us | Terms of Service (Dec 31, 2014)

The Wayback Machine is an initiative of the Internet Archive, a 501(c)(3) non-profit, building a digital library of Internet sites and other cultural artifacts in digital form. Other projects include Open Library & archive-it.org.

Your use of the Wayback Machine is subject to the Internet Archive's Terms of Use.

https://web.archive.org/web/20130919062938/http://www.farmshow.com/a_issue.php?volume=27&issue=3 May 7, 2024

INTERNET ARCHIVE WayBackMachine http://www.farmshow.com/a_issue.php?volume=27&issue=3 Go AUG SEP 19 2013 APR 2012 2015 About this capture
15 captures
19 Sep 2013 - 2 Dec 2022



Subscribe now!

STORE

Books
Back Issue DVD-ROM
DVDs
Back Issues

Search
Send Us Your Ideas
Free Issue
Free Classifieds

Farm Show - Volume 27, Issue 3, 2003



All Stories in this Issue
[View Sample Stories From This Issue - Complete]

- Domed "Hoop" Building Ready For Market
- Low-Cost "Culvert Feed Bunks
- Portable Wood Chipper
- State-Of-The-Art Self Propelled Sprayer
- Simple Drag Improves Seedbed
- 2-Wheeled, Electric-Operated Forklift Built For ATV
- Tag-Along Bale Scale
- Bin Windows Help Check Grain Level
- B & B Worm Farms Bankrupt
- He Does Custom Work With Home-Built "Lawn Sprayer"
- Goat Milk Soap A "Natural" Business
- Used Processing Equipment Puts Small Farm Dairy In Business
- "Chile Man" Makes A Living On 2 1/2 Acres
- Aqua Farm Ties Fish Tanks To Greenhouse
- Online Birdseed Business
- Low-Cost Engine Analyzer
- Rabbit-Raising Equiment
- Do-It-Yourself Alcohol Stills
- "Logging Arch" For ATV's
- Low-Slung Cart Makes Harvest Fun
- "Lay Down" Electric-Powered Crawler
- Custom Rut Filler Business Minimizes Crop Damage
- Center Pivot "Rut Filler"
- Track Packer
- Trailer-Type Rut Filler
- Track Tamer
- T-Post Driver Doubles As A Puller
- Hand Pump Fits Existing Wells
- Lastest New Accessories For ATV's
- Crashedtoys.com Sells "Totaled" ATV's, Motorcycles, Boats, Etc.
- Allis-Chalmers Manure Spreader
- Utility Vehile Built For Less Than $500
- Home-Built Deere Utility Vehicle
- Skid Steer Splitter Handles Giant Logs
- Repowered Garden Tractors Work "Better Than New"
- Deere Garden Tractor Specialists
- Clamshell Tie-Down Secures Big Pickup Loads
- Tag-Along Loader Made On Truck Frame
- Owatonna Swather Fitted With Forklift
- Combine Attachment Reduces Plugging
- Scaled-Down New Holland Baler Makes "Mini Bales"
- 3-Pt. High-Lift Bale Spear
- His Big Bale Feeder Saves Tons Of Hay
- "Fabric Layer" Fights Erosion In Waterways
- Bale Burner Turns "Waste Bales" Into Fuel
- Garden Towers Boost Production 800 Percent
- Radar Finds Old Drain Tile Lines
- Two-Wheeled Parade Cart Bobs Up And Down
- Scooter Built From Bike Parts
- Perfect Replica Of First Bike Ever
- Fold-Up Play Fence
- He Created A New Kind Of Cat
- Woman Finds Success As Champion Tractor Puller
- One Horse PTO Power
- Dog Walking Carts Catching On Fast
- Dog Walking Carts Catching On Fast
- Articulated Tractor Patterned After An Allis Chalmers 440
- He Put Tracks On A Pedal Tractor
- Old Crawler Collection Is Gradually Being Restored
- Triple Farmall Runs On One, Two, Or Three Engines
- Triple Farmall Runs On One, Two, Or Three Engines
- Home-Built Devices Make Bale-Handling A Breeze
- "Rubber Lumber" Outlasts The Real Thing
- Tire Holder Saves Your back
- Convert Your Pickup To A Dually
- Ganged Mowers Cut A 6-Ft. Swath
- 4-WD Articulated "Mower Tractor"
- Lawn Edger Converted Into "Tree Root Planner"
- Trailing Mower Provides 7-Ft. Cutting Width
- He Mows Grass In Air-Conditioned Comfort
- Mower Has Built-In Trimmer
- Side-Mount Mower Built Out Of Cub Cadet Tractor
- Deck Doubles Cutting Width
- Repowered IH 4-WD Uses 50% Less Fuel
- Bale Handling Truck Loads, Hauls, And Stacks
- Bale Handling Truck Loads, Hauls, And Stacks
- Tillage Tool Rebuilds Ridges In One Pass
- Bucket-Mounted Tractor Lights
- Portable Mineral Feeder Goes Pasture To Pasture
- "Slope-Proof" Spray Rig
- Heavy Duty Grapple Fork Can Break Up Concrete
- Baby Bottle Sling
- Pogo Seat Makes Pickin' Fun
- Way To "Crock" Vegetables
- Rake Wheel Picnic Table
- State-Of-The-Art Knife Sharpener
- One-Handed Fish Cleaner
- Elevator Eliminates Stair Climbing
- Flower Pot Clamps Onto Post

- Performance Boosting Tips From Combine Expert
- High Capacity Grass Catcher
- Build-It-Yourself Barrel Composter
- "Claw" Handles Thorny Trees
- Self-Contained Hydraulic Power Kit
- Pulley Change Lets Him Roll Up Short Straw
- Make Your Own Electricity For Free?
- CB Radio Irrigation Alert System
- "No Drill" Spare Tire Carrier
- "How I Keep Birds Out Of My Shed"
- Tool For Knocking Tire Beads Off Wheel Rims
- Metal Tray Mounts On Top Of Welder
- Welding Pipes Together At An Angle With "Pipemaster"
- Bolt Bin Wall Uses Grain Cups
- Triangular Magnet And Pipe Pickup Hitch
- Company Offers Inventory Of Military Trucks, Parts And Equipment
- Seller Of Calssic Bronco Parts And Accessories
- SealLube Seal Expander Stop Rubber Oil Seal Leaks In Engines Transmission
- Company Offers Auxiliary Fuel Tank Systems For Pickups
- Fencing Tool Holds Up TO 48 Steel Fence Staples At A Time In A Cartridge
- Extension For Shop Crane Lift 4 By 8-Ft. Sheets To Shop's Ceiling
- Homemade Oil Filter Remover
- Cleaning Out PVC Sewer Lines With A Snake
- Removing Broken Bolts From Castings
- He Uses Anti-Freeze To Kill Rats And Mice
- Solution To Dented Grain Auger
- "Vet" Needles Used On Grease Gun
- Simple Small Engine "Oil Vac"
- No More Trouble Starting Small Tecumseh Engines
- How To Keep Radiator Clean
- Solution To Problems With Super M And Super æMTA' Disc Brakes
- Portable Welding Shop Mounts On Old Garbage Truck
- "Oil Caddy" Made From Office Chair
- Dodge 4-WD Transmission Fix
- 3-Pt. "No Freeze" Fabric Roller
- Portable Sail-Type Windmill
- Sens-Alert Tells Growers When Hay Is Ready To Bale
- Home-Built Cab For Ford Tractor
- Cab For IH Garden Tractor
- Update To Article On All Wool Mattresses
- Exhaust Conversions For Deere Articulating 4-WD Tractors
- Update On Brewing Giant Batches Of "Compost Tea"
- Update To Article On Automatic Tailgate Control For Pickups
- Trailer Combination Of Deere Planter And Dump Box Off Old Truck
- Electric Powered Wagon
- "Aligator Jaw" Gadget
- Portable Backhoe Makes Digging Faster, Easier
- Deere 400 Lawn Tractor With A Front-End Loader
- Home-Built ATV-Mounted Sprayer
- Wooden Spool Rolls Up High Tensile
- Homemade Dump Trailer
- Water Tank Converted Into Ice Fishing House
- Self Propelled Sprayer Converted In Combine
- Grain Bin Stores Wood For Outdoor Furnace
- Accessories For Motorized Pedal Tractor
- Homemade Mailbox Built From Used Farm Machinery Parts
- Pulling Sled For 4-Wheeler ATV
- Attachment For Riding Mowers Lets You Lift The Discharge Chute Up Out Of The Way
- He Runs Skid Steer Loader With External Controls
- Bracket-Mounted Port Gripper
- Hat Collection Reaches 54,386
- Remote-Controlled "Blaster" Kills Underground Pests
- "Auto Dump" Bucket For ATV's, Garden Tractors
- How To Buy A Great Used Combine
- Brake Repair Tool For Ford Tractors

Price:

Instant PDF Download- $3.95 ADD TO CART

CLICK HERE TO VIEW PREVIOUS ISSUES
GET A FREE ISSUE
FARM SHOW ON DVD-ROM BUY NOW $39.95

FARM SHOW Magazine
P.O. Box 1029
Lakeville, Minnesota 55044-1029
1-800-834-9665

Subscribe
Free Issue
Farm the WWW
Tell A Friend

FIND US ONLINE
facebook
Become a fan

GIVE A GIFT SUBSCRIPTION



©2013 Farm Show - All Rights Reserved. Contact Us | Terms of Use

PayPal. VISA DISCOVER SECURE SHOPPING 128 bit encryption

APPENDIX IA03

https://web.archive.org/web/20100401000000*/http://toro.com/customercare/commercial/education/pdf/08159sl.pdf May 16, 2024

INTERNET ARCHIVE SIGN UP | LOG IN UPLOAD Search

ABOUT BLOG PROJECTS HELP DONATE CONTACT JOBS VOLUNTEER PEOPLE

DONATE

INTERNET ARCHIVE WayBackMachine

Explore more than 866 billion web pages saved over time

http://toro.com/customercare/commercial/education/pdf/08159sl.pdf

Calendar · Collections · Changes · Summary · Site Map · URLs

Saved **3 times** between February 3, 2010 and December 26, 2010.

001 2002 2003 2004 2005 2006 2007 2008 2009 **2010** 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024

JAN

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

FEB

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28						

MAR

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

APR

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

MAY

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

JUN

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

JUL

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

AUG

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

SEP

		1	2	3	4	
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

OCT

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

NOV

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

DEC

				1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Note

This calendar view maps the number of times **http://toro.com/customercare/commercial/education/pdf/08159sl.pdf** was crawled by the Wayback Machine, *not* how many times the site was actually updated. More info in the FAQ.

FAQ | Contact Us | Terms of Service (Dec 31, 2014)

The Wayback Machine is an initiative of the Internet Archive, a 501(c)(3) non-profit, building a digital library of Internet sites and other cultural artifacts in digital form. Other projects include Open Library & archive-it.org.

Your use of the Wayback Machine is subject to the Internet Archive's Terms of Use.

https://web.archive.org/web/20100203203155/http://toro.com/customercare/commercial/education/pdf/08159sl.pdf May 16, 2024

INTERNET ARCHIVE WayBack Machine http://toro.com/customercare/commercial/education/pdf/08159sl.pdf Go JAN FEB DEC
3 captures 3 Feb 2010 - 26 Dec 2010 2009 03 2010 2011 About this capture


1


2


3

Part No. 08159SL

TORO

Service Manual

Groundsmaster® 5900 & 5910

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Groundsmaster 5900 and 5910.

REFER TO THE OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. For reference, insert a copy of the Operator's Manual and Parts Catalog for your machine into Chapter 2 of this service manual. Additional copies of the Operator's Manual and Parts Catalog are available on the internet at www.Toro.com.

The Toro Company reserves the right to change product specifications or this publication without notice.

This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

NOTE: A **NOTE** will give general information about the correct operation, maintenance, service, testing or repair of the machine.

IMPORTANT: The IMPORTANT notice will give important instructions which must be followed to prevent damage to systems or components on the machine.



TORO

Service Manual

Groundsmaster® 5900 & 5910

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Groundsmaster 5900 and 5910.

REFER TO THE OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. For reference, insert a copy of the Operator's Manual and Parts Catalog for your machine into Chapter 2 of this service manual. Additional copies of the Operator's Manual and Parts Catalog are available on the internet at www.Toro.com.

The Toro Company reserves the right to change product specifications or this publication without notice.

This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

NOTE: A **NOTE** will give general information about the correct operation, maintenance, service, testing or repair of the machine.

IMPORTANT: The IMPORTANT notice will give important instructions which must be followed to prevent damage to systems or components on the machine.



© The Toro Company - 2009

This page is intentionally blank.

Table Of Contents

Chapter 1 – Safety

General Safety Instructions . . . . . 1 – 2
Jacking Instructions . . . . . 1 – 5
Safety and Instruction Decals . . . . . 1 – 6

Chapter 2 – Product Records and Maintenance

Product Records . . . . . 2 – 1
Maintenance . . . . . 2 – 1
Equivalents and Conversions . . . . . 2 – 2
Torque Specifications . . . . . 2 – 3

Chapter 3 – Diesel Engine

General Information . . . . . 3 – 2
Engine Specifications . . . . . 3 – 4
Engine Fastener Torque Specifications . . . . . 3 – 5
Adjustments . . . . . 3 – 7
Service and Repairs . . . . . 3 – 8

Chapter 4 – Hydraulic System

Specifications . . . . . 4 – 2
General Information . . . . . 4 – 3
Hydraulic Schematic . . . . . 4 – 11
Hydraulic Flow Diagrams . . . . . 4 – 12
Special Tools . . . . . 4 – 30
Troubleshooting . . . . . 4 – 33
Testing . . . . . 4 – 38
Adjustments . . . . . 4 – 60
Service and Repairs . . . . . 4 – 61
SAUER DANFOSS D SERIES GEAR PUMP SEAL KIT SERVICE INSTRUCTION BULLETIN
REXROTH VARIABLE PUMP A10VG REPAIR INSTRUCTIONS
REXROTH VARIABLE PUMP A10VG REPAIR MANUAL
EATON REPAIR INFORMATION: MODEL 74318 and 74348 PISTON MOTORS
PARKER TORQMOTOR™ SERVICE PROCEDURE (TC, TB, TE, TJ, TF, TG, TH AND TL SERIES)
EATON PARTS AND REPAIR INFORMATION: 5 SERIES STEERING CONTROL UNITS

Chapter 5 – Electrical System

General Information . . . . . 5 – 2
Electrical Drawings . . . . . 5 – 3
Special Tools . . . . . 5 – 4
Troubleshooting . . . . . 5 – 6
Info Center Display . . . . . 5 – 11
Electrical System Quick Checks . . . . . 5 – 28
Adjustments . . . . . 5 – 30
Component Testing . . . . . 5 – 32
Service and Repairs . . . . . 5 – 63

Chapter 6 – Axles, Planetaries and Brakes

Specifications . . . . . 6 – 2
General Information . . . . . 6 – 3
Service and Repairs . . . . . 6 – 4

Chapter 7 – Chassis

General Information . . . . . 7 – 1
Service and Repairs . . . . . 7 – 2

Chapter 8 – Cutting Decks

Specifications . . . . . 8 – 2
Troubleshooting . . . . . 8 – 3
General Information . . . . . 8 – 4
Service and Repairs . . . . . 8 – 6

This page is intentionally blank.

Table Of Contents (Continued)

Chapter 9 – Operator Cab

General Information . . . . . 9 – 2
Service and Repairs . . . . . 9 – 3
ICE COMPRESSOR SERVICE MANUAL

Chapter 10 – Foldout Drawings

Hydraulic Schematic . . . . . 10 – 3
Electrical Schematics . . . . . 10 – 4
Wire Harness Drawings . . . . . 10 – 10

This page is intentionally blank.

Chapter 1

Safety

Table of Contents

GENERAL SAFETY INSTRUCTIONS 2
Before Operating 2
While Operating 3
Maintenance and Service 4
JACKING INSTRUCTIONS 5
Jacking the Front End 5
Jacking the Rear End 5
SAFETY AND INSTRUCTION DECALS 6

General Safety Instructions

The Groundsmaster 5900 and 5910 are tested and certified by Toro for compliance with existing safety standards and specifications. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

WARNING

To reduce the potential for injury or death, comply with the following safety instructions.

Before Operating

1. Review and understand the contents of the Operator's Manual and Operator's DVD before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. Additional copies of the Operator's Manual are available on the internet at www.Toro.com.

2. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective, illegible or damaged, repair or replace it before operating the machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

3. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and PTO switch is OFF (disengaged).

4. Since diesel fuel is flammable, handle it carefully:

   A. Use an approved fuel container.

   B. Do not remove fuel tank cap while engine is hot or running.

   C. Do not smoke while handling fuel.

   D. Fill fuel tank outdoors and only to within an inch of the top of the tank, not the filler neck. Do not overfill fuel tank.

   E. Wipe up any spilled fuel.

While Operating

1. Sit on the seat when starting and operating the machine.

2. Before starting the engine:

   A. Engage the parking brake.

   B. Make sure the traction pedal is in the neutral position and the PTO switch is OFF (disengaged).

   C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction pedal is adjusted incorrectly; therefore, shut engine off and adjust traction system until machine does not move when traction pedal is released.

3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.

4. Do not touch engine, radiator or exhaust system while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

5. Before getting off the seat:

   A. Ensure that traction pedal is in the neutral position.

   B. Apply parking brake.

   C. Lower the cutting decks fully to the ground. This relieves pressure from the lift circuit and eliminates the risk of the cutting decks accidentally lowering to the ground.

   D. Disengage cutting decks and wait for cutting blades to stop completely.

   E. Allow engine to run at low idle speed for at least five (5) minutes after full load operation to allow the turbocharger to cool.

   F. Stop engine and remove key from switch. Wait for all machine movement to stop.

6. Do not park machine on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. Before servicing or making machine adjustments, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.

2. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.

3. Shut engine off before checking or adding oil to the engine crankcase.

4. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.

5. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.

6. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, check maximum engine speed.

7. Disconnect batteries before servicing the machine. Disconnect negative battery cables first and positive cables last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the batteries. Reconnect positive battery cables first and negative cables last.

8. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Protect your face, eyes and clothing when working with a battery.

9. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.

10. When changing attachments, tires or performing other service that requires the machine to be raised, use correct jacks, hoists and supports. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use suitable jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury (see Jacking Instructions in this chapter).

11. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the system.

12. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

13. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering the cutting decks to the ground.

14. Make sure all engine fuel system connectors and components are correctly installed, and all fuel hoses are in good condition before starting engine.

15. Keep body and hands away from leaks in engine fuel injection lines. Use cardboard or paper to find high pressure fuel leaks if they may exist. Leaking fuel under pressure can penetrate skin and cause injury.

16. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting decks and other moving parts. Keep bystanders away.

17. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards, and the warranty may be voided.

18. When welding on machine, disconnect all battery cables to prevent damage to machine electronic equipment. Disconnect negative battery cable first and positive cable last. Disconnect and remove engine electronic control module (ECM) from engine before welding on the machine. Also, attach welder ground cable no more than two (2) feet (0.61 meters) from the welding location.

19. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.

Jacking Instructions

CAUTION

When changing attachments, tires or performing other service that requires the machine to be raised, use correct jacks, hoists and supports to raise and support the machine. Make sure machine is parked on a solid level surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use appropriate jack stands to support the raised machine. If the machine is not properly supported by jack stands, the machine may move or fall, which may result in personal injury.

Jacking the Front End (Fig. 1)

1. Chock both rear tires to prevent the machine from moving.

2. Position jack securely under the frame, just to the inside of the front tire. Make sure that jack does not contact hydraulic lift cylinder.

3. Position appropriate jack stands under the frame as close to the front wheel as possible to support the machine.

Jacking the Rear End (Fig. 2)

1. Apply parking brake and chock both front tires to prevent the machine from moving.

2. Place jack securely under the center of rear axle. Jack rear of machine off the ground.

3. Use appropriate jack stands under the rear axle to support the machine.

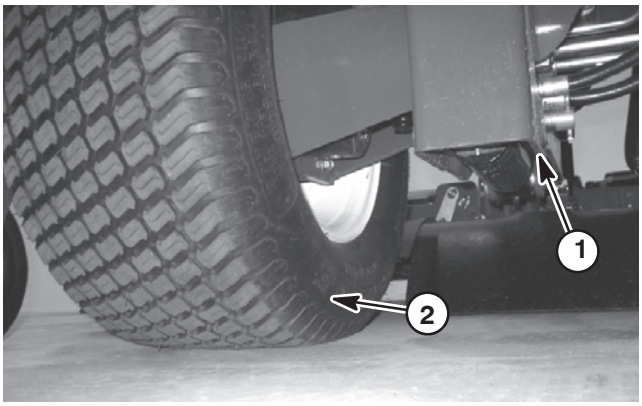


Figure 1

1. Frame jacking point **2. Front tire**

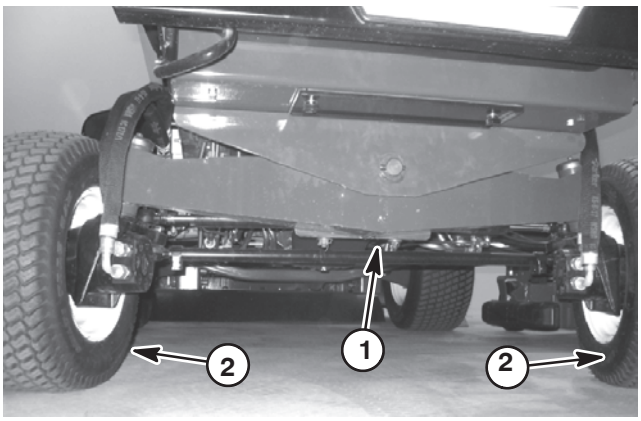


Figure 2

1. Rear axle jacking point **2. Rear tire**

Safety and Instruction Decals

Numerous safety and instruction decals are affixed to your Groundsmaster. If any decal becomes illegible or damaged, install a new decal. Decal part numbers are listed in your Parts Catalog.

Product Records and Maintenance

Table of Contents

PRODUCT RECORDS 1
MAINTENANCE 1
EQUIVALENTS AND CONVERSIONS 2
Decimal and Millimeter Equivalents 2
U.S. to Metric Conversions 2
TORQUE SPECIFICATIONS 3
Fastener Identification 3
Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series) 4
Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric) 5
Other Torque Specifications 6
Conversion Factors 6

Product Records

Insert Operator's Manuals and Parts Catalogs for your Groundsmaster at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your machine, insert the Installation Instructions, Operator's Manuals and Parts Catalogs for those options at the end of this chapter.

Maintenance

Maintenance procedures and recommended service intervals for your Groundsmaster are covered in the Operator's Manuals. Refer to this publication when performing regular equipment maintenance.

Equivalents and Conversions

Decimal and Millimeter Equivalents

Fractions	Decimals	mm	Fractions	Decimals	mm
1/64	0.015625	— 0.397	33/64	0.515625	— 13.097
1/32	0.03125	— 0.794	17/32	0.53125	— 13.494
3/64	0.046875	— 1.191	35/64	0.546875	— 13.891
1/16	0.0625	— 1.588	9/16	0.5625	— 14.288
5/64	0.078125	— 1.984	37/64	0.578125	— 14.684
3/32	0.09375	— 2.381	19/32	0.59375	— 15.081
7/64	0.109275	— 2.778	39/64	0.609375	— 15.478
1/8	0.1250	— 3.175	**5/8**	0.6250	— 15.875
9/64	0.140625	— 3.572	41/64	0.640625	— 16.272
5/32	0.15625	— 3.969	21/32	0.65625	— 16.669
11/64	0.171875	— 4.366	43/64	0.671875	— 17.066
3/16	0.1875	— 4.762	11/16	0.6875	— 17.462
13/64	0.203125	— 5.159	45/64	0.703125	— 17.859
7/32	0.21875	— 5.556	23/32	0.71875	— 18.256
15/64	0.234375	— 5.953	47/64	0.734375	— 18.653
1/4	0.2500	— 6.350	**3/4**	0.7500	— 19.050
17/64	0.265625	— 6.747	49/64	0.765625	— 19.447
9/32	0.28125	— 7.144	25/32	0.78125	— 19.844
19/64	0.296875	— 7.541	51/64	0.796875	— 20.241
5/16	0.3125	— 7.938	13/16	0.8125	— 20.638
21/64	0.328125	— 8.334	53/64	0.828125	— 21.034
11/32	0.34375	— 8.731	27/32	0.84375	— 21.431
23/64	0.359375	— 9.128	55/64	0.859375	— 21.828
3/8	0.3750	— 9.525	**7/8**	0.8750	— 22.225
25/64	0.390625	— 9.922	57/64	0.890625	— 22.622
13/32	0.40625	— 10.319	29/32	0.90625	— 23.019
27/64	0.421875	— 10.716	59/64	0.921875	— 23.416
7/16	0.4375	— 11.112	15/16	0.9375	— 23.812
29/64	0.453125	— 11.509	61/64	0.953125	— 24.209
15/32	0.46875	— 11.906	31/32	0.96875	— 24.606
31/64	0.484375	— 12.303	63/64	0.984375	— 25.003
1/2	0.5000	— 12.700	**1**	1.000	— 25.400

1 mm = 0.03937 in. **0.001 in. = 0.0254 mm**

U.S.to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
Volume	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
Liquid Volume	Quarts	Liters	0.9463
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subract 32° 2. Multiply by 5/9

Torque Specifications

Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

These Torque Specifications for the installation and tightening of fasteners shall apply to all fasteners which do not have a specific requirement identified in this Service Manual. The following factors shall be considered when applying torque: cleanliness of the fastener, use of a thread sealant (e.g. Loctite), degree of lubrication on the fastener, presence of a prevailing torque feature (e.g. Nylock nut), hardness of the surface underneath the fastener's head or similar condition which affects the installation.

As noted in the following tables, torque values should be **reduced by 25% for lubricated fasteners** to achieve the similar stress as a dry fastener. Torque values may also have to be reduced when the fastener is threaded into aluminum or brass. The specific torque value should be determined based on the aluminum or brass material strength, fastener size, length of thread engagement, etc.

The standard method of verifying torque shall be performed by marking a line on the fastener (head or nut) and mating part, then back off fastener 1/4 of a turn. Measure the torque required to tighten the fastener until the lines match up.

Fastener Identification

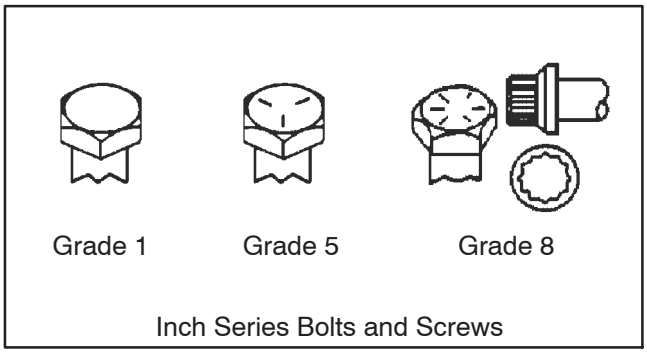


Figure 1

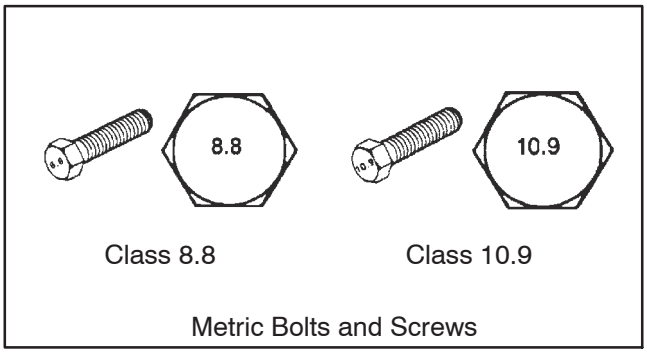


Figure 2

Standard Torque for Dry, Zinc Plated and Steel Fasteners (Inch Series)

Thread Size	Grade 1, 5 & 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 5 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)		SAE Grade 8 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 5 or Stronger Nuts)	
	in-lb	**in-lb**	**N-cm**	**in-lb**	**N-cm**	**in-lb**	**N-cm**
# 6 - 32 UNC	10 ± 2	13 ± 2	147 ± 23	15 ± 2	169 ± 23	23 ± 3	262 ± 34
# 6 - 40 UNF				17 ± 2	192 ± 23	25 ± 3	282 ± 34
# 8 - 32 UNC	13 ± 2	25 ± 5	282 ± 56	29 ± 3	328 ± 34	41 ± 5	463 ± 56
# 8 - 36 UNF				31 ± 4	350 ± 45	43 ± 5	486 ± 56
# 10 - 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 5	475 ± 56	60 ± 6	678 ± 68
# 10 - 32 UNF				48 ± 5	542 ± 56	68 ± 7	768 ± 79
1/4 - 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1130 ± 113	140 ± 15	1582 ± 169
1/4 - 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 12	1299 ± 136	160 ± 17	1808 ± 192
5/16 - 18 UNC	115 ± 15	105 ± 15	1186 ± 169	200 ± 25	2260 ± 282	300 ± 30	3390 ± 339
5/16 - 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2542 ± 282	325 ± 33	3672 ± 373
	ft-lb	**ft-lb**	**N-m**	**ft-lb**	**N-m**	**ft-lb**	**N-m**
3/8 - 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 5	58 ± 7
3/8 - 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 4	47 ± 5	50 ± 6	68 ± 8
7/16 - 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 - 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 6	75 ± 8	77 ± 8	104 ± 11
1/2 - 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 11	142 ± 15
1/2 - 20 UNF	32 ± 4	53 ± 7	72 ± 9	85 ± 9	115 ± 12	120 ± 12	163 ± 16
5/8 - 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 21	285 ± 28
5/8 - 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 18	230 ± 24	240 ± 24	325 ± 33
3/4 - 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 27	359 ± 37	375 ± 38	508 ± 52
3/4 - 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 30	407 ± 41	420 ± 43	569 ± 58
7/8 - 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 - 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 48	644 ± 65	667 ± 66	904 ± 89

NOTE: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as engine oil or thread sealant such as Loctite.

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

NOTE: The nominal torque values listed above for Grade 5 and 8 fasteners are based on 75% of the minimum proof load specified in SAE J429. The tolerance is approximately ± 10% of the nominal torque value. Thin height nuts include jam nuts.

Standard Torque for Dry, Zinc Plated and Steel Fasteners (Metric Series)

Thread Size	Class 8.8 Bolts, Screws and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 6 in-lb	644 ± 68 N-cm	78 ± 8 in-lb	881 ± 90 N-cm
M6 X 1.0	96 ± 10 in-lb	1085 ± 113 N-cm	133 ± 14 in-lb	1503 ± 158 N-cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N-m	28 ± 3 ft-lb	38 ± 4 N-m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N-m	54 ± 6 ft-lb	73 ± 8 N-m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N-m	93 ± 10 ft-lb	126 ± 14 N-m
M16 X 2.0	166 ± 17 ft-lb	225 ± 23 N-m	229 ± 23 ft-lb	310 ± 31 N-m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N-m	450 ± 46 ft-lb	610 ± 62 N-m

NOTE: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as engine oil or thread sealant such as Loctite.

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

NOTE: The nominal torque values listed above are based on 75% of the minimum proof load specified in SAE J1199. The tolerance is approximately ± 10% of the nominal torque value.

Other Torque Specifications

SAE Grade 8 Steel Set Screws

Thread Size	Recommended Torque	
	Square Head	Hex Socket
1/4 – 20 UNC	140 ± 20 in–lb	73 ± 12 in–lb
5/16 – 18 UNC	215 ± 35 in–lb	145 ± 20 in–lb
3/8 – 16 UNC	35 ± 10 ft–lb	18 ± 3 ft–lb
1/2 – 13 UNC	75 ± 15 ft–lb	50 ± 10 ft–lb

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque**	
7/16 – 20 UNF Grade 5	65 ± 10 ft–lb	88 ± 14 N–m
1/2 – 20 UNF Grade 5	80 ± 10 ft–lb	108 ± 14 N–m
M12 X 1.25 Class 8.8	80 ± 10 ft–lb	108 ± 14 N–m
M12 X 1.5 Class 8.8	80 ± 10 ft–lb	108 ± 14 N–m

** For steel wheels and non–lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

Type 1, Type 23 or Type F	
Thread Size	Baseline Torque*
No. 6 – 32 UNC	20 ± 5 in–lb
No. 8 – 32 UNC	30 ± 5 in–lb
No. 10 – 24 UNC	38 ± 7 in–lb
1/4 – 20 UNC	85 ± 15 in–lb
5/16 – 18 UNC	110 ± 20 in–lb
3/8 – 16 UNC	200 ± 100 in–lb

Thread Cutting Screws (Zinc Plated Steel)

Thread Size	Threads per Inch		Baseline Torque*
	Type A	Type B	
No. 6	18	20	20 ± 5 in–lb
No. 8	15	18	30 ± 5 in–lb
No. 10	12	16	38 ± 7 in–lb
No. 12	11	14	85 ± 15 in–lb

* Hole size, material strength, material thickness and finish must be considered when determining specific torque values. All torque values are based on non–lubricated fasteners.

Conversion Factors

in–lb X 11.2985 = N–cm
ft–lb X 1.3558 = N–m

N–cm X 0.08851 = in–lb
N–m X 0.7376 = ft–lb

Chapter 3

Diesel Engine

Table of Contents

GENERAL INFORMATION 2
- Operator's Manual 2
- Engine Identification 2
- Engine Electronic Control Module (ECM) 2
- Stopping the Engine 3
- Fuel Injection System 3

ENGINE SPECIFICATIONS 4
ENGINE FASTENER TORQUE SPECIFICATIONS 5
ADJUSTMENTS 7
- Valve Clearance 7

SERVICE AND REPAIRS 8
- Air Filter System 8
- Exhaust System 10
- Turbocharger 12
- Fuel System 14
  - Check Fuel Lines and Connections 14
  - Drain and Clean Fuel Tank 14
  - Fuel Tank Removal 15
  - Fuel Tank Installation 15
- Radiator 16
- Alternator 18
- Starter Motor 20
- Valve Cover 22
- Engine Breather System 24
- Thermostat 26
- Water Pump 28
- Front Cover 30
- Oil Pan 34
- Engine 36
  - Engine Removal 36
  - Engine Installation 38
- Flywheel Coupling Assembly 40

General Information

This Chapter gives information about specifications of the Cummins B3.3 diesel engine used in the Groundsmaster 5900 and 5910. Additionally, some engine repair procedures are described in this manual. Described adjustments and repairs require tools which are commonly available in many service shops.

Some service and repair parts for the engine in your Groundsmaster are supplied through your Authorized Toro Distributor. Be prepared to provide your distributor with the Toro model and serial number of your machine to obtain parts.

Detailed information on engine troubleshooting, testing, disassembly and reassembly is identified in the Cummins Service Manual that is available from Cummins. The use of some specialized tools and test equipment is explained in the Cummins Service Manual. However, the specialized nature of some engine repairs may dictate that the work be done at an engine repair facility.

Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. Refer to the Operator's Manual for additional information when servicing the machine.

Engine Identification

The engine dataplate located near the starter motor includes the engine serial number and control parts list number. The fuel injection dataplate is located on the fuel injection pump. The ECM dataplate is on the electronic control module attached to the flywheel end of the engine. These engine identification tags will assist in identifying the correct parts and service information for the Cummins engine in your Groundsmaster.

Engine Electronic Control Module (ECM)

The Cummins engine that is used in the Groundsmaster 5900 and 5910 uses an electronic control module (ECM) for engine management and also to communicate with the TEC controllers and the operator Info Center on the machine. All engine ECM electrical connectors should be plugged into the controller before the machine ignition switch is moved from the OFF position to either the ON or START position. If the engine ECM is to be disconnected for any reason, make sure that the ignition switch is in the OFF position with the key removed before disconnecting the ECM. Also, to prevent possible module damage when welding on the machine, disconnect and remove the engine ECM from the engine before welding.

Stopping the Engine

IMPORTANT: Before stopping the engine after mowing or full load operation, allow the engine to run at low idle speed for five (5) minutes. This will allow the turbocharger and internal engine components to adequately cool down. Failure to allow this cool down period may lead to premature turbocharger and engine failure.

Fuel Injection System

The engine fuel injection system operates at high pressures during engine operation. Do not loosen any fuel system components, fittings or hoses while the engine is running.

Keep body and hands away from leaks in engine fuel injection lines. Use cardboard or paper to find high pressure fuel leaks if they may exist. Leaking fuel under pressure can penetrate skin and cause injury.

Engine Specifications

Item	Description
Make / Designation	Cummins, 4–Cycle, 4 Cylinder, Liquid Cooled, Turbocharged, Diesel Engine
Bore	3.74 in (95.0 mm)
Stroke	4.53 in (115 mm)
Total Displacement	201 in^3 (3300 cc)
Firing Order	1 (Closest to Engine Pulley) – 2 – 4 – 3
Direction of Rotation	Clockwise (Viewed from Engine Pulley)
Compression Ratio	17:1
Valve Clearance Intake Exhaust	 0.014” (0.35 mm) 0.020” (0.50 mm)
Fuel	Diesel or Biodiesel (up to B20) with Low/Ultra Low Sulfur Content
Fuel Tank Capacity	35 U.S. gallons (132 liters)
Fuel Injection Pump	Zexel Rotary Type VE Pump
Injection Nozzle	Closed Nozzle, Hole Type
Governor	Electronic
Low Idle (no load)	1350 RPM
High Idle (no load)	2750 RPM
Oil Pump	Geroter Type
Engine Oil	API CH–4 or CI–4 (see Operator’s Manual for Viscosity)
Crankcase Oil Capacity	8.5 U.S. quarts (8.0 liters) with Filter
Starter	12 VDC, 2.2 kW
Alternator/Regulator	12 VDC, 120 AMP
Coolant Capacity GM 5900 (without cab) GM 5910 (with cab)	 13.5 U.S. quarts (12.8 liters) 18 U.S. quarts (17 liters)
Engine Dry Weight	606 U.S. pounds (275 kg)

Engine Fastener Torque Specifications

Item	Description
Alternator Adjusting Cap Screw	23 ft-lb (31 N-m)
Alternator Mounting Bracket Cap Screw (2 used)	23 ft-lb (31 N-m)
Alternator Mounting Cap Screw	49 ft-lb (66 N-m)
Crankshaft Pulley Bolt	274 ft-lb (372 N-m)
Exhaust Manifold Flange Head Screw (8 used)	33 ft-lb (45 N-m)
Front Cover Flange Head Screw (16 used)	14 ft-lb (19 N-m)
Oil Drain Plug	38 ft-lb (51 N-m)
Oil Pan Flange Head Screw (24 used)	24 to 38 ft-lb (32 to 51 N-m)
Oil Suction Tube Flange Head Screw (2 used)	14 ft-lb (19 N-m)
Starter Mounting Flange Head Screw (2 used)	32 ft-lb (43 N-m)
Thermostat Housing Flange Head Screw (2 used)	14 ft-lb (19 N-m)
Turbocharger Mounting Nut (4 used)	22 ft-lb (30 N-m)
Turbocharger Oil Drain Line Cap Screw (2 used)	18 ft-lb (24 N-m)
Turbocharger Oil Supply Line Banjo Bolt	18 ft-lb (24 N-m)
Valve Adjustment Nut (rocker arm)	29 to 36 ft-lb (39 to 49 N-m)
Valve Cover Nut (3 used)	80 in-lb (9 N-m)
Water Pump Pulley Flange Head Screw (4 used)	23 ft-lb (31 N-m)

This page is intentionally blank.

Valve Clearance

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood.

3. Remove valve cover from engine (see Valve Cover Removal in the Service and Repairs section of this chapter).

4. Position engine crankshaft so cylinder #1 is at top dead center (TDC) at the end of the compression stroke:

   A. While watching the movement of the cylinder #4 intake valve, rotate engine crankshaft in normal rotation direction (clockwise). When the cylinder #4 intake valve starts to open, cylinder #1 is approaching TDC at the end of the compression stroke.

   B. Continue rotating the crankshaft in the normal rotation direction (clockwise) until the cutout in the tone wheel attached to the back of the crankshaft pulley aligns with "1.4 TOP" cast in engine front cover (Fig. 1).

5. In this crankshaft position, adjust valve clearance for intake valves for cylinders #1 and #3 and exhaust valves for cylinders #1 and #2 (Fig. 2 and 3).

   A. Loosen the lock nut on the rocker arm adjustment screw.

   B. Insert correct feeler gauge between the valve stem and the rocker arm. Intake valve clearance specification is 0.014" (0.35 mm). Exhaust valve clearance specification is 0.020" (0.50 mm).

   C. Adjust screw until a slight drag is felt on the feeler gauge.

   D. Hold adjustment screw in position and tighten lock nut to secure valve clearance adjustment. Torque lock nut from **29 to 36 ft-lb (39 to 49 N-m)**.

   E. After tightening lock nut, re-check valve clearance.

6. Rotate crankshaft in the normal rotation direction (clockwise) one complete revolution. The tone wheel cutout should again be aligned with "1.4 TOP".

7. In this crankshaft position, adjust valve clearance for intake valves for cylinders #2 and #4 and exhaust valves for cylinders #3 and #4. Follow procedure under step 5 above.

8. Install valve cover to engine (see Valve Cover Installation in the Service and Repairs section of this chapter).

9. Lower and secure hood.

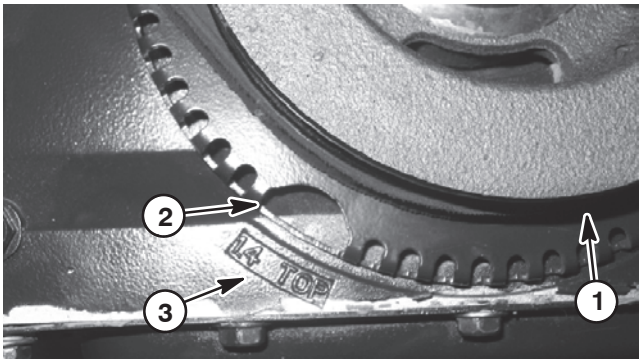


Figure 1

1. **Crankshaft pulley**
2. **Tone wheel cutout**
3. **TDC indicator**

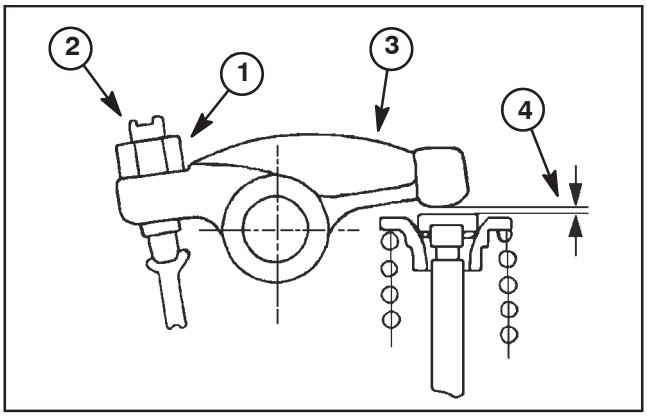


Figure 2

1. **Lock nut**
2. **Adjustment screw**
3. **Rocker arm**
4. **Valve clearance**

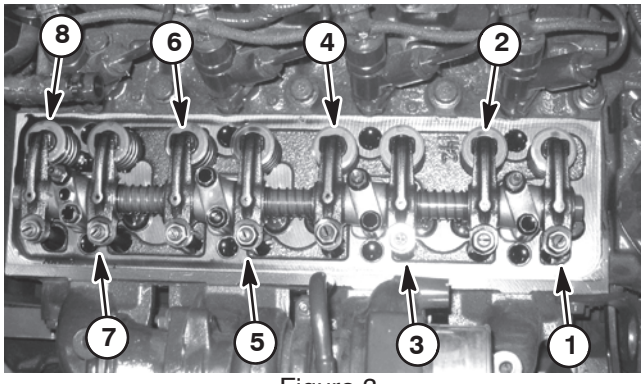


Figure 3

1. **#1 intake**
2. **#1 exhaust**
3. **#2 intake**
4. **#2 exhaust**
5. **#3 intake**
6. **#3 exhaust**
7. **#4 intake**
8. **#4 exhaust**

Air Filter System

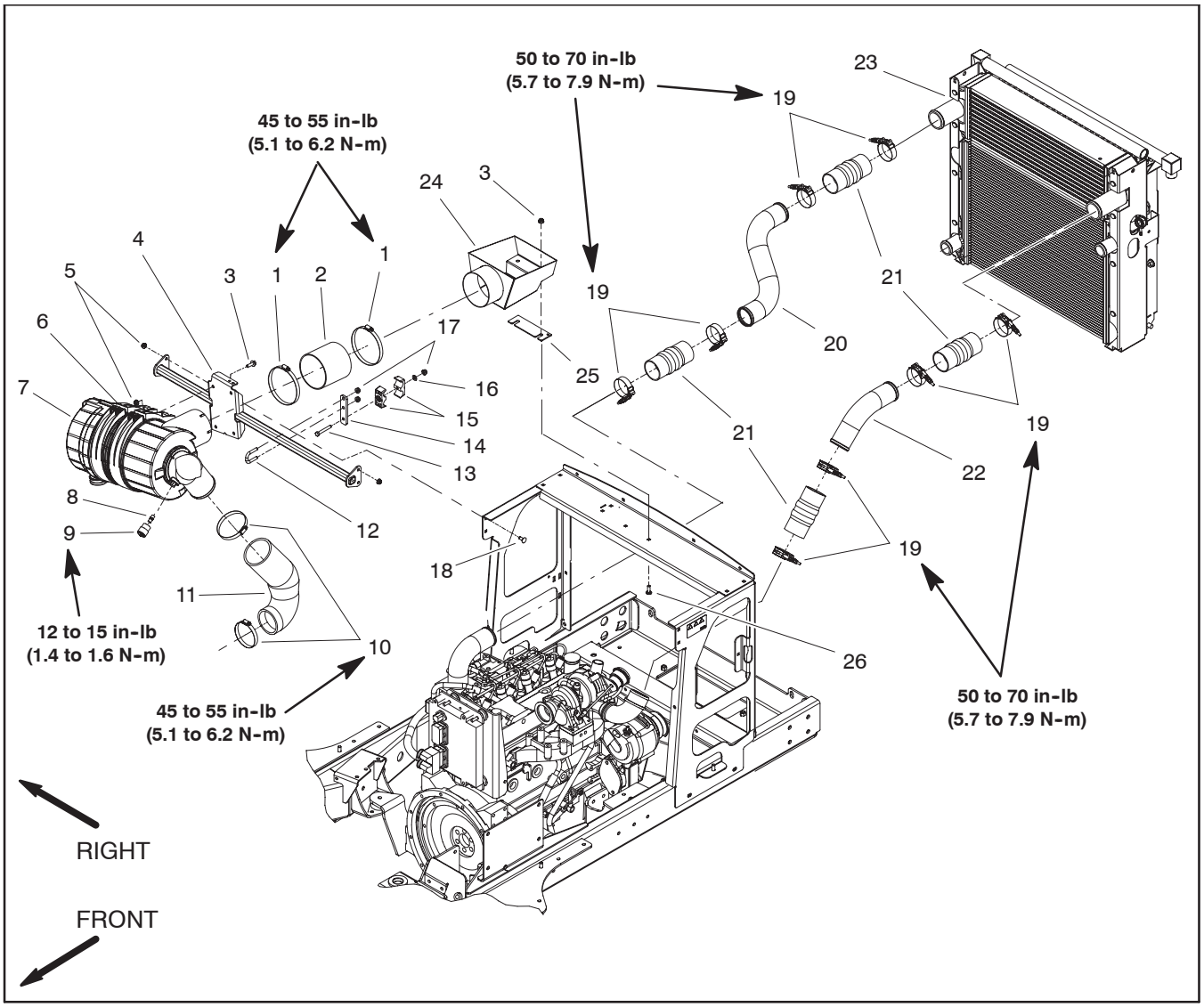


Figure 4

1. Clamp
2. Air hose
3. Flange head screw (6 used)
4. Air cleaner mount
5. Flange nut (8 used)
6. Air cleaner mounting band (2 used)
7. Air cleaner assembly
8. Adapter
9. Service indicator
10. Worm clamp
11. Intake tube
12. U-bolt
13. Cap screw
14. Mount plate
15. Tube clamp
16. Flat washer
17. Flange nut (3 used)
18. Carriage screw (4 used)
19. Hose clamp (8 used)
20. Tube
21. Air intake tube (4 used)
22. Tube
23. Radiator assembly
24. Airbox
25. Spacer plate (as needed)
26. Carriage screw (2 used)

Removal (Fig. 4)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

3. Remove air cleaner components as needed using Figure 4 as a guide.

4. Inspect all tubes and clamps for evidence of wear or damage. Replace components as needed.

NOTE: If charge air cooler in radiator assembly needs to be serviced (Fig. 5), refer to Radiator Removal and Installation in this section.

Installation (Fig. 4)

IMPORTANT: Any leaks in the air filter system will cause serious engine damage. Make sure that all air cleaner components are in good condition and are properly secured during installation.

1. Assemble air cleaner system using Figure 4 as a guide.

   A. Verify that tabs in air cleaner mounting bands mesh fully with slots in air cleaner body.

   B. Position hose clamps (item 1) so that there is no interference with hood foam when hood is closed.

   C. Torque hose clamps (items 1 and 10) from **45 to 55 in-lb (5.1 to 6.2 N-m)**.

   D. Torque hose clamps (item 19) from **50 to 70 in-lb (5.7 to 7.9 N-m)**.

   E. Make sure that air cleaner vacuator valve is pointed down after assembly (Fig. 6).

   F. If service indicator (item 8) and adapter (item 9) were removed from air cleaner housing, apply thread sealant to adapter threads before installing adapter and indicator to housing. Install adapter so that grooves in adapter hex and adapter filter element are installed toward service indicator (Fig. 7). Torque indicator from **12 to 15 in-lb (1.4 to 1.6 N-m)**.

2. Apply chalk on airbox lip, lower hood and check that hood makes a continuous seal around airbox (item 24). If necessary, use shim(s) (item 25) to adjust location of airbox for proper sealing with hood.

3. Lower and secure hood.

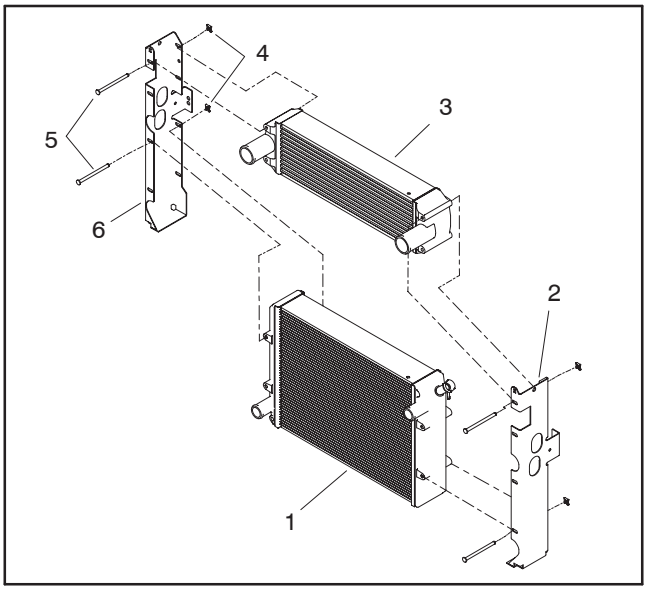


Figure 5

1. **Radiator**
2. **LH cooler bracket**
3. **Charge air cooler**
4. **Pin clip (8 used)**
5. **Pin (8 used)**
6. **RH cooler bracket**

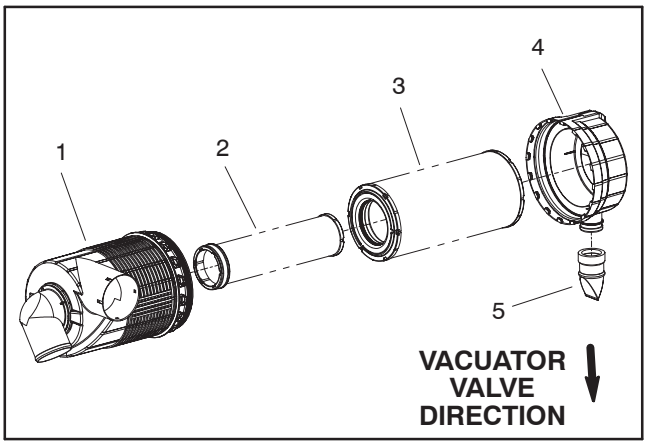


Figure 6

1. **Air cleaner housing**
2. **Safety filter**
3. **Filter element**
4. **Cover**
5. **Vacuator valve**

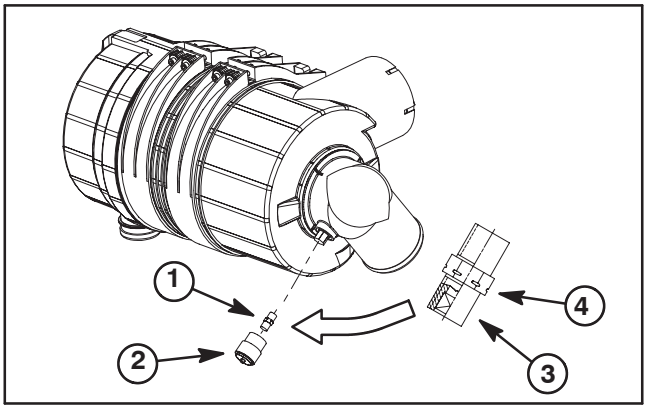


Figure 7

1. **Adapter**
2. **Service indicator**
3. **Adapter filter element**
4. **Adapter grooves**

Exhaust System

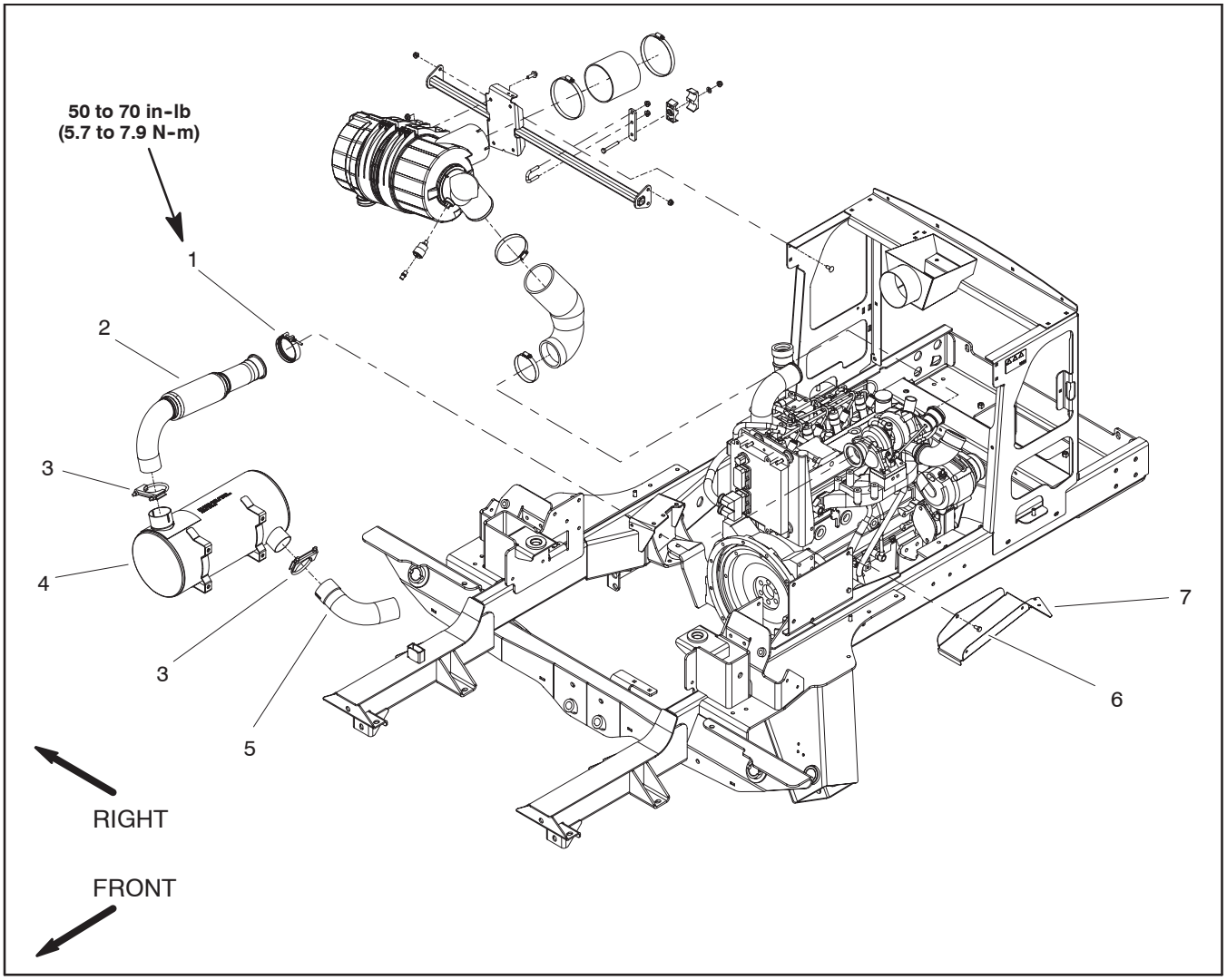


Figure 8

1. **Exhaust clamp**
2. **Exhaust tube**
3. **Muffler clamp (2 used)**
4. **Muffler**
5. **Tailpipe**
6. **Flange head screw (4 used)**
7. **Heat shield**

Removal (Fig. 8)

CAUTION

The engine and exhaust system may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the exhaust system.

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to exhaust system.

3. Remove side panel from right side of frame to allow easier access to exhaust system components.

4. Remove muffler and/or exhaust tube from the engine as necessary using Figure 8 as a guide.

5. If necessary, remove exhaust manifold from engine (Fig. 9):

   A. Remove turbocharger from exhaust manifold (see Turbocharger Removal in this section).

   B. Support exhaust manifold to prevent it from falling.

   C. Remove eight (8) flange head screws that secure exhaust manifold to cylinder head. Remove manifold from engine.

   D. Remove and discard manifold gasket. Clean mating surfaces of cylinder head and manifold.

6. If exhaust openings are to be left open for any length of time, cover openings to prevent any material from falling into openings.

Installation (Fig. 8)

NOTE: Make sure all exhaust system sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Remove all covers and plugs that were placed during removal to prevent contamination entry.

2. Install exhaust manifold to engine if removed (Fig. 9):

   A. Apply antiseize lubricant to threads of flange head screws used to secure exhaust manifold.

   B. Position new manifold gasket and exhaust manifold to cylinder head and secure with eight (8) flange head screws. Tighten the screws in the sequence shown in Figure 10. Torque screws **33 ft-lb (45 N-m)**.

   C. Secure turbocharger to exhaust manifold (see Turbocharger Installation in this section).

3. Install muffler and/or exhaust tube to the engine using Figure 8 as a guide. Torque exhaust clamp (item 1) from **50 to 70 in-lb (5.7 to 7.9 N-m)**.

4. After exhaust system assembly, check that tailpipe is approximately parallel to the ground. Loosen clamp and adjust tailpipe if necessary.

5. Install and secure side panel to right side of frame.

6. Lower and secure hood.

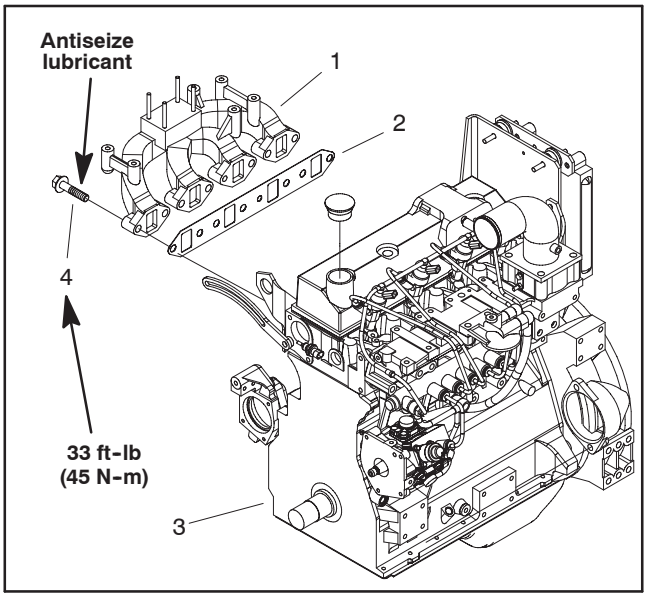


Figure 9

1. **Exhaust manifold**
2. **Manifold gasket**
3. **Engine**
4. **Flange screw (8 used)**

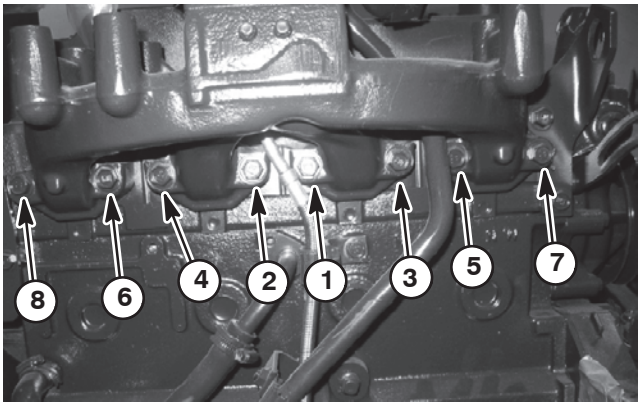


Figure 10

Turbocharger

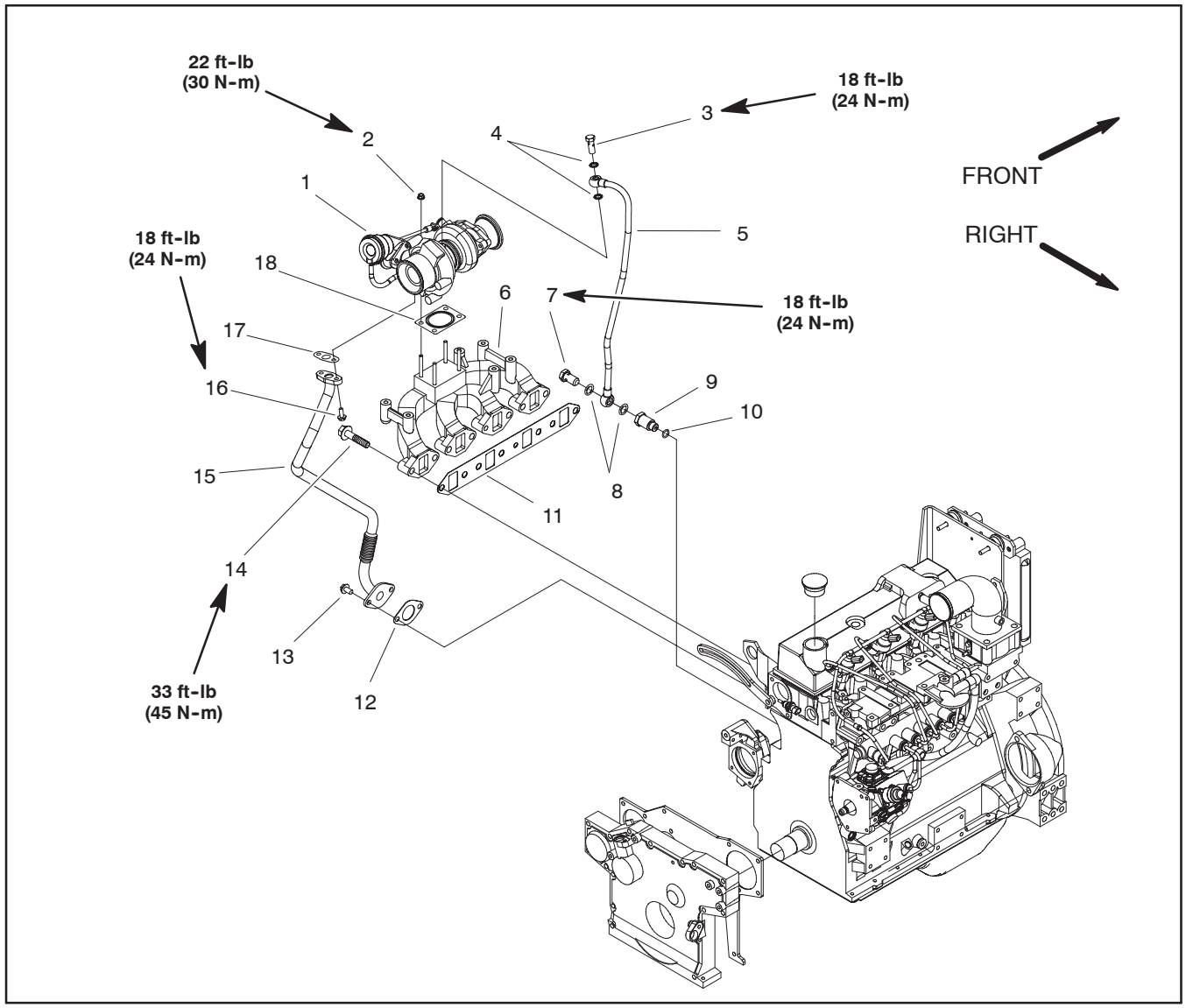


Figure 11

1. Turbocharger assembly
2. Flange nut (4 used)
3. Banjo bolt
4. Sealing washer
5. Oil supply tube
6. Exhaust manifold
7. Banjo bolt
8. Sealing washer
9. Coupling
10. O-ring
11. Exhaust manifold gasket
12. Gasket
13. Flange head screw (2 used)
14. Flange head screw (8 used)
15. Oil drain tube
16. Flange head screw (2 used)
17. Gasket
18. Turbocharger gasket

Removal (Fig. 11)

CAUTION

The engine and exhaust system may be hot. To avoid possible burns, allow the engine and exhaust system to cool before working on the turbocharger.

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

3. Thoroughly clean turbocharger area to prevent contaminants from entering engine.

4. Loosen clamps that secure exhaust tube to turbocharger outlet and muffler inlet. Remove exhaust tube.

5. Loosen clamps that secure air intake tube to turbocharger inlet and air cleaner outlet. Remove air intake tube.

6. Remove two (2) cap screws that secure oil drain line to turbocharger. Separate oil drain line from turbocharger.

7. Remove banjo bolt that secures oil supply line to turbocharger. Separate oil supply line from turbocharger.

8. Remove four (4) nuts that secure turbocharger to exhaust manifold.

9. Carefully lift turbocharger from exhaust manifold.

10. Cover engine, air cleaner and turbocharger openings to prevent any material from falling into openings. Also, plug openings in oil supply and drain lines.

Installation (Fig. 11)

NOTE: Make sure muffler flange and exhaust manifold sealing surfaces are free of debris or damage that may prevent a tight seal.

1. Install new gaskets if original gasket was damaged.

2. Remove all covers and plugs that were placed to prevent contamination entry.

3. Position turbocharger to exhaust manifold and secure with four (4) nuts. Torque nuts **22 ft-lb (30 N-m)**.

4. Position oil drain line to turbocharger and secure with two (2) cap screws. Torque screws **18 ft-lb (24 N-m)**.

5. Pour clean engine oil into oil supply line port to ensure turbocharger lubrication on start-up.

6. Position oil supply line to turbocharger and secure with banjo bolt. Torque banjo bolt **18 ft-lb (24 N-m)**.

7. Fit air intake tube to turbocharger inlet and air cleaner outlet. Secure intake tube with clamps.

8. Fit exhaust tube to turbocharger outlet and muffler inlet. Secure exhaust tube with clamps.

9. Lower and secure hood.

Fuel Tank

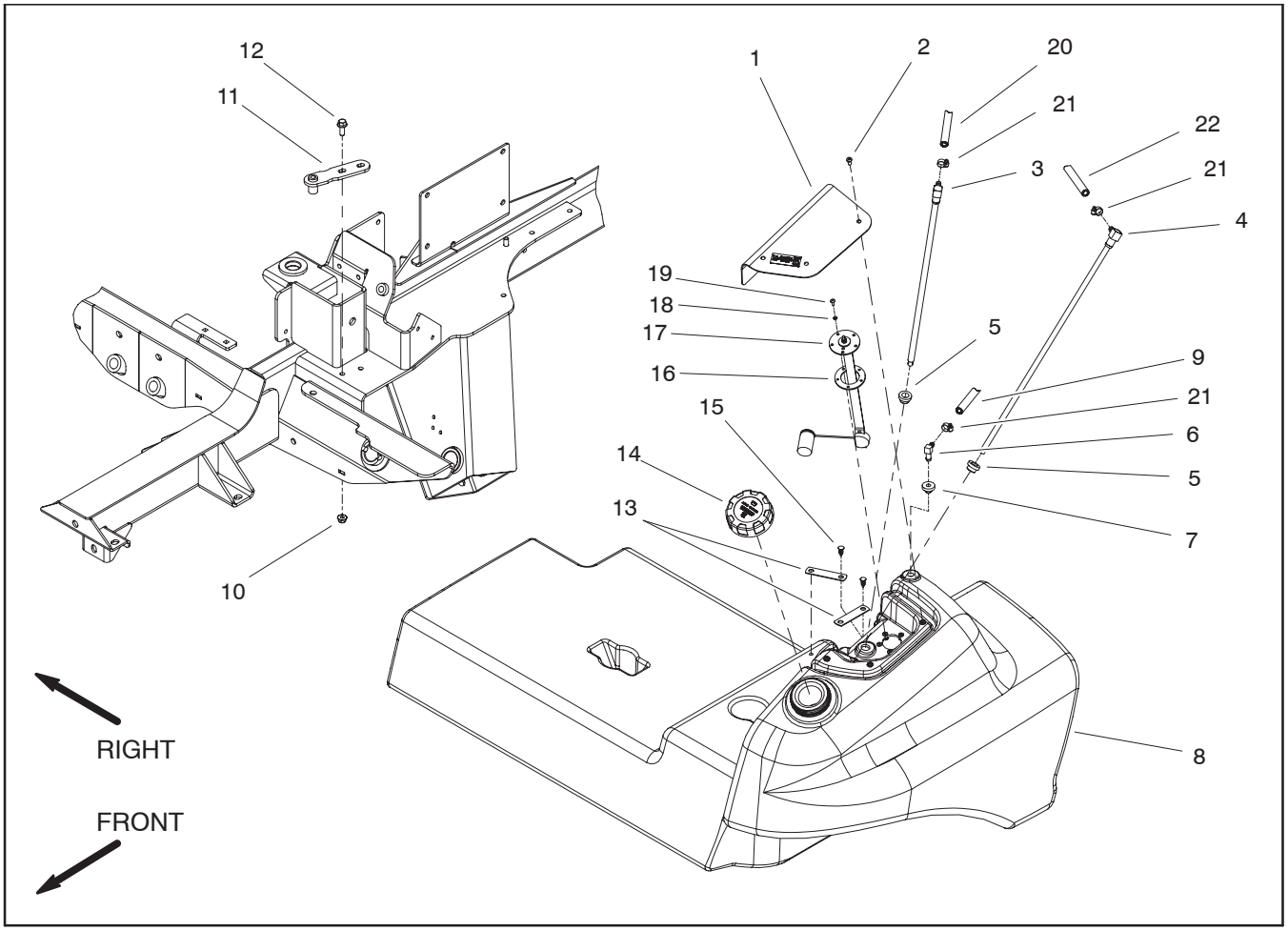


Figure 12

1. Fitting cover
2. Screw (3 used)
3. Fuel supply standpipe
4. Fuel return standpipe
5. Bushing (2 used)
6. Elbow fitting
7. Bushing
8. Fuel tank
9. Fuel hose (2 used)
10. Flange nut (2 used)
11. Tank hold down
12. Flange head screw (2 used)
13. Clamp (2 used)
14. Cap
15. Plug (4 used)
16. Gasket
17. Fuel sender
18. Lock washer (5 used)
19. Screw (5 used)
20. Fuel hose
21. Worm clamp (3 used)
22. Fuel hose

DANGER

Because diesel fuel is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled diesel fuel before starting the engine. Store fuel in a clean, safety-approved container and keep cap in place. Use diesel fuel as an engine fuel only; not for any other purpose.

Check Fuel Lines and Connections

Check fuel lines and connections periodically as recommended in the Operator's Manual. Check lines for deterioration, damage, leaks or loose connections. Replace hoses, clamps and connections as necessary.

Drain and Clean Fuel Tank

Drain and clean the fuel tank periodically as recommended in the Operator's Manual. Also, drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

To clean fuel tank, flush tank out with clean diesel fuel. Make sure tank is free of contaminates and debris.

Fuel Tank Removal (Fig. 12)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Chock rear wheels and jack up front of machine. Support machine on jack stands. Remove front, left wheel to allow fuel tank removal.

3. Use a fuel transfer pump to remove fuel from the fuel tank and into a suitable container.

4. Remove three (3) socket head screws that secure fitting cover (item 1) to fuel tank. Remove fitting cover.

5. Disconnect power (blue/red) and ground (black) wires from the fuel sender on the fuel tank (Fig. 13).

6. Label fuel hoses to assure proper assembly. Disconnect fuel hoses from the fuel supply standpipe (item 3), the return standpipe (item 4) and the vent elbow fitting (item 6) in top of tank (Fig. 13).

7. Route fuel lines from under clamps (item 13) that route fuel lines from standpipes. If necessary, remove plugs and clamps from top of tank.

8. Remove two (2) flange head screws and lock nuts that secure tank hold down (item 11) to frame. Remove tank hold down.

9. Slide fuel tank from left side of machine to remove tank.

10. If necessary, remove standpipes, elbow bushings and fuel sender from fuel tank.

Fuel Tank Installation (Fig. 12)

1. If removed, install standpipes, elbow bushings and fuel sender into fuel tank.

2. Install fuel tank from left side of machine.

3. Position tank hold down (item 11) to fuel tank and machine frame. Secure hold down with two (2) flange head screws and lock nuts.

4. Route fuel supply and return hoses under clamps in top of tank.

5. Using labels placed during tank removal, correctly connect fuel hoses to the fuel supply standpipe, the return standpipe and the vent elbow fitting. Secure hoses with hose clamps.

6. Connect electrical wiring to the fuel sender.

   A. Connect blue/red wire to the center terminal and black wire to any of the screws that secure the fuel sender to the fuel tank.

   B. Apply skin-over grease (Toro Part No. 505-165) to the wire terminal connections.

7. Position fitting cover to fuel tank and secure with three (3) socket head screws.

WARNING

Failure to maintain proper torque could result in failure or loss of wheel and may result in personal injury.

8. Install front, left wheel assembly.

9. Lower machine to ground. Torque wheel lug nuts in a crossing pattern from **70 to 90 ft-lb (95 to 122 N-m)**.

10. Fill fuel tank.

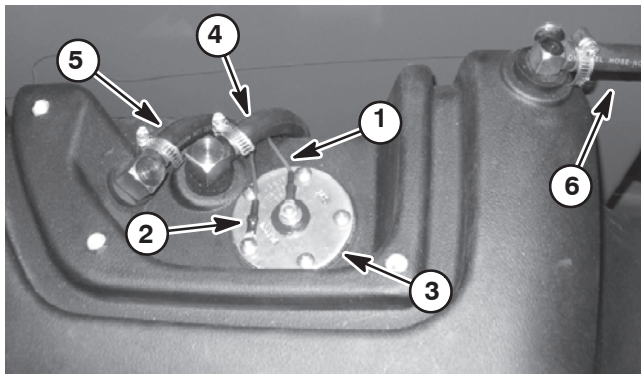


Figure 13

1. Sender power wire
2. Sender ground wire
3. Fuel sender
4. Fuel supply hose
5. Return fuel hose
6. Vent hose

Radiator

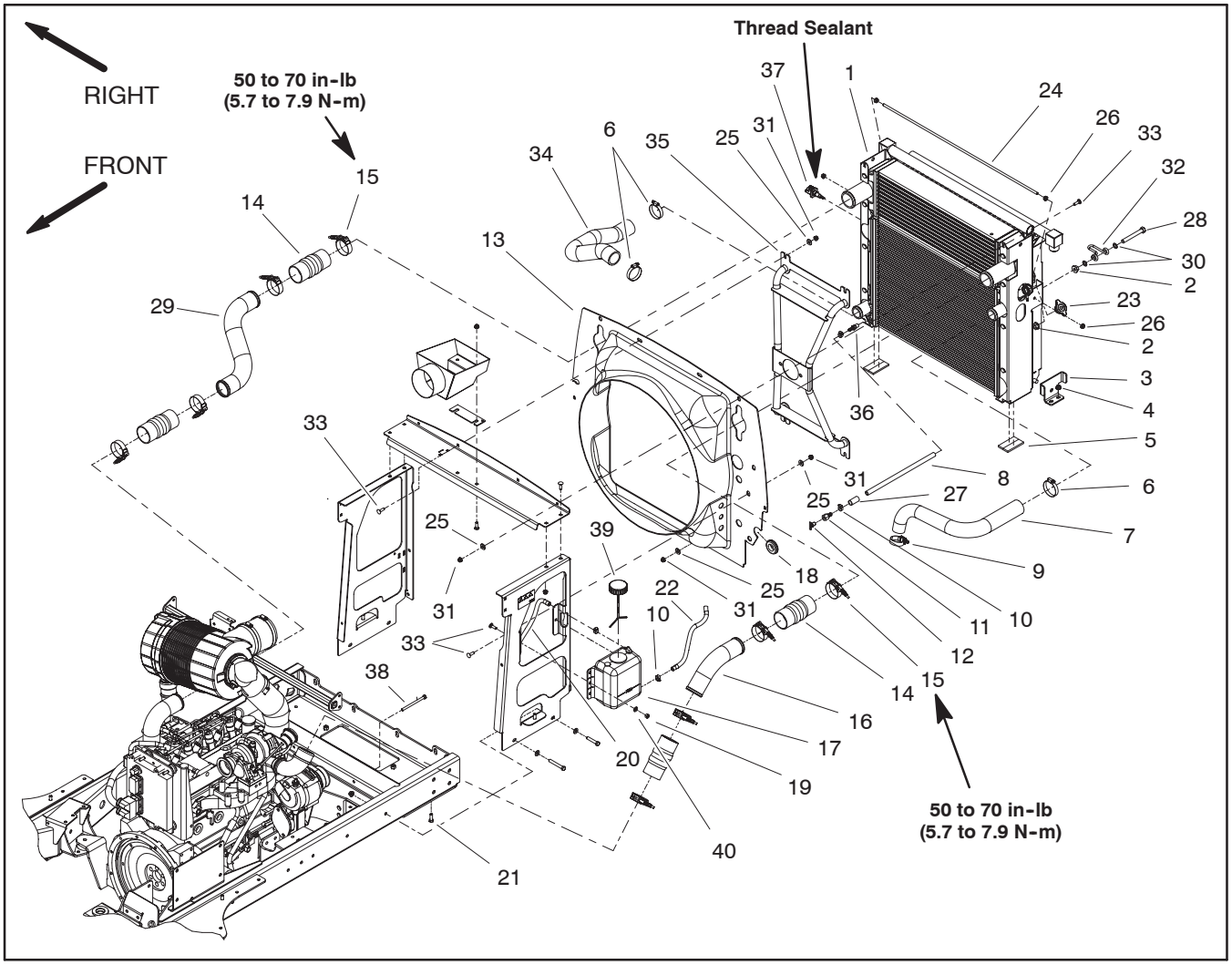


Figure 14

1. Radiator assembly
2. Flange nut (4 used)
3. Support plate (2 used)
4. Flange nut (4 used)
5. Rubber pad (4 used)
6. Hose clamp (3 used)
7. Upper radiator hose
8. Overflow hose
9. Hose clamp
10. Worm clamp (5 used)
11. Barb fitting
12. Drain cock fitting
13. Fan shroud
14. Air intake tube (4 used)
15. Hose clamp (8 used)
16. Tube
17. Coolant reservoir
18. Grommet (2 used)
19. Lock nut (2 used)
20. Hose
21. Cap screw (4 used)
22. Hose
23. Radiator cap
24. Support rod
25. Flat washer (10 used)
26. Flange nut (4 used)
27. Hose sleeve
28. Cap screw (2 used)
29. Tube
30. Washer (4 used)
31. Flange nut (14 used)
32. Clamp (2 used)
33. Carriage screw (14 used)
34. Lower radiator hose
35. Fan motor bracket
36. Fitting
37. Coolant level sensor
38. Cap screw (2 used)
39. Reservoir cap
40. Flat washer (2 used)

Removal (Fig. 14)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to radiator.

3. Rotate clamps that secure oil cooler to radiator frame. Tilt oil cooler toward rear of machine.

4. Loosen hose clamps and disconnect air intake tubes (item14) from the charge air cooler.

5. Disconnect wire harness connector from coolant level sensor on right side of radiator.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

6. Drain radiator into a suitable container using the radiator drain. The radiator drain is located near the hydraulic 4WD manifold (Fig. 15).

7. Loosen hose clamps and disconnect upper and lower coolant hoses (item 6) from the radiator.

8. Loosen hose clamp that secures coolant drain hose to fitting (item 36) on bottom of radiator. Remove coolant drain hose assembly from radiator.

9. Disconnect reservoir hose (item 22) from the radiator vent tube.

10. Detach radiator from the fan shroud and support by removing two (2) carriage screws (item 33), flat washers and flange nuts.

11. Tilt radiator and charge air cooler assembly toward rear of machine and carefully lift assembly from the machine.

12. Plug all radiator and hose openings to prevent contamination.

13. Inspect rubber pads (item 5) at bottom of radiator. Replace pads if worn or damaged.

14. Disassemble radiator and charge air cooler assembly as needed using Figure 16 as a guide.

Installation (Fig. 14)

1. Assemble radiator and charge air cooler assembly as needed using Figure 14 as a guide. Apply thread sealant to coolant level sensor if it was removed.

2. Remove plugs from radiator and hoses placed during the removal procedure.

3. Carefully lower radiator and charge air cooler assembly into the machine.

4. Attach radiator to the fan shroud and support with two (2) carriage screws, flat washers and flange nuts.

5. Connect upper and lower coolant hoses (item 6) to the radiator. Secure hoses with hose clamps.

6. Connect air intake tubes (item14) to the charge air cooler and secure with hose clamps. Torque clamps from **50 to 70 in-lb (5.7 to 7.9 N-m)**.

7. Connect wire harness connector to coolant level sensor on right side of radiator.

8. Install coolant drain hose assembly to radiator fitting and secure with hose clamp.

9. Connect reservoir hose (item 22) to the radiator vent tube and secure with hose clamp.

10. Make sure radiator drain is closed. Fill radiator with coolant.

11. Secure oil cooler to radiator frame.

12. Run engine and check for any coolant leaks.

13. Lower and secure hood.

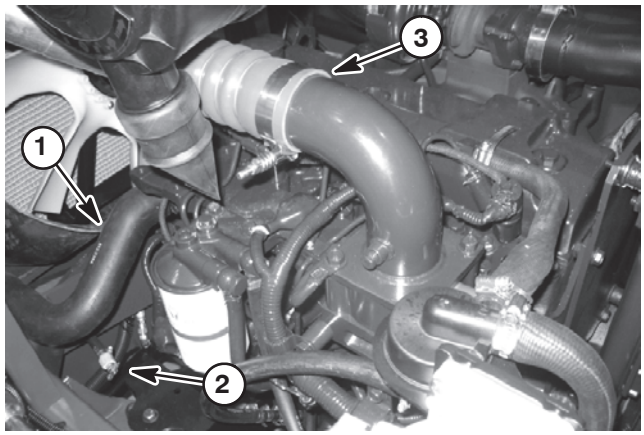


Figure 15

1. **Radiator hose**
2. **Radiator drain**
3. **Air intake tube**

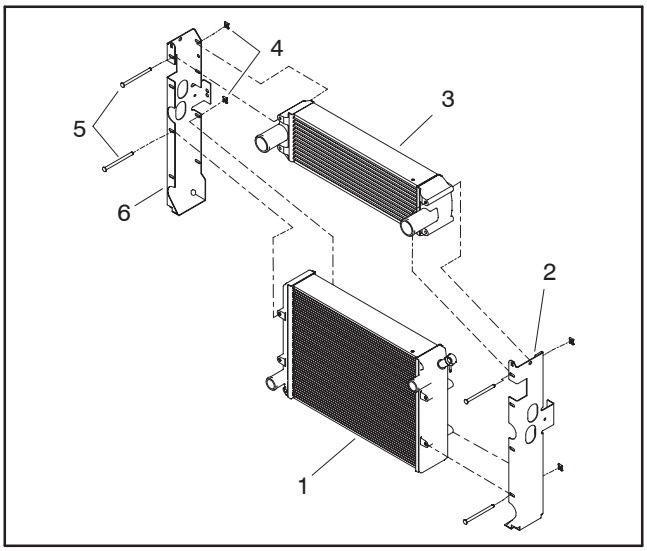


Figure 16

1. **Radiator**
2. **LH cooler bracket**
3. **Charge air cooler**
4. **Pin clip (8 used)**
5. **Pin (8 used)**
6. **RH cooler bracket**

Alternator

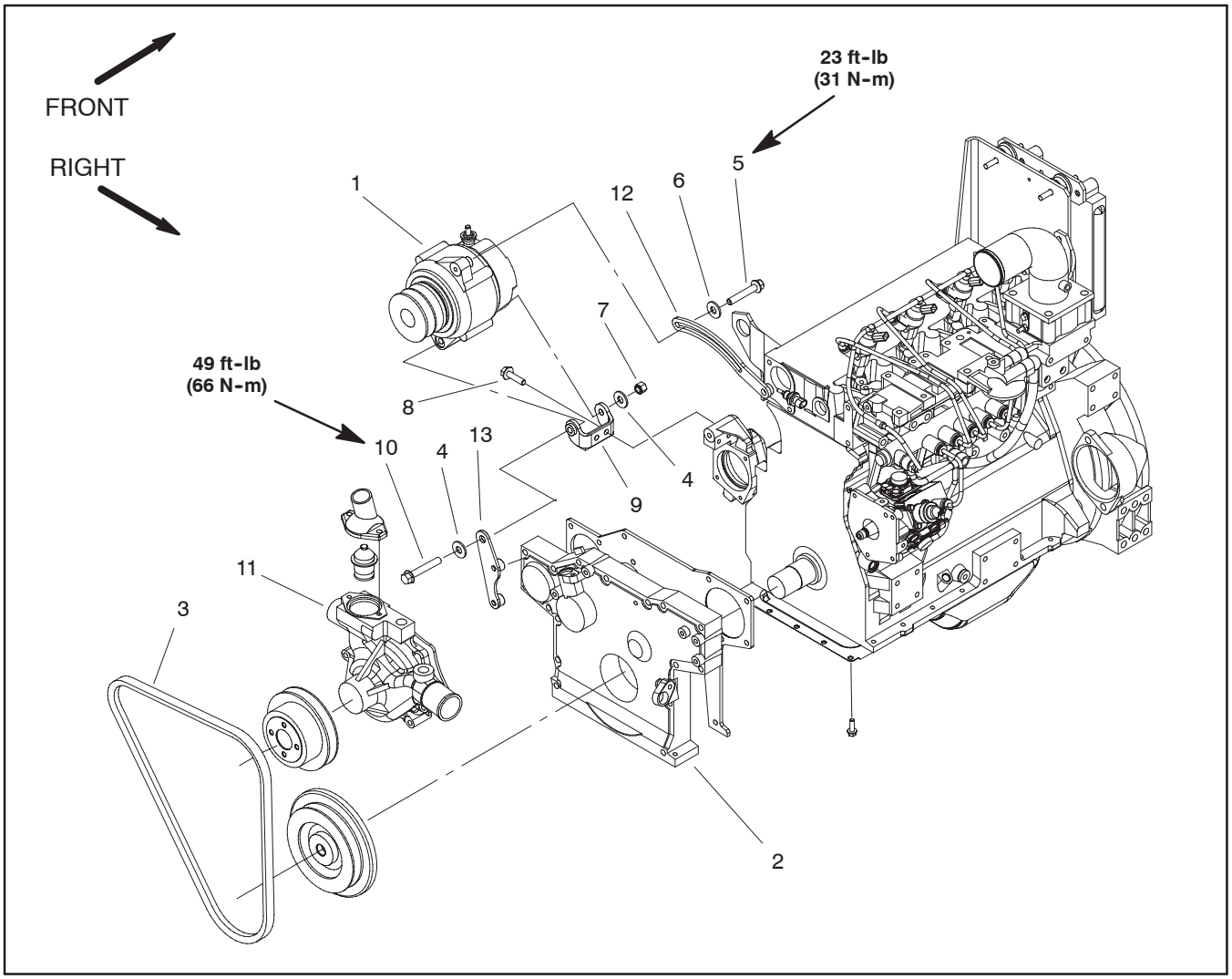


Figure 17

1. Alternator
2. Front cover
3. Belt
4. Bevel washer (2 used)
5. Flange head screw
6. Flat washer
7. Hex nut
8. Flange head screw (2 used)
9. Alternator bracket
10. Cap screw
11. Water pump
12. Adjusting bracket
13. Alternator bracket

Removal (Fig. 17)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

3. Remove battery access panel. Disconnect negative battery cable first and then positive battery cable (see Battery Removal in the Service and Repairs section of Chapter 5 – Electrical System).

4. Loosen flange head screw (item 5) that secures alternator to adjusting bracket. Rotate alternator toward engine to loosen drive belt. Remove belt from alternator pulley.

5. Inspect drive belt for glazing or damage. Replace belt if necessary.

6. For assembly purposes, label all wires that connect to alternator. Disconnect wires from alternator terminals and position wires away from alternator.

7. Support alternator to prevent it from shifting or falling.

8. Remove flange head screw and flat washer that secure alternator to adjusting bracket (item 12). Remove cap screw, two (2) bevel washers and hex nut that secure alternator to mounting brackets (items 9 and 13).

9. Carefully remove alternator from engine and machine.

Installation (Fig. 17)

1. Position alternator to engine brackets.

2. Secure alternator to mounting brackets and adjusting bracket with removed fasteners and washers. Do not fully tighten fasteners.

3. Place drive belt on alternator pulley. Rotate alternator away from engine to properly tension drive belt.

4. Tighten screws to secure alternator. Torque cap screw at mounting bracket (item 10) to **49 ft-lb (66 N-m)**. Torque flange head screw at adjusting bracket (item 5) to **23 ft-lb (31 N-m)**.

5. Using labels placed during alternator removal, correctly connect all wires to alternator terminals.

6. Connect positive battery cable to positive battery terminal. Then, connect negative battery cable to negative battery terminal (see Battery Installation in the Service and Repairs section of Chapter 5 – Electrical System). Install battery access panel.

7. Lower and secure hood.

Starter Motor

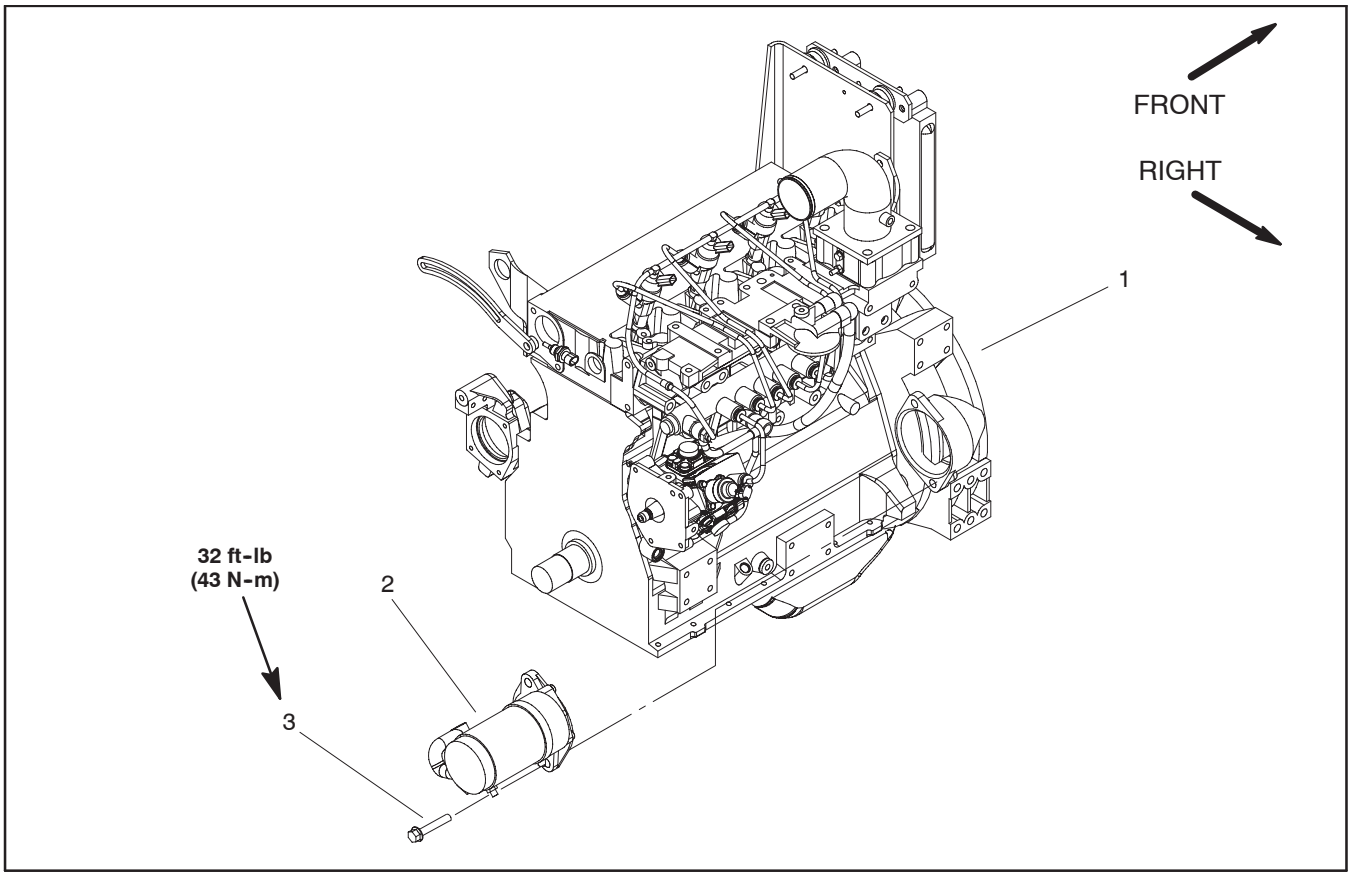


Figure 18

1. **Engine**
2. **Starter motor**
3. **Flange head screw (2 used)**

Removal (Fig. 18)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

3. Remove battery access panel. Disconnect negative battery cable first and then positive battery cable (see Battery Removal in the Service and Repairs section of Chapter 5 – Electrical System).

4. Label all wires that connect to starter for assembly purposes. Disconnect wires from starter terminals. and position away from starter (Fig. 19).

   A. Remove nut and lock washer that secure cable to starter stud. Remove cable from starter stud.

   B. Loosen screw used to secure harness blue wire to starter solenoid. Unplug wire from starter.

5. Support starter to prevent it from shifting or falling.

6. Remove two (2) flange head screws that secure starter to engine.

7. Carefully remove starter from engine and machine.

Installation (Fig. 18)

1. Position starter to engine housing.

2. Secure starter to engine with two (2) flange head screws. Torque screws **32 ft-lb (43 N-m)**.

3. Using labels placed during removal, correctly connect and secure removed wires to starter terminals.

4. Connect positive battery cable to positive battery terminal. Then, connect negative battery cable to negative battery terminal (see Battery Installation in the Service and Repairs section of Chapter 5 – Electrical System). Install battery access panel.

5. Lower and secure hood.

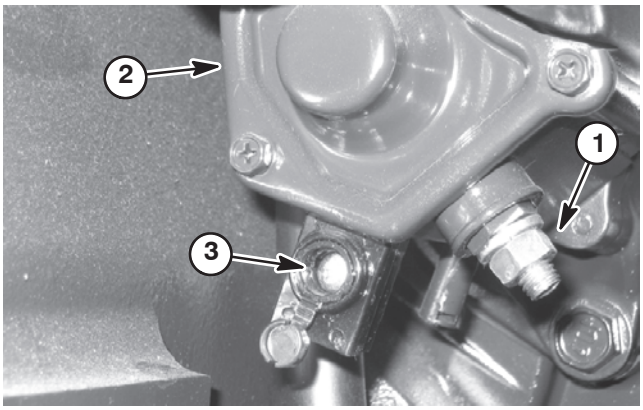


Figure 19

1. **Starter stud**
2. **Starter solenoid**
3. **Screw**

Valve Cover

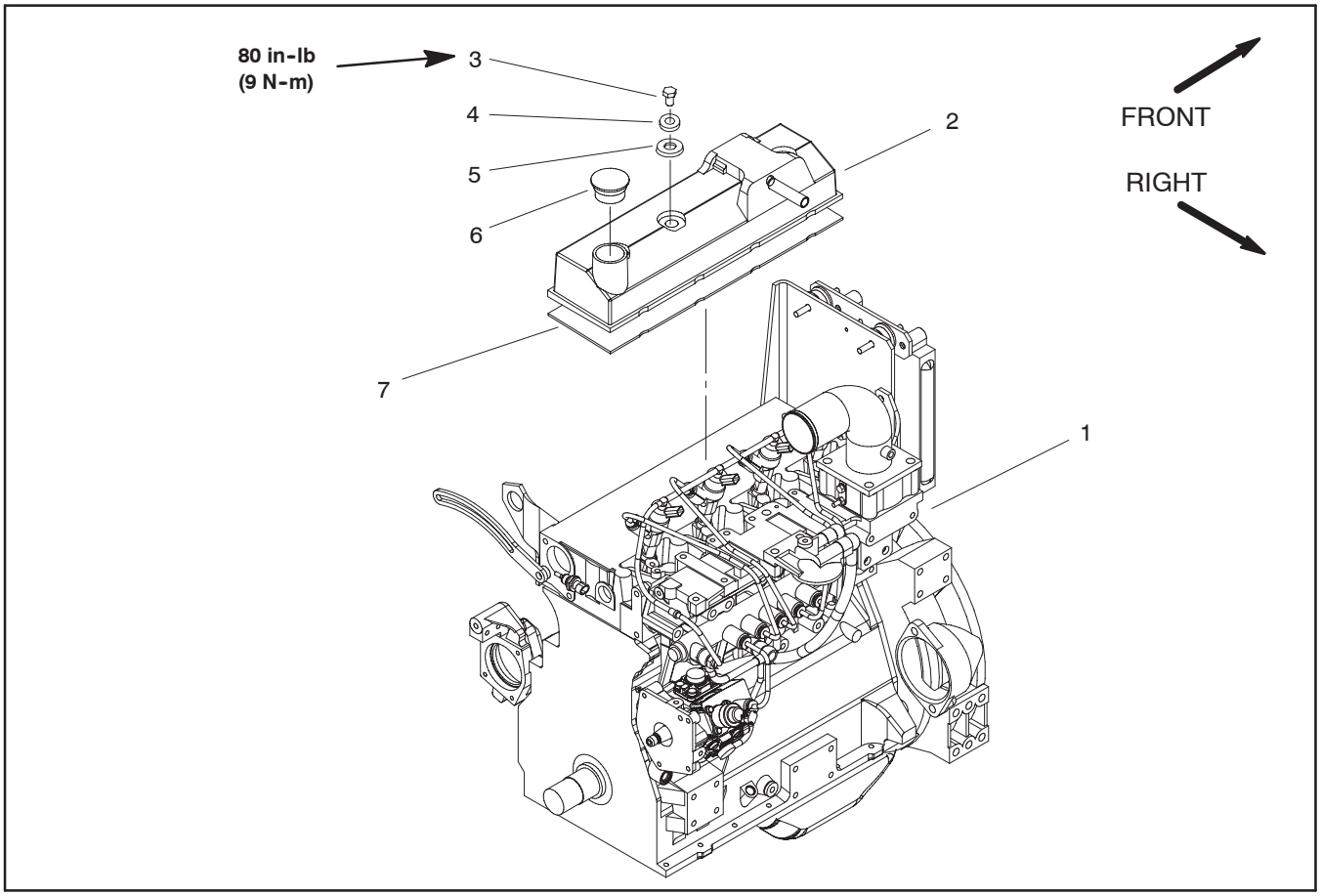


Figure 20

1. **Engine**
2. **Valve cover**
3. **Lock nut (3 used)**
4. **Flat washer (3 used)**
5. **Isolation washer (3 used)**
6. **Oil fill cap**
7. **Valve cover gasket**

Removal (Fig. 20)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

3. Thoroughly clean valve cover and cylinder head to prevent contaminant entry into engine.

4. Remove crankcase breather tube from valve cover (see Engine Breather Removal in this section).

5. Remove three (3) lock nuts, flat washers and isolator washers.

6. Remove valve cover from cylinder head. Remove and discard valve cover gasket.

Installation (Fig. 20)

1. Position new gasket and valve cover to cylinder head.

2. Secure valve cover to cylinder head with three (3) isolator washers, flat washers and lock nuts. Torque lock nuts **80 in-lb (9 N-m)**.

3. Connect crankcase breather tube to valve cover and secure with hose clamp (see Engine Breather Installation in this section).

4. Check engine oil level and add oil if necessary.

5. Lower and secure hood.

Engine Breather System

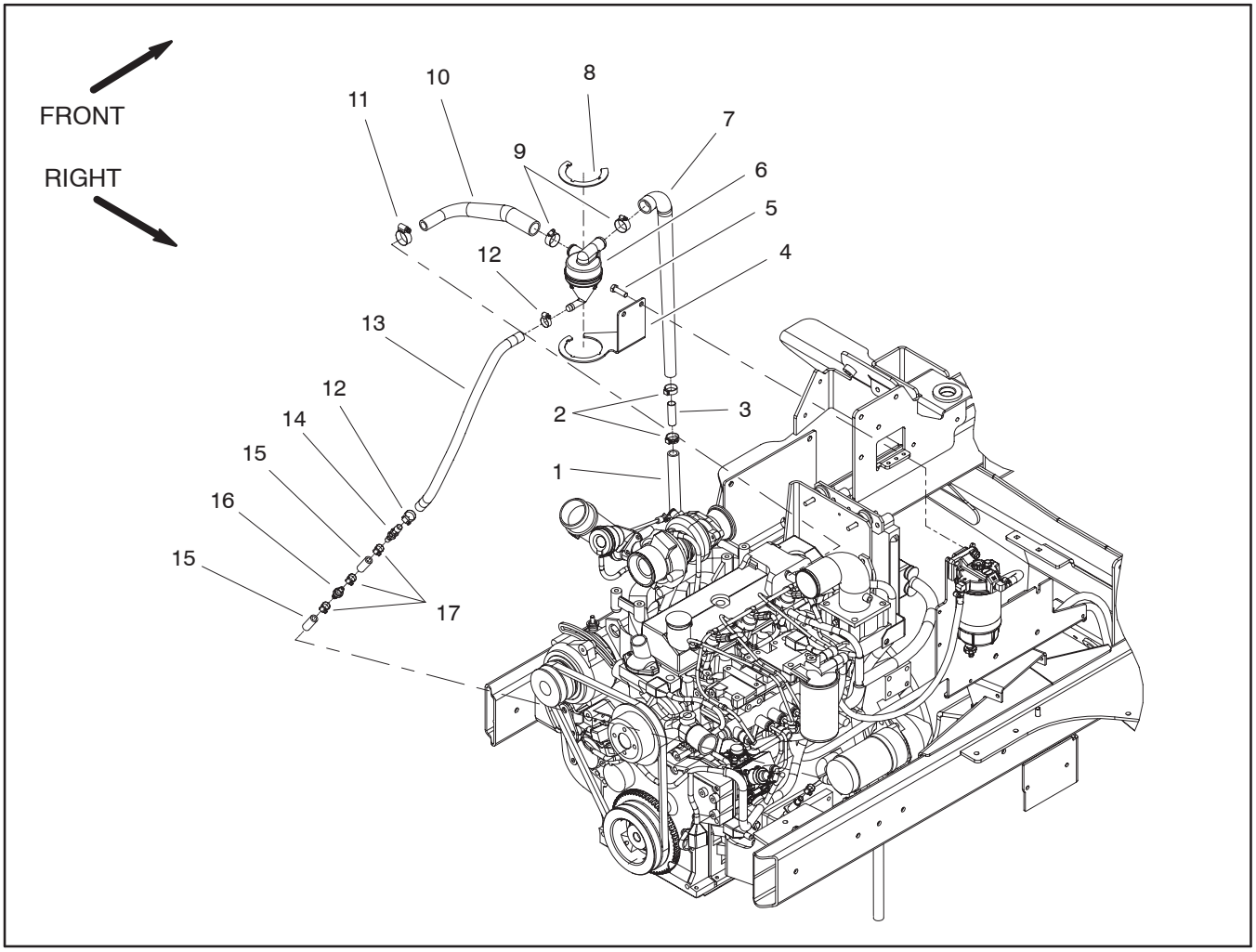


Figure 21

1. Hose
2. Hose clamp
3. Spacer
4. Breather mount plate
5. Cap screw (2 used)
6. Breather
7. Breather outlet hose
8. Latch plate
9. Hose clamp
10. Breather inlet hose
11. Hose clamp
12. Hose clamp
13. Breather hose
14. Hose barb
15. Hose
16. Check valve
17. Worm clamp

Removal (Fig. 21)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

3. Clean breather components before removal to prevent contaminant entry into breather system.

4. Remove breather components as necessary using Figure 21 as a guide.

Installation (Fig. 21)

1. Install removed breather components using Figure 21 as a guide. If removed, make sure that check valve (item 16) is installed with black side toward the engine oil pan (Fig. 22).

2. Lower and secure hood.

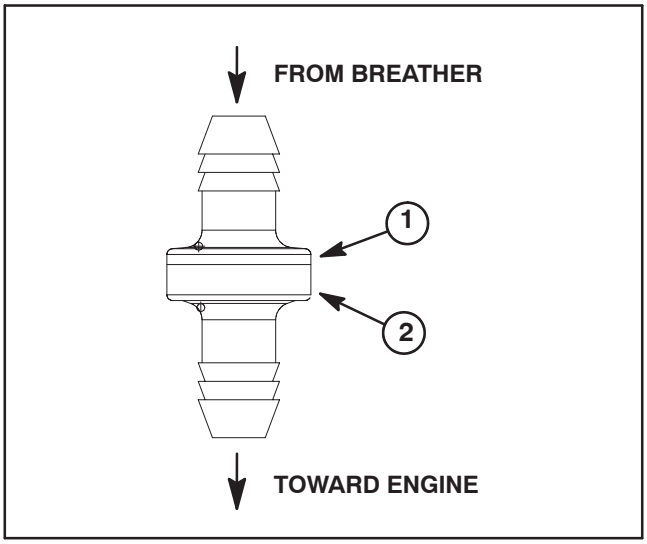


Figure 22

1. **Base (gray)**
2. **Cover (black)**

Thermostat

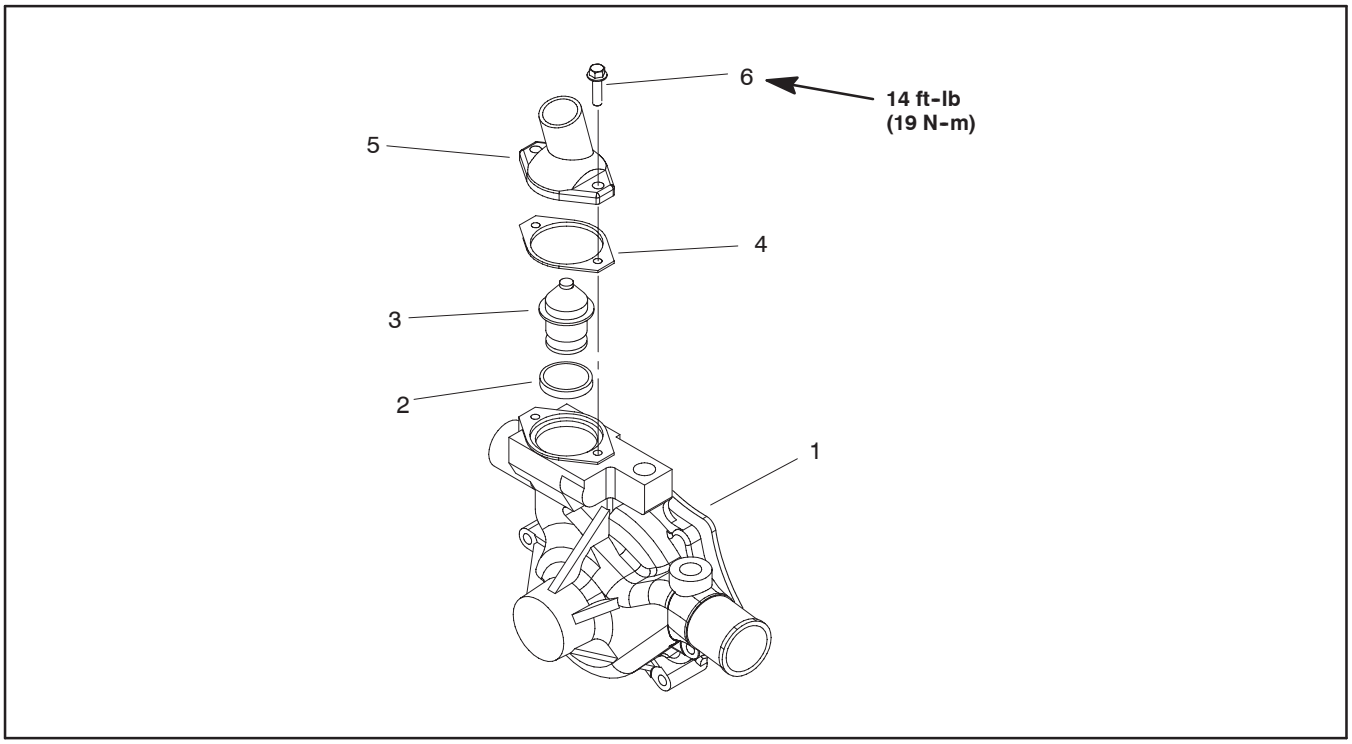


Figure 23

1. **Water pump**
2. **Seal**
3. **Thermostat**
4. **Gasket**
5. **Thermostat housing**
6. **Flange head screw (2 used)**

Removal (Fig. 23)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

3. Drain coolant from radiator and engine (see Radiator Removal in this section).

4. Remove upper coolant hose from thermostat housing.

5. Remove two (2) flange head screws that secure thermostat housing to water pump. Remove thermostat housing.

6. Remove thermostat and seal from water pump housing.

7. Clean gasket surfaces of pump and thermostat housing.

8. Inspect thermostat sealing areas in pump housing. Thoroughly clean sealing surfaces if any corrosion or debris buildup is evident.

Thermostat Testing

1. Remove the thermostat (see Water Pump, Hose, Pipe and Thermostat Removal and Installation).

2. Suspend the thermostat and a thermometer in a container of water (Fig. 24). For accurate test results, do not allow the thermostat or thermometer to contact the container.

3. Slowly heat the water and stir water to allow uniform water temperature. Note and record the temperature for the following:

A. The thermostat should start to open at 180ºF (82ºC).

B. The thermostat should be fully open (0.315" (8 mm) lift) at 203ºF (95ºC).

4. If the thermostat fails to open, only partially opens or sticks, it should be replaced.

Installation (Fig. 23)

1. Install seal and thermostat into water pump housing.

2. Position thermostat gasket and housing to water pump housing. Secure thermostat housing with two (2) flange head screws. Torque screws **14 ft-lb (19 N-m)**.

3. Install upper coolant hose to thermostat housing and secure with hose clamp.

4. Fill cooling system with coolant.

5. Run engine and check for any coolant leaks.

6. Lower and secure hood.

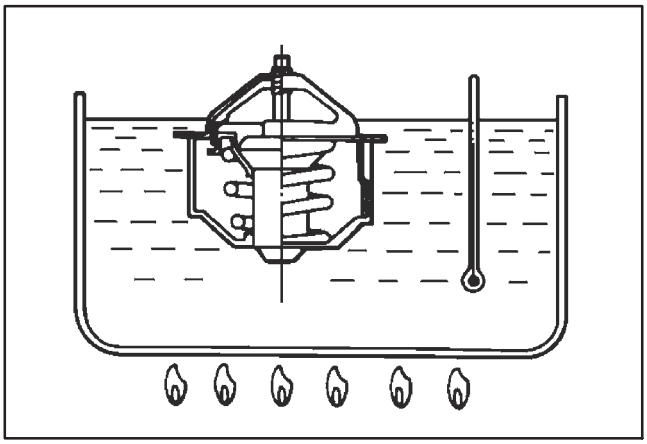


Figure 24

Water Pump

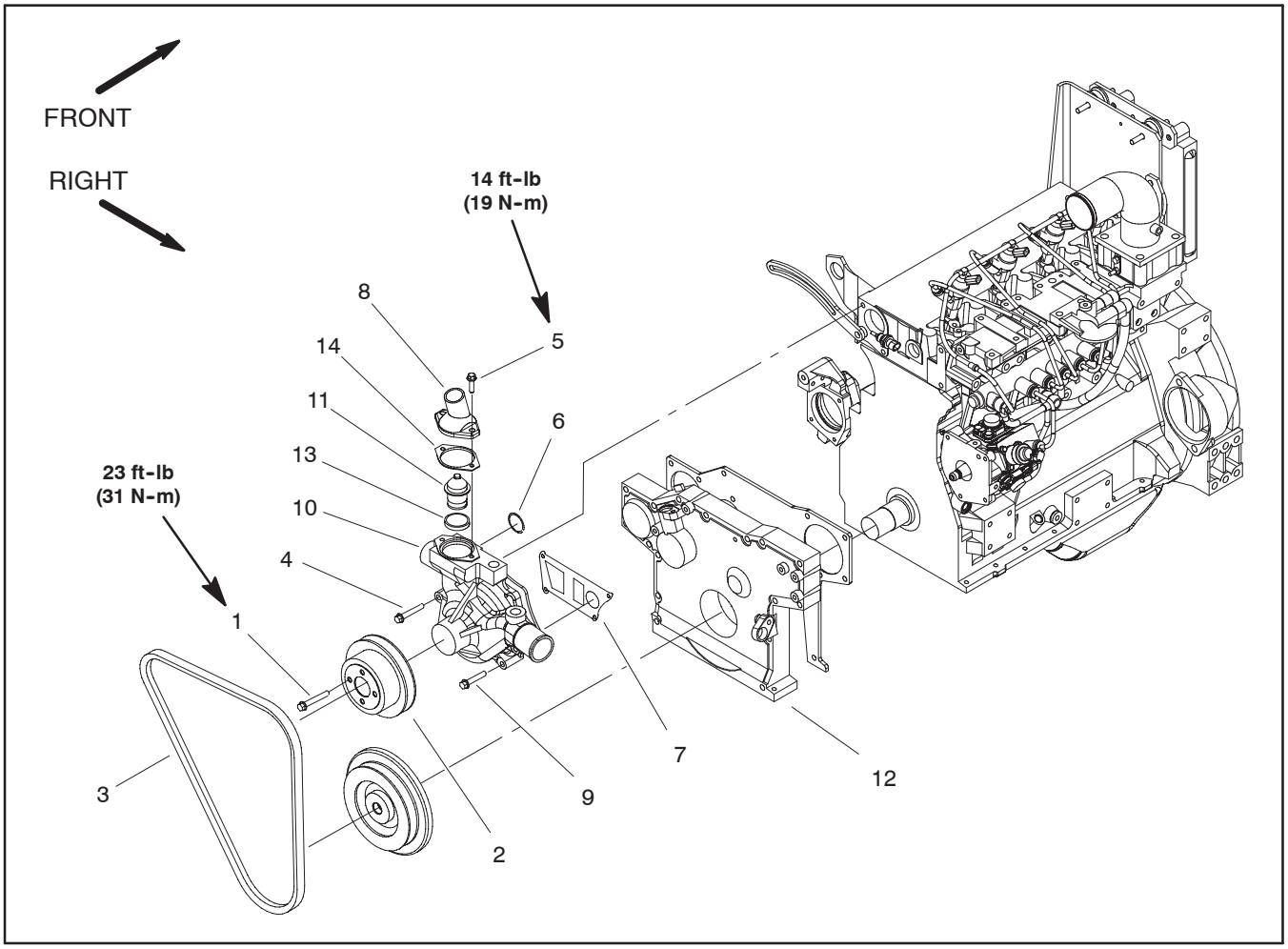


Figure 25

1. Flange head screw (4 used)
2. Water pump pulley
3. Belt
4. Flange head screw
5. Flange head screw (2 used)
6. O-ring
7. Gasket
8. Thermostat housing
9. Flange head screw (3 used)
10. Water pump
11. Thermostat
12. Front cover
13. Seal
14. Gasket

Removal (Fig. 25)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

3. Drain coolant from radiator and engine (see Radiator Removal in this section).

4. Disconnect wire harness connector from temperature sensor on water pump housing (Fig. 26).

5. Remove upper and lower radiator hoses from water pump.

6. On Groundsmaster 5910 machines:

   A. Remove cab heater hoses from water pump.

   B. Remove A/C compressor drive belt.

7. Remove alternator and drive belt from engine (see Alternator Removal in this section).

8. Remove four (4) cap screws that secure water pump to engine.

9. Carefully remove water pump from engine.

10. Remove and discard O-ring and gasket from between water pump and engine.

11. If necessary, remove thermostat from water pump (see Thermostat Removal in this section). Make sure that gasket surfaces on water pump and thermostat housing are thoroughly cleaned.

12. If necessary, remove pulley from water pump.

   A. Remove four (4) cap screws that secure pulley to pump shaft.

   B. Pull pulley from pump shaft.

Installation (Fig. 25)

1. Make sure that gasket surfaces on engine, water pump and thermostat housing are thoroughly cleaned.

2. Position new O-ring and gasket to water pump housing.

3. Secure water pump to engine with four (4) cap screws.

4. If pulley was removed from water pump shaft, secure pulley with four (4) cap screws. Torque cap screws **23 ft-lb (31 N-m)**.

5. If thermostat was removed from water pump, install thermostat to water pump (see Thermostat Installation in this section).

6. Install upper and lower radiator hoses to water pump. Secure hoses with hose clamps.

7. On Groundsmaster 5910 machines:

   A. Install and secure cab heater hoses to water pump.

   B. Install and adjust A/C compressor drive belt.

8. Connect wire harness connector to temperature sensor on water pump (Fig. 26).

9. Install alternator and drive belt to engine (see Alternator Installation in this section). Adjust drive belt.

10. Fill cooling system with coolant.

11. Run engine and check for any coolant leaks.

12. Lower and secure hood.

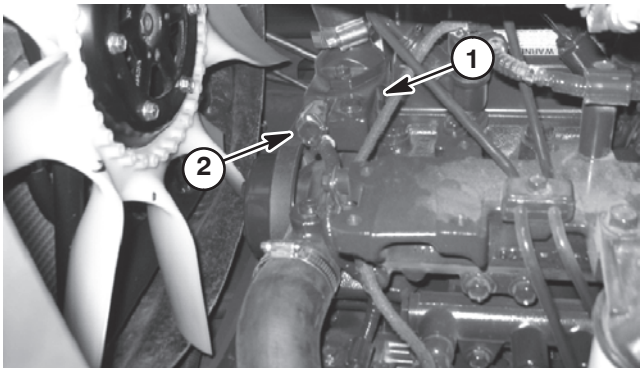


Figure 26

1. **Water pump** 2. **Temperature sensor**

Front Cover

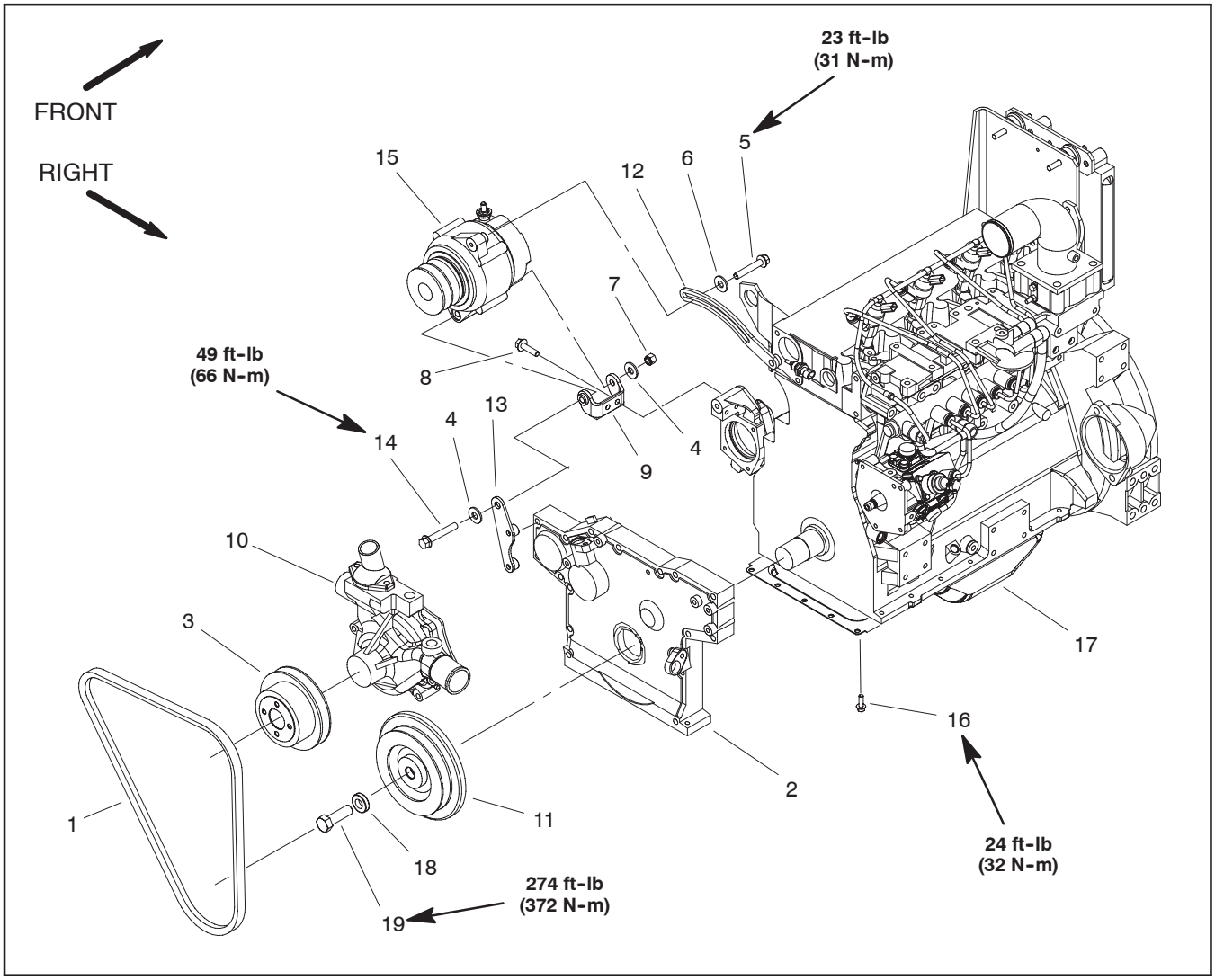


Figure 27

1. Belt
2. Front cover
3. Water pump pulley
4. Bevel washer (2 used)
5. Flange head screw
6. Flat washer
7. Hex nut
8. Flange head screw (2 used)
9. Alternator bracket
10. Water pump assembly
11. Crankshaft pulley with tone wheel
12. Adjusting bracket
13. Alternator bracket
14. Cap screw
15. Alternator
16. Flange head screw
17. Oil pan
18. Mounting plate
19. Cap screw

Removal (Fig. 27)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

3. Loosen screws that secure alternator to mounting brackets and rotate alternator toward engine to loosen drive belt. Remove belt from machine.

4. On Groundsmaster 5910 machines, remove A/C compressor drive belt.

5. Remove electrical components from front cover (Fig. 28):

A. Remove screws that secure electrical harness clamps to front cover.

B. Remove screws that secure crankshaft and camshaft position sensors to front cover.

C. Carefully pull two (2) sensors from front cover. Inspect O−rings on sensors and replace if necessary.

D. Position wire harness and sensors away from front cover.

6. Remove five (5) flange head screws that secure oil pan to front cover (see Oil Pan Removal in this section).

7. Remove lock nut and thrust washer that secure rear axle pivot shaft to frame. Slide pivot shaft toward rear of machine to allow clearance for engine pulley bolt to be removed (see Rear Axle Removal in the Service and Repairs section of Chapter 6− Axles, Planetaries and Brakes).

8. Remove crankshaft pulley (Fig. 28):

IMPORTANT: When removing crankshaft pulley, take care to not damage tone wheel that is secured to back of pulley.

A. Use appropriate holding tool to prevent the pulley and engine crankshaft from rotating.

B. Loosen and remove cap screw and mounting plate that secure pulley to crankshaft.

C. Slide pulley from crankshaft. Locate and retrieve woodruff key from crankshaft.

IMPORTANT: Three (3) different lengths of flange head screws are used to secure the front cover. To assist with assembly, note location of screws as they are removed.

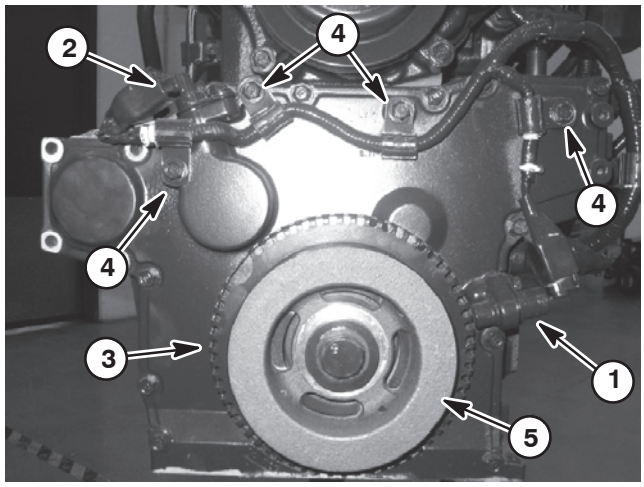


Figure 28

1. Crankshaft sensor
2. Camshaft sensor
3. Tone wheel
4. Harness clamp
5. Crankshaft pulley

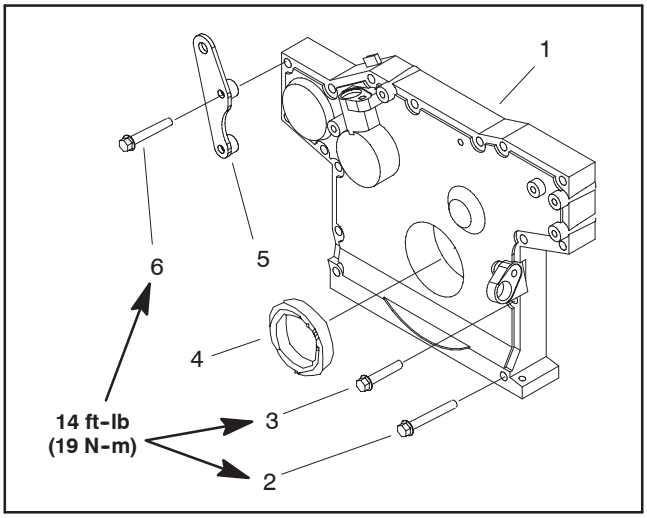


Figure 29

1. Front cover
2. Flange head screw
3. Flange head screw
4. Oil seal
5. Alternator bracket
6. Flange head screw

9. Remove sixteen (16) flange head screws that secure front cover to engine (Fig. 29). Rotate alternator bracket away from front cover.

10. Carefully remove front cover from engine.

11. Remove seal from front cover taking care to not damage seal bore in cover.

12. Thoroughly clean all removed components. Make sure that all sealant is removed from front cover sealing surfaces.

13. Inspect crankshaft surface in oil seal area for any evidence of wear or damage. Repair or replace crankshaft if necessary.

Installation (Fig. 27)

1. Make sure that mounting surfaces on engine, front cover and oil pan are thoroughly cleaned.

2. Fill 50% of the seal lip space with grease. Use Cummins seal installer tool #3164900 (or equivalent) to install new oil seal into front cover.

3. Apply Cummins sealant #3164067 (or equivalent), to the front cover mounting surfaces. Make sure to apply sealant to all engine and oil pan mating surfaces.

4. Carefully install front cover to engine taking care to not damage the oil seal during assembly.

5. Rotate alternator bracket to front cover.

6. Using notes taken during front cover removal to identify correct screw location, secure front cover to engine with sixteen (16) flange head screws. Torque screws **14 ft-lb (19 N-m)**.

7. Secure oil pan to front cover with five (5) flange head screws. Torque screws **14 ft-lb (19 N-m)**.

8. Install crankshaft pulley:

IMPORTANT: When installing crankshaft pulley, take care to not damage tone wheel that is secured to back of pulley.

A. Place woodruff key into crankshaft slot.

B. Carefully slide pulley onto crankshaft making sure to not damage oil seal in front cover. Also, make sure to align keyslot in pulley with woodruff key in crankshaft.

C. Install mounting plate (item 18) and cap screw (item 19) to pulley and crankshaft.

D. Using an appropriate holding tool to prevent the pulley and engine crankshaft from rotating, torque cap screw **274 ft-lb (372 N-m)**.

9. Secure electrical components to front cover (Fig. 28):

A. Position wire harness and sensors to front cover.

B. Apply a light film of clean oil to crankshaft and camshaft position sensors O-rings. Carefully install sensors into front cover and secure with screws.

C. Secure electrical harness clamps to front cover.

10. Secure rear axle pivot shaft to frame (see Rear Axle Removal in the Service and Repairs section of Chapter 6- Axles, Planetaries and Brakes).

A. Slide axle pivot shaft toward front of machine. Make sure that that roll pin on pivot shaft is positioned in frame reliefs.

B. Install thrust washer and lock nut onto pivot shaft.

C. Tighten lock nut to eliminate any axial movement of rear axle. Make sure that axle can still pivot freely after lock nut is tightened.

11. Position drive belt to crankshaft, water pump and alternator pulleys. Tension belt and tighten alternator mounting screws (see Alternator Installation in this section).

12. On Groundsmaster 5910 machines, install and adjust A/C compressor drive belt.

13. Check engine oil level and adjust if necessary.

14. Start engine and check for any oil leakage.

15. Lower and secure hood.

This page is intentionally blank.

Oil Pan

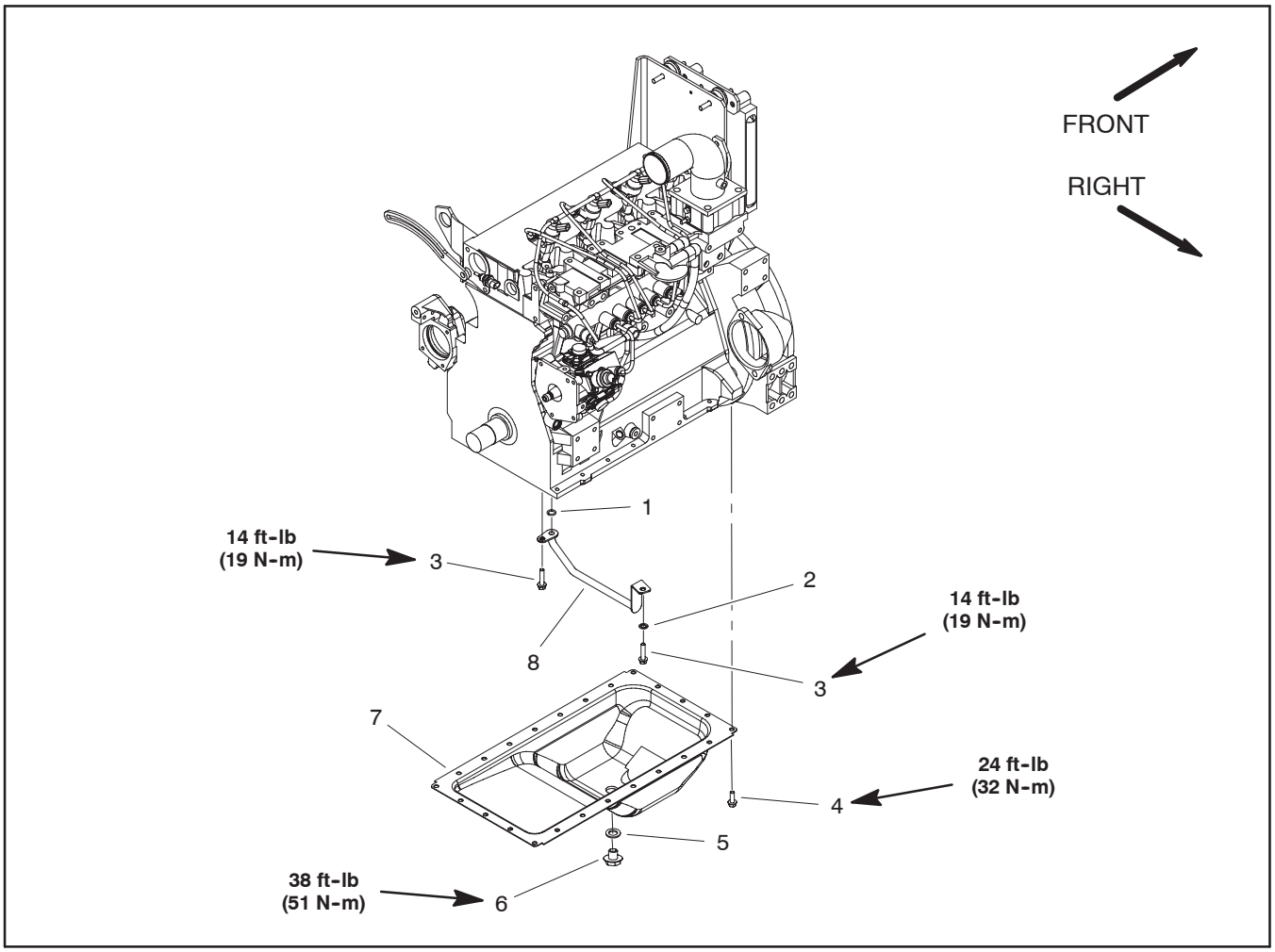


Figure 30

1. O-ring
2. Flat washer
3. Flange head screw (2 used)
4. Flange head screw (24 used)
5. Sealing washer
6. Drain plug
7. Oil pan
8. Oil suction tube

Removal (Fig. 30)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. Raise and support hood to allow access to engine.

3. Drain oil from engine.

4. Remove twenty four (24) flange head screws that secure oil pan to engine.

5. Carefully, remove oil pan from engine taking care to not damage the oil pan or the sealing surface. Remove oil pan from engine.

6. If necessary, remove two (2) flange head screws that secure oil suction tube to engine. Remove oil suction tube.

7. Thoroughly clean sealing surfaces of removed components. Inspect parts for cracks or other damage.

Installation (Fig. 30)

1. If oil suction tube was removed, place O−ring on tube and position tube to engine. Secure with two (2) flange head screws. Torque screws **14 ft−lb (19 N−m)**.

2. Using Cummins sealant #3164067 (or equivalent), apply a 0.039" (1 mm) sealant bead around all oil pan mounting screw holes. Then, apply a 0.118" (3 mm) sealant bead to the oil pan mounting surface.

3. Carefully raise oil pan to cleaned engine mounting surface and secure oil pan to engine with twenty four (24) flange head screws. Torque screws **24 ft−lb (32 N−m)**.

4. Make sure that drain plug (item 6) is installed into oil pan. Torque drain plug **38 ft−lb (51 N−m)**.

5. Add oil to engine to the proper level.

6. Start engine and check for any oil leakage.

7. Lower and secure hood.

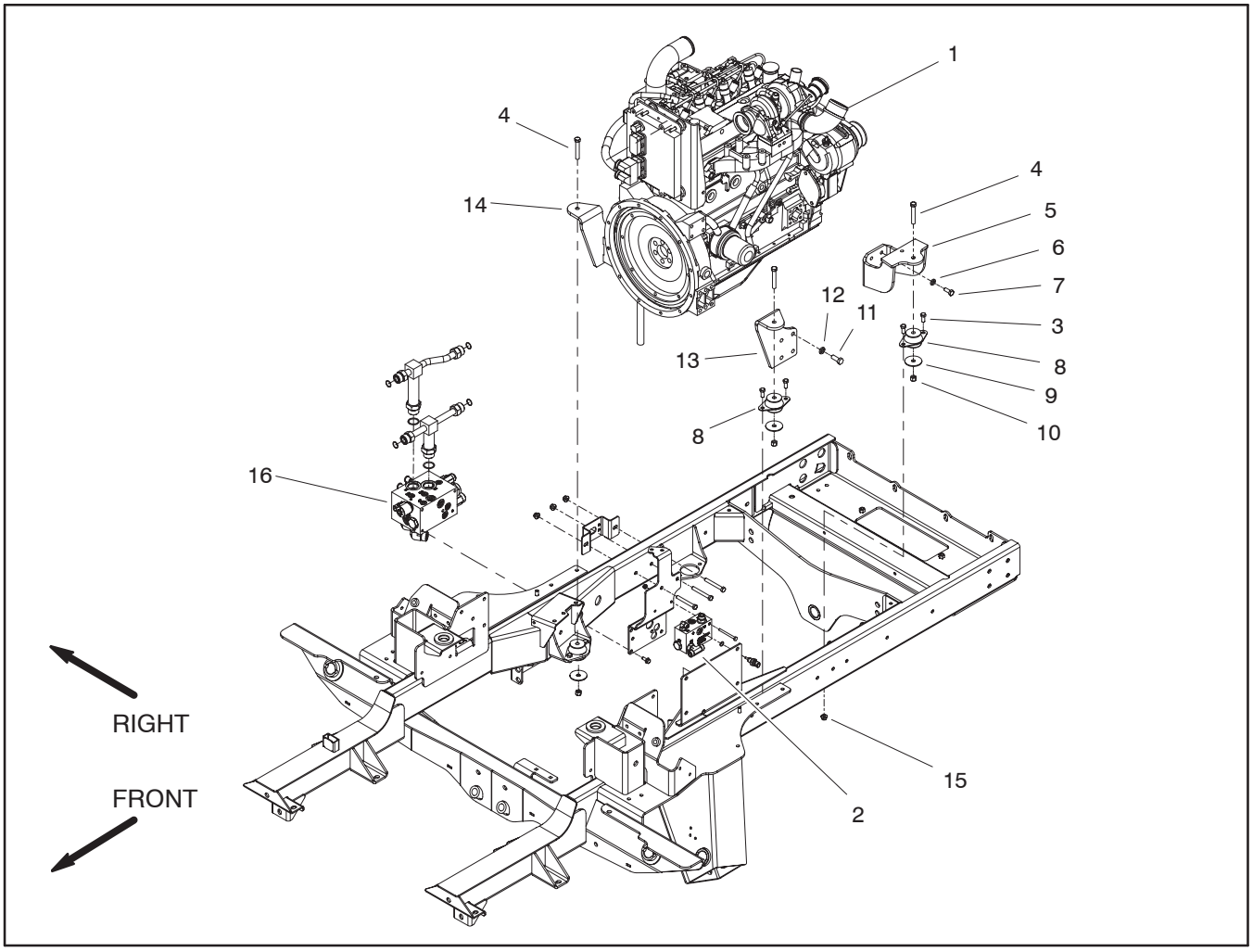


Figure 31

1. **Engine assembly**
2. **Traction flush manifold**
3. **Cap screw (8 used)**
4. **Cap screw (4 used)**
5. **Rear engine mount (2 used)**
6. **Lock washer (4 used per mount)**
7. **Cap screw (4 used per mount)**
8. **Engine isolator mount (4 used)**
9. **Snubbing washer (4 used)**
10. **Lock nut (4 used)**
11. **Cap screw (4 used per mount)**
12. **Lock washer (4 used per mount)**
13. **Front LH engine mount**
14. **Front RH engine mount**
15. **Flange nut (8 used)**
16. **4WD control manifold**

Engine Removal (Fig. 31)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.

2. If engine is to be disassembled, drain oil from engine.

3. Remove hood (see Hood Removal in the Service and Repairs section of Chapter 7 – Chassis).

4. Remove battery access panel. Disconnect negative battery cable first and then positive battery cable (see Battery Removal in the Service and Repairs section of Chapter 5 – Electrical System).

CAUTION

Do not open radiator cap or drain coolant if the radiator or engine is hot. Pressurized, hot coolant can escape and cause burns.

Ethylene-glycol antifreeze is poisonous. Dispose of coolant properly, or store it in a properly labeled container away from children and pets.

5. Drain coolant from the radiator into a suitable container (see Radiator Removal in this section). Disconnect coolant hoses from the radiator.

CAUTION

The muffler and exhaust pipe may be hot. To avoid possible burns, allow the exhaust system to cool before working on or near the muffler.

6. Remove exhaust system from engine (see Exhaust System Removal in this section).

7. Remove air cleaner system from engine (see Air Cleaner Removal in this section). Also, remove intake hoses from charge air cooler.

8. Note location of cable ties used to secure electrical wires. Disconnect wires and/or electrical connections from the following electrical components:

A. The alternator (Fig 32).

B. The temperature sensor on water pump housing (Fig. 33).

C. Battery, frame and wire harness ground at the engine block (Fig. 34).

D. The engine electronic control module.

E. The electric starter motor.

F. The air intake heater.

G. The air conditioning compressor (Groundsmaster 5910 machines) (Fig. 35).

9. Disconnect fuel hose from water separator outlet (Fig. 36). Cap fuel hose and water separator outlet to prevent contamination.

IMPORTANT: Support hydraulic pump assembly to prevent it from falling and being damaged.

10. Remove hydraulic pump assembly from engine (see Pump Assembly Removal in the Service and Repairs section of Chapter 4 – Hydraulic System).

11. On Groundsmaster 5910 machines, remove air conditioning compressor from brackets (see Air Conditioning Compressor Removal in the Service and Repairs section of Chapter 10 – Operator Cab). Position compressor away from engine taking care to not damage compressor or hoses. Support compressor to make sure it will not fall during engine removal.

12. Make sure that all cable ties securing the wiring harness, fuel lines and hydraulic hoses to the engine are removed.

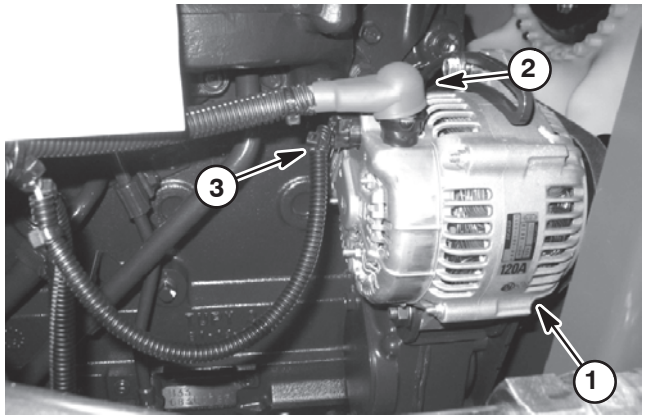


Figure 32

1. **Alternator**
2. **Cable**
3. **Harness connector**

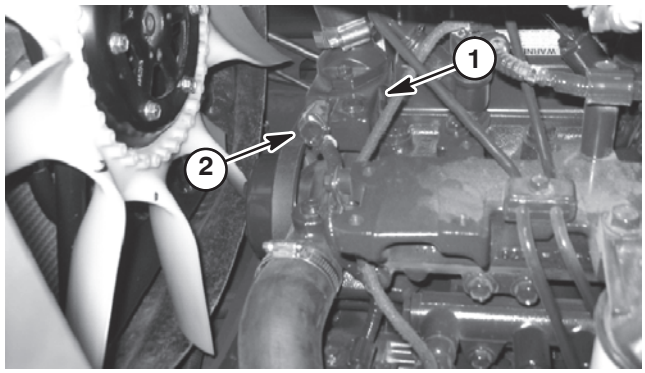


Figure 33

1. **Water pump**
2. **Temperature sensor**

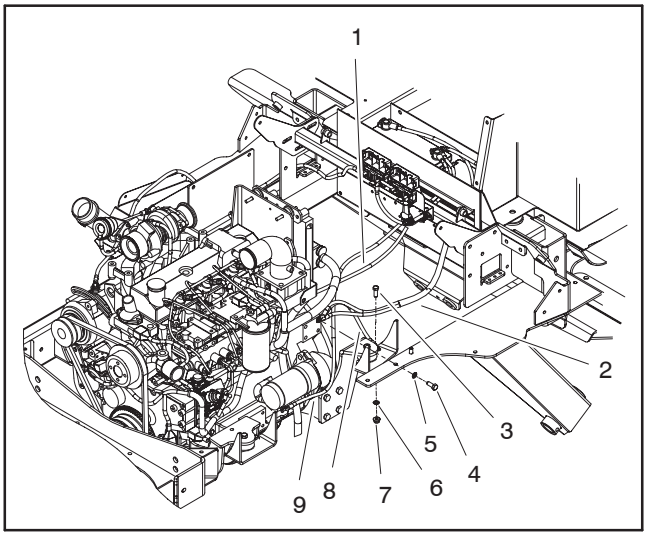


Figure 34

1. **Positive battery cable**
2. **Negative battery cable**
3. **Cap screw**
4. **Cap screw**
5. **Internal lock washer**
6. **Internal lock washer**
7. **Flange nut**
8. **Negative battery cable**
9. **Positive battery cable**

CAUTION

Make sure that hoist or lift used to remove engine can properly support engine. Engine weighs approximately 606 pounds (275 kg).

13. Connect suitable hoist or lift to the front and rear lift tabs on engine.

14. Remove lock nuts, snubbing washers and cap screws securing the engine brackets to the engine isolator mounts.

CAUTION

One person should operate lift or hoist while the other person guides the engine out of the machine.

IMPORTANT: Make sure to not damage the engine, fuel lines, hydraulic lines, electrical harness or other machine components while removing the engine.

15. Carefully raise engine from the machine.

16. If necessary, remove engine mount brackets from the engine.

17. If necessary, remove engine isolator mounts (item 8) from frame. Note that one of the fasteners for the RH front motor mount also secures the frame ground cable.

18. Cover or plug all engine openings to prevent contaminants from entering engine.

Engine Installation (Fig. 31)

1. If removed, install engine mount brackets to engine and isolator mounts to frame.

2. Make sure that all parts removed from the engine during maintenance or rebuilding are correctly installed to the engine.

3. Remove all covers and plugs from engine openings that were placed during engine removal.

CAUTION

Make sure that hoist or lift used to install engine can properly support engine. Engine weighs approximately 606 pounds (275 kg).

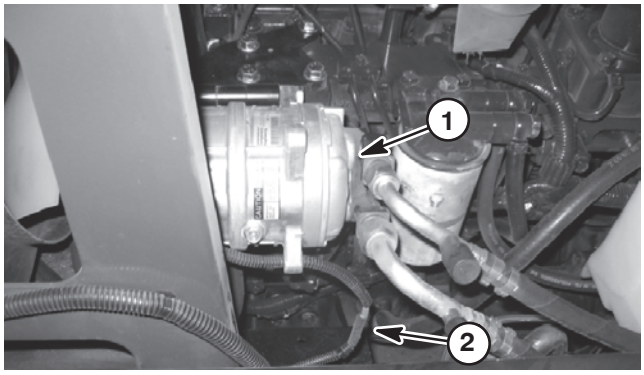


Figure 35

1. **AC compressor**
2. **Connector**

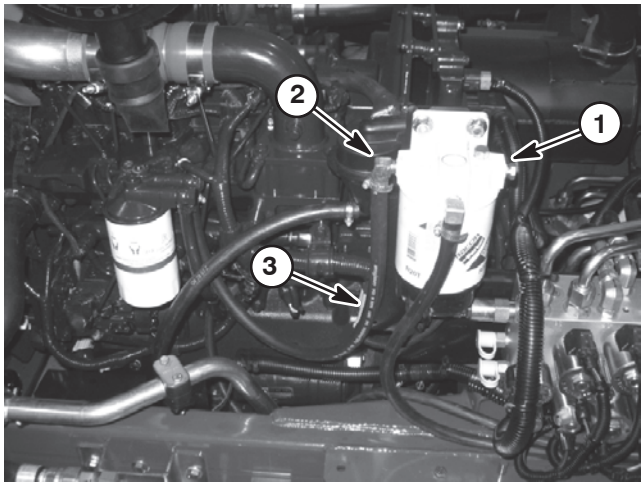


Figure 36

1. **Water separator**
2. **Outlet**
3. **Fuel hose**

4. Connect suitable hoist or lift to the front and rear lift tabs on engine.

CAUTION

One person should operate lift or hoist while the other person guides the engine into the machine.

IMPORTANT: Make sure not to damage the engine, fuel and hydraulic lines, electrical harness or other parts while installing the engine.

5. Slowly lower engine into the machine.

6. Align engine mount brackets to the engine isolator mounts and secure with cap screws, snubbing washers and lock nuts.

7. Connect fuel hose to water separator outlet (Fig. 36).

8. Install hydraulic pump assembly to engine (see Pump Assembly Installation in the Service and Repairs section of Chapter 4 – Hydraulic Systems).

9. On Groundsmaster 5910 machines, install air conditioning compressor to brackets (see Air Conditioning Compressor Installation in the Service and Repairs section of Chapter 10 – Operator Cab). Make sure that drive belt is properly tensioned.

10. Using notes taken during engine removal, connect wires and/or electrical connections to the following electrical components:

A. The alternator (Fig 32).

B. The temperature sensor on water pump housing (Fig. 33).

C. Battery, frame and wire harness ground at the engine block (Fig. 34).

IMPORTANT: When connecting wire harness to engine electronic control module, make sure that harness connector tab is aligned with corresponding slot in control module.

D. The engine electronic control module.

E. The electric starter motor.

F. The air intake heater.

G. The air conditioning compressor (Groundsmaster 5910 machines) (Fig. 35).

11. Install air cleaner assembly to the engine and intake hoses to charge air cooler (see Air Cleaner Installation in this section). Make sure to torque hose clamps that secure intake system hoses from **45 to 55 in-lb (5.1 to 6.2 N-m)**.

12. Install exhaust system to machine (see Exhaust System Installation in this section).

13. Connect coolant hoses to the radiator. Make sure radiator drain is shut. Fill radiator and reservoir with coolant.

14. Check position of electrical harnesses, fuel lines and hydraulic hoses for proper clearance with rotating, high temperature and moving components.

15. Connect positive battery cable first and then negative battery cable (see Battery Installation in the Service and Repairs section of Chapter 5 – Electrical System). Secure batteries to machine with straps. Install access panel.

16. Check and adjust engine oil as needed.

17. Check and adjust hydraulic oil as needed.

18. Bleed fuel system.

19. Run engine and check for any leaks.

20. Operate hydraulic controls to properly fill hydraulic system (see Charge Hydraulic System in the Service and Repairs section of Chapter 4 – Hydraulic System).

21. Install hood to machine (see Hood Installation in the Service and Repairs section of Chapter 7 – Chassis).

Flywheel Coupling Assembly

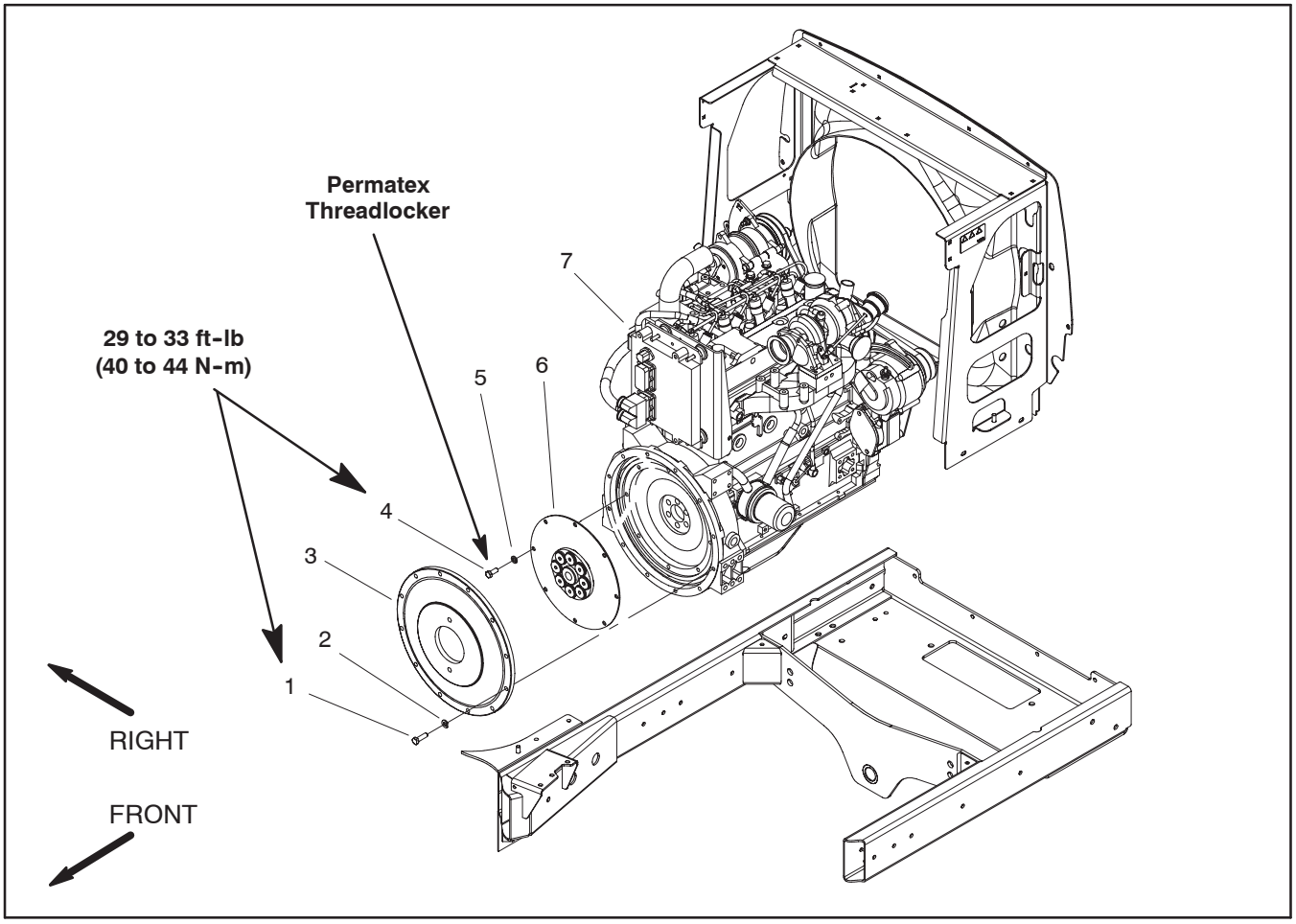


Figure 37

1. **Cap screw (12 used)**
2. **Washer (12 used)**
3. **Coupling housing**
4. **Cap screw (8 used)**
5. **Washer (8 used)**
6. **Flywheel coupling**
7. **Engine assembly**

Disassembly (Fig. 37)

1. If engine is in machine, hydraulic pump assembly needs to be removed from engine before coupling can be serviced (see Pump Assembly in Chapter 4 – Hydraulic Systems).

2. Remove coupling housing and flywheel coupling from engine using Figure 37 as a guide.

Assembly (Fig. 37)

1. Position flywheel coupling to engine flywheel. Make sure that coupling hub is away from engine flywheel (Fig. 38).

2. Apply Permatex Blue Gel medium strength threadlocker (or equivalent) to threads of cap screws (item 4). Secure coupling to engine flywheel with eight (8) cap screws and washers. Torque cap screws from **29 to 33 ft-lb (40 to 44 N-m)**.

3. Position coupling housing to engine. Secure housing with twelve (12) cap screws and washers using a crossing pattern tightening procedure. Torque screws from **29 to 33 ft-lb (40 to 44 N-m)**.

4. If engine is in machine, install hydraulic pump assembly (see Pump Assembly in Chapter 4 – Hydraulic Systems).

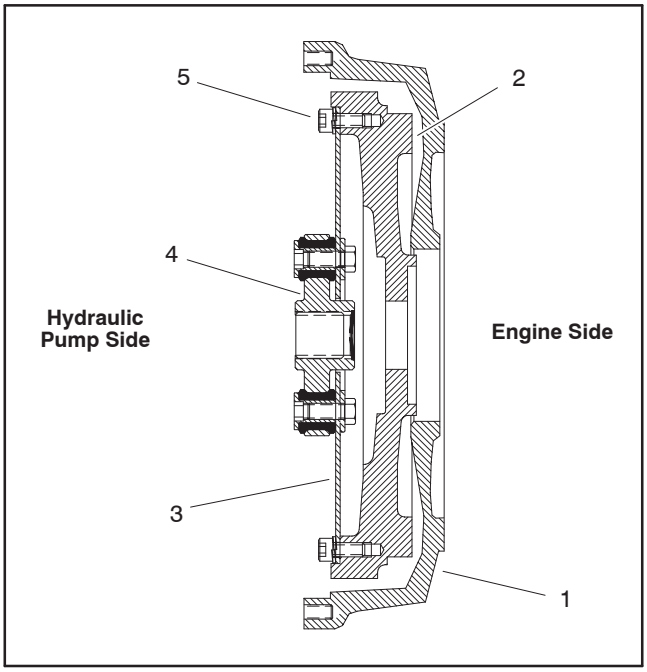


Figure 38

1. **Flywheel housing**
2. **Engine flywheel**
3. **Flywheel coupling**
4. **Coupling hub**
5. **Cap screw (8 used)**

This page is intentionally blank.



Chapter 4

Hydraulic System

Table of Contents

SPECIFICATIONS 2
GENERAL INFORMATION 3
- Traction Unit Operator's Manual 3
- Check Hydraulic Fluid 3
- Relieving Hydraulic System Pressure 3
- Towing Traction Unit 4
- Traction Circuit Component Failure 5
- Hydraulic Hoses 6
- Hydraulic Hose and Tube Installation (O−Ring Face Seal Fitting) 7
- Hydraulic Fitting Installation (SAE Straight Thread O−Ring Fitting into Component Port) 8

HYDRAULIC SCHEMATIC 11
HYDRAULIC FLOW DIAGRAMS 12
- Traction Circuit: Low Speed 12
- Traction Circuit: High Speed 14
- Traction Circuit: Traction Control 16
- Raise Cutting Deck 18
- Lower Cutting Deck 20
- PTO Mow Circuit 22
- PTO Mow Circuit Cutting Deck Blade Braking . . 24
- Steering Circuit 26
- Engine Cooling Fan Circuit 28

SPECIAL TOOLS 30
TROUBLESHOOTING 33
TESTING 38
- Traction Circuit Charge Pressure Test 40
- Traction Circuit Relief Pressure Test 42
- Rear Traction Circuit (RV) Relief Pressure Test . 44
- Traction Circuit Reducing Valve (PR) Pressure Test 46
- Counterbalance Pressure Test 48
- Cutting Deck Circuit Pressure Test 50
- Lift/Lower Circuit Relief Pressure Test 52
- Steering Circuit Relief Pressure Test 54
- Steering Cylinder Internal Leakage Test 56
- Gear Pump (P3) Flow Test 58

ADJUSTMENTS 60
- Adjustable Pressure Valve 60

SERVICE AND REPAIRS 61
- General Precautions for Removing and Installing Hydraulic System Components 61
- Check Hydraulic Lines and Hoses 61
- Flush Hydraulic System 62
- Charge Hydraulic System 64
- Hydraulic Reservoir 66
- Gear Pump 68
- Gear Pump Service 70
- Traction Circuit 72
- Piston (Traction) Pump 74
- Piston (Traction) Pump Service 76
- Front Wheel Motors 78
- Front Wheel Motor Service 80
- Rear Wheel Motors 82
- Rear Wheel Motor Service 84
- Traction Control Manifold 86
- Traction Control Manifold Service 88
- 4WD Control Manifold 90
- 4WD Control Manifold Service 92
- Traction Flush Manifold 94
- PTO Circuit 96
- Cutting Deck Motor 98
- Cutting Deck Motor Service 100
- PTO Control Manifolds 104
- PTO Control Manifold Service 108
- Filter Manifold 110
- Hydraulic Oil Cooler 112
- Cutting Deck Raise/Lower Circuit 114
- Front Deck Lift Cylinder 116
- Front Deck Lift Cylinder Service 118
- Wing Deck Lift Cylinder 120
- Wing Deck Lift Cylinder Service 122
- Lift Control Manifold 124
- Lift Control Manifold Service 126
- Steering and Engine Cooling Fan Circuit 128
- Steering Control Valve 130
- Steering Control Valve Service 132
- Steering Cylinders 134
- Steering Cylinder Service 136
- Engine Cooling Fan Motor 138
- Engine Cooling Fan Motor Service 140
- Steering/Engine Cooling Fan Control Manifold 142
- Steering/Engine Cooling Fan Control Manifold Service 144

SAUER DANFOSS D SERIES GEAR PUMP SEAL KIT SERVICE INSTRUCTION BULLETIN
REXROTH VARIABLE PUMP A10VG REPAIR INSTRUCTIONS
REXROTH VARIABLE PUMP A10VG REPAIR MANUAL
EATON REPAIR INFORMATION: MODEL 74318 and 74348 PISTON MOTORS
PARKER TORQMOTOR™ SERVICE PROCEDURE (TC, TB, TE, TJ, TF, TG, TH AND TL SERIES)
EATON PARTS AND REPAIR INFORMATION: 5 SERIES STEERING CONTROL UNITS

Specifications

Item	Description
Piston (Traction) Pump Maximum Pump Displacement (per revolution)	Rexroth Bosch, Variable Displacement Piston Pump 3.84 Cubic Inches (63 cc)
Traction Relief Pressure Forward Reverse	 4330 PSI (299 bar) 5330 PSI (368 bar)
Charge Circuit Relief Pressure	330 PSI (22.8 bar)
Front Wheel Motors Displacement (per revolution)	Eaton Fixed Displacement Piston Motor 1.80 Cubic Inches (29.5 cc)
Rear Wheel Motors Displacement (per revolution)	Parker Orbital Rotor Motor, TG Series 14.5 Cubic Inches (238 cc)
Gear Pump Section P1 Displacement (per revolution) Section P2 Displacement (per revolution) Section P3 Displacement (per revolution)	Sauer-Danfoss 3 Section Gear Pump, D Series 1.94 Cubic Inches (31.8 cc) 1.94 Cubic Inches (31.8 cc) 1.25 Cubic Inches (20.5 cc)
Cutting Deck Motors Displacement (per revolution) Relief Pressure (front and left decks) Relief Pressure (right deck)	Casappa Gear Motor 1.61 Cubic Inches (26.4 cc) 3000 PSI (207 bar) 2000 PSI (138 bar)
Steering Valve	Eaton Steering Unit, Series 5
Steering Circuit Relief Pressure	2100 PSI (145 bar)
Lift/Lower Circuit Relief Pressure	1350 PSI (93 bar)
Engine Cooling Fan Motor Displacement (per revolution)	Casappa Gear Motor 1.03 Cubic Inches (16.9 cc)
Hydraulic Filters (2 used)	Spin-on Cartridge Type 40 PSI (2.8 bar) Bypass in Filter Manifold Filter Manifold Includes Filter Restriction Indicator
Hydraulic Reservoir Capacity	19 U.S. Gallons (71.9 Liters)
Hydraulic Reservoir In-line Suction Strainer	100 Mesh (in Reservoir)
Hydraulic Oil	See Operator's Manual

General Information

Traction Unit Operator's Manual

The Traction Unit Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster machine. Refer to that publication for additional information when servicing the machine.

Check Hydraulic Fluid

The hydraulic system on your Groundsmaster is designed to operate on anti−wear hydraulic fluid. The reservoir holds approximately 19 gallons (71.9 liters) of hydraulic fluid. **Check level of hydraulic fluid daily.** See Operator's Manual for fluid level checking procedure and hydraulic oil recommendations.

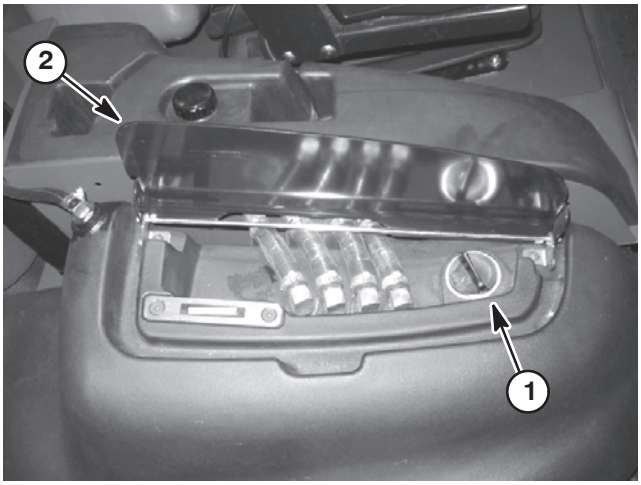


Figure 1

1. **Hydraulic oil cap**
2. **Tank cover**

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the hydraulic system, all pressure in the hydraulic system must be relieved. Park machine on a level surface, lower cutting decks fully, disengage PTO, stop engine and engage parking brake.

System pressure in mow circuit is relieved when the cutting decks are disengaged. To relieve hydraulic pressure in steering circuit, rotate steering wheel in both directions.

To relieve hydraulic pressure in lift circuit, make sure that engine is not running and have operator seat occupied. Turn ignition switch to RUN, depress deck lift switches to the deck lower position and then release switch. Return ignition switch to the OFF position.

Towing Traction Unit

IMPORTANT: If towing limits are exceeded, severe damage to the piston (traction) pump may occur.

If it becomes necessary to tow or push the machine, move machine in a forward direction at a speed below 2 mph (3.2 kph), and for a very short distance. If the machine needs to be moved more than 1/4 mile (0.4 km), machine should be transported on a trailer. The piston (traction) pump is equipped with two (2) bypass valves that must be opened for towing or pushing (Fig. 2).

IMPORTANT: If the machine must be pushed or towed in a reverse direction, the check valve in the 4WD control manifold must be bypassed. To bypass this check valve, connect a hydraulic hose between the traction pump reverse pressure test port (MA) and the 4WD control manifold test port (G2) (Fig. 3). Toro part numbers 95-8843 (hydraulic hose), 95-0985 (coupler fitting) (2 required) and 340-77 (hydraulic fitting) (2 required) are needed for this connection.

If towing the machine is necessary, use the following procedure:

1. Locate bypass valves on the traction pump (Fig. 2).

2. Open both bypass valves in traction pump:

   A. Loosen the jam nut on bypass valve stem.

   B. Thread bypass valve stem in six (6) turns.

   C. Tighten the jam nut.

3. Tow or push machine in a forward direction as required. Make sure to not exceed speed or distance listed above.

IMPORTANT: Using the tow option bypasses the high pressure relief valves. Catastrophic component damage can occur if hydraulic traction circuit empties or overheats.

4. After moving machine, close both bypass valves:

   A. Loosen the jam nut on bypass valve stem.

   B. Thread bypass valve stem all the way out. Do not exceed **8 ft-lb (11 N-m)** torque to close bypass valve.

   C. Tighten jam nut to secure bypass valve.

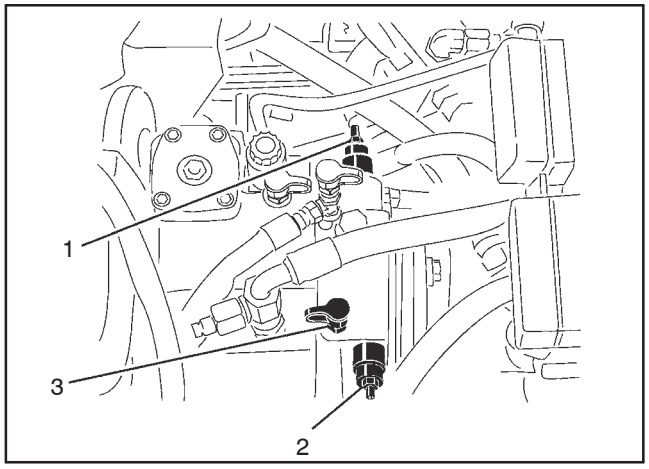


Figure 2

1. **Forward bypass valve**
2. **Reverse bypass valve**
3. **Reverse test port (MA)**

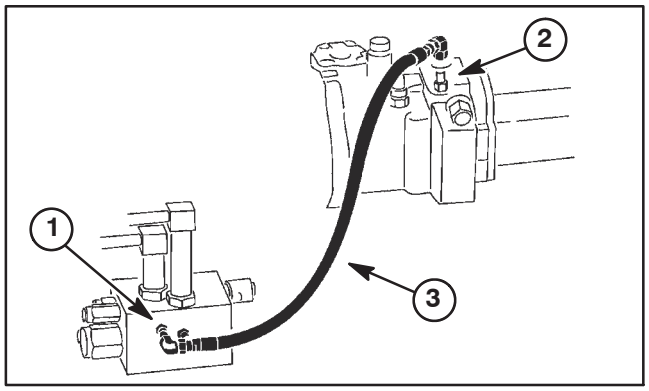


Figure 3

1. **4WD manifold reverse test port (G2)**
2. **Traction pump reverse test port (MA)**
3. **Hydraulic hose**

Traction Circuit Component Failure

The traction circuit on Groundsmaster 5900 and 5910 machines is a closed loop system that includes the piston (traction) pump and four (4) wheel motors. If a component in the traction circuit should fail, debris and contamination from the failed component will circulate throughout the traction circuit. This contamination can damage other components in the circuit so it must be removed to prevent additional component failure.

If a component failure occurs in the traction circuit, it is recommended that the entire traction circuit be disassembled, drained and thoroughly cleaned to ensure that all contamination is removed from the circuit. If any debris remains in the traction circuit and the machine is operated, the debris can cause additional component failure.

An alternative method of removing traction circuit contamination would be to temporarily install a high pressure hydraulic oil filter (see Special Tools) into the circuit. The filter should be used when connecting hydraulic test gauges in order to test traction circuit components or after replacing a failed traction circuit component (e.g. traction (piston) pump or wheel motor). The filter will ensure that contaminates are removed from the closed loop and thus, do not cause additional component damage.

Once the filter has been placed in the circuit, operate the traction circuit to allow oil flow through the circuit. The filter will remove contamination from the traction circuit during circuit operation. The filter can be removed from the machine after contamination has been removed from the traction circuit.

IMPORTANT: When operating the traction system with the high pressure filter installed, make sure that flow is always directed through the filter before entering a replaced component (e.g. do not press the traction pedal in the reverse direction if the filter is placed for forward direction flow). If flow is reversed, debris from the filter will re−enter the traction circuit.

Hydraulic Hoses

Hydraulic hoses are subject to extreme conditions such as pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions or mishandling during operation and maintenance. These conditions can cause hose damage and deterioration. Some hoses are more susceptible to these conditions than others. Inspect all machine hydraulic hoses frequently for signs of deterioration or damage:

Hard, cracked, cut, abraded, charred, leaking or otherwise damaged hose.

Kinked, crushed, flattened or twisted hose.

Blistered, soft, degraded or loose hose cover.

Cracked, damaged or badly corroded hose fittings.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint (layline) on the hose. Use two wrenches; hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the other wrench (See Hydraulic Hose and Tube Installation in this section). If the hose has an elbow at one end, tighten the swivel nut on that end before tightening the nut on the straight end of the hose.

For additional hydraulic hose information, refer to Toro Service Training Book, Hydraulic Hose Servicing (Part Number 94813SL).

WARNING

Before disconnecting or performing any work on hydraulic system, relieve all pressure in system (see Relieving Hydraulic System Pressure in this section).

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

Hydraulic Hose and Tube Installation (O-Ring Face Seal Fitting)

1. Make sure threads and sealing surfaces of the hose/tube and the fitting are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the face seal O-ring be replaced any time the connection is opened. Make sure the O-ring is installed and properly seated in the fitting groove. Lightly lubricate the O-ring with clean hydraulic oil.

3. Place the hose/tube against the fitting body so that the flat face of the hose/tube sleeve fully contacts the O-ring in the fitting.

4. Thread the swivel nut onto the fitting by hand. While holding the hose/tube with a wrench, use a torque wrench to tighten the swivel nut to the recommended installation torque shown in Figure 6. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 - Product Records and Maintenance).

5. If a torque wrench is not available or if space at the swivel nut prevents use of a torque wrench, an alternate method of assembly is the Flats From Wrench Resistance (F.F.W.R.) method (Fig. 2).

A. Using a wrench, tighten the swivel nut onto the fitting until light wrench resistance is reached (approximately 30 in-lb).

B. Mark the swivel nut and fitting body. Hold the hose/tube with a wrench to prevent it from turning.

C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (F.F.W.R.). The markings on the nut and fitting body will verify that the connection has been properly tightened.

Size	F.F.W.R.
4 (1/4 in. nominal hose or tubing)	1/2 to 3/4
6 (3/8 in.)	1/2 to 3/4
8 (1/2 in.)	1/2 to 3/4
10 (5/8 in.)	1/2 to 3/4
12 (3/4 in.)	1/3 to 1/2
16 (1 in.)	1/3 to 1/2

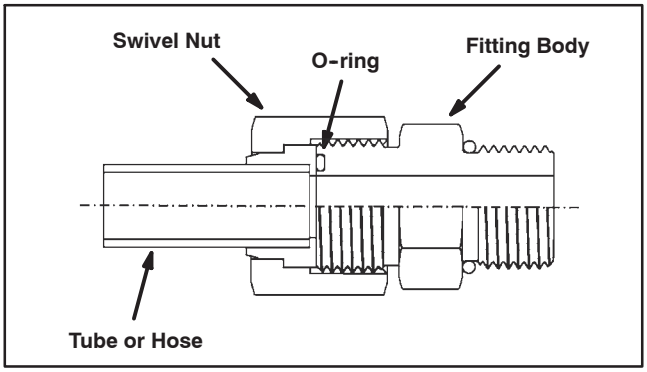


Figure 4

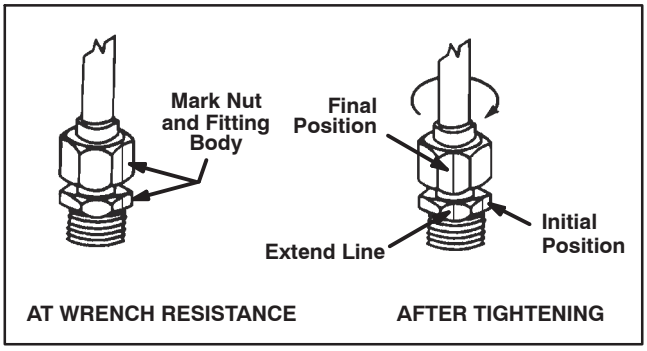


Figure 5

Fitting Dash Size	Hose/Tube Side Thread Size	Installation Torque
4	9/16 - 18	18 to 22 ft-lb (25 to 29 N-m)
6	11/16 - 16	27 to 33 ft-lb (37 to 44 N-m)
8	13/16 - 16	37 to 47 ft-lb (51 to 63 N-m)
10	1 - 14	60 to 74 ft-lb (82 to 100 N-m)
12	1 3/16 - 12	85 to 105 ft-lb (116 to 142 N-m)
16	1 7/16 - 12	110 to 136 ft-lb (150 to 184 N-m)
20	1 11/16 - 12	140 to 172 ft-lb (190 to 233 N-m)

Figure 6

Hydraulic Fitting Installation (SAE Straight Thread O-Ring Fitting into Component Port)

Non-Adjustable Fitting (Fig. 7)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.

3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.

4. Install the fitting into the port. Then, use a torque wrench and socket to tighten the fitting to the recommended installation torque shown in Figure 8.

NOTE: Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be less than the recommended installation torque. See Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 - Product Records and Maintenance to determine necessary conversion information.

5. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method.

A. Install the fitting into the port and tighten it down full length until finger tight.

B. If port material is steel, tighten the fitting to the listed F.F.F.T. If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

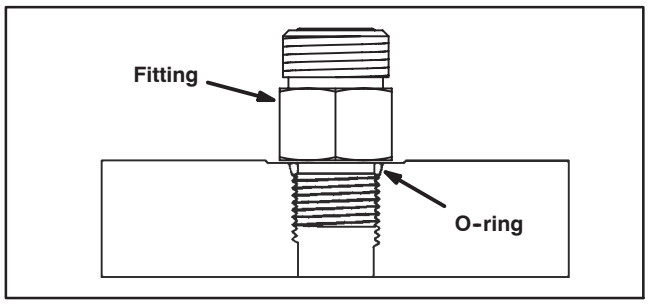


Figure 7

Fitting Dash Size	Fitting Port Side Thread Size	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
4	7/16 - 20	15 to 19 ft-lb (21 to 25 N-m)	9 to 11 ft-lb (13 to 15 N-m)
5	1/2 - 20	18 to 22 ft-lb (25 to 29 N-m)	11 to 15 ft-lb (15 to 20 N-m)
6	9/16 - 18	34 to 42 ft-lb (47 to 56 N-m)	20 to 26 ft-lb (28 to 35 N-m)
8	3/4 - 16	58 to 72 ft-lb (79 to 97 N-m)	35 to 43 ft-lb (48 to 58 N-m)
10	7/8 - 14	99 to 121 ft-lb (135 to 164 N-m)	60 to 74 ft-lb (82 to 100 N-m)
12	1 1/16 - 12	134 to 164 ft-lb (182 to 222 N-m)	81 to 99 ft-lb (110 to 134 N-m)
14	1 3/16 - 12	160 to 196 ft-lb (217 to 265 N-m)	96 to 118 ft-lb (131 to 160 N-m)
16	1 5/16 - 12	202 to 248 ft-lb (274 to 336 N-m)	121 to 149 ft-lb (165 to 202 N-m)
20	1 5/8 - 12	247 to 303 ft-lb (335 to 410 N-m)	149 to 183 ft-lb (202 to 248 N-m)

Figure 8

Adjustable Fitting (Fig. 9)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.

3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

4. Turn back the lock nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1 in Figure 10).

IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).

6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).

7. Hold the fitting in the desired position with a wrench and use a torque wrench to tighten the fitting to the recommended installation torque shown in Figure 8. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance).

8. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method. Hold the fitting in the desired position with a wrench and, if port material is steel, tighten the lock nut with a second wrench to the listed F.F.F.T (Step 4). If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

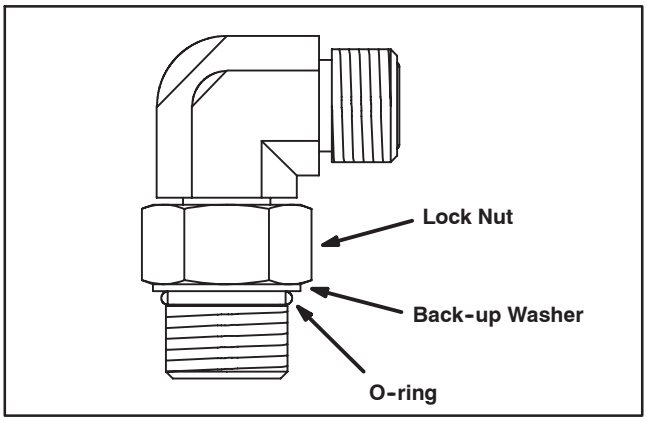


Figure 9

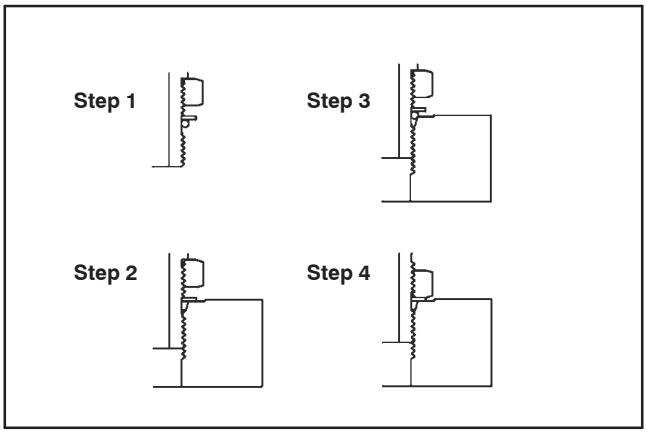


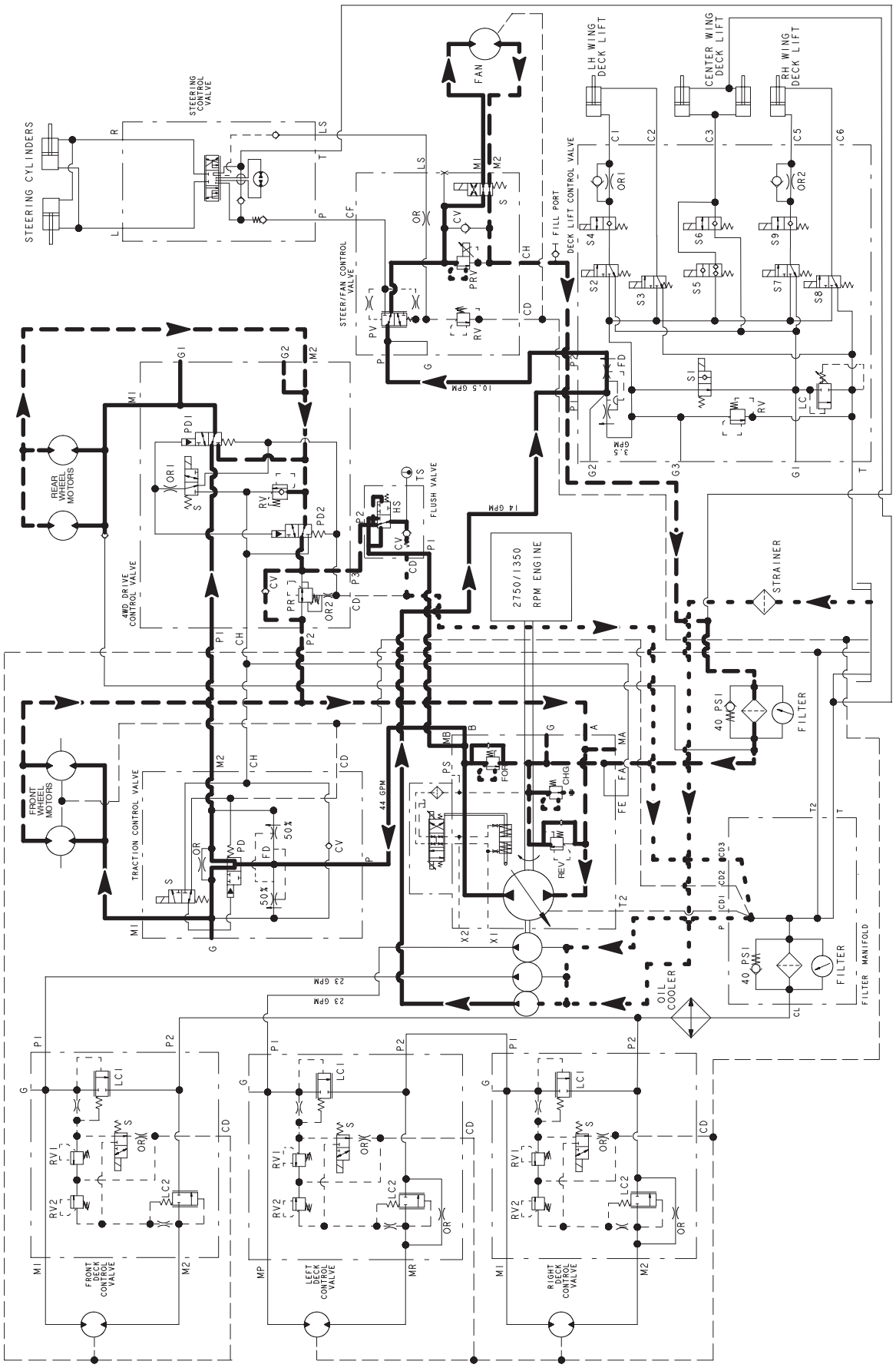
Figure 10

This page is intentionally blank.

Hydraulic Schematic

The hydraulic schematic for Groundsmaster 5900 and 5910 machines is located in Chapter 10 – Foldout Drawings.

Hydraulic Flow Diagrams



Traction Circuit: Low Speed

A variable displacement, bi−directional piston pump is directly coupled to the engine flywheel to provide hydraulic flow for the traction circuit. The piston pump swash plate movement is controlled by an electronic proportional servo assembly. Pushing the traction pedal rotates a potentiometer that sends a signal to the machine TEC−5002 controller. The controller in turn sends a corresponding PWM (Pulse Width Modulation) output signal to the hydrostat electronic control to rotate the pump swash plate accordingly to control the pump's output. The oil from the hydrostat is directed to the front and rear wheel motors through the traction, 4WD and traction flush control manifolds.

Operating pressure on the high pressure side of the closed loop traction circuit is determined by the amount of load developed at the fixed displacement wheel motors. As the load increases, circuit pressure can increase to relief valve settings: 4330 PSI (299 bar) in the forward direction and 5330 PSI (368 bar) in reverse. If pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the closed loop traction circuit.

Traction circuit pressure (forward and reverse) can be measured at test ports located on the hydrostat.

The traction circuit provides operation in either low speed (four wheel assist) or high speed (two wheel drive).

The traction pump and wheel motors use a small amount of hydraulic fluid for internal lubrication. Fluid is designed to leak across the pump and motor parts and into the component case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced. The charge circuit is designed to replace this traction circuit leakage.

The gear pump section (P3) that supplies oil to the steering, lift and cooling fan circuits, also provides charge oil for the traction circuit. The gear pump is driven directly off the traction pump. It provides a constant supply of charge oil to the traction circuit to make up for oil that is lost to internal leakage in the traction pump and wheel motors. Charge pump flow is directed through the charge oil filter before entering the hydrostat. This filter has a bypass valve that allows charge oil flow to the closed traction loop if the filter becomes plugged.

The charge pressure is limited to 330 PSI (22.8 bar) by a relief valve located in the hydrostat. Charge pressure can be measured at the charge pressure test port (G) on the hydrostat.

Forward Direction

With the low speed range selected and the traction pedal pushed in the forward direction, oil from the hydrostat port MB passes through the traction control valve (see Traction Circuit: Traction Control in this section). Oil flow from traction control valve port M1 drives the front wheel motors in the forward direction and then returns to the hydrostat. Oil flow from traction control valve port M2 is routed to the P1 port of the 4WD control valve where it is directed to the PD1 cartridge and out of the manifold to drive the rear wheel motors in the forward direction. Oil returning from the rear motors re−enters the 4WD control valve at the M2 port. Flow passes through the PD2 cartridge, through the CV check valve, out valve port P2 and back to the hydrostat.

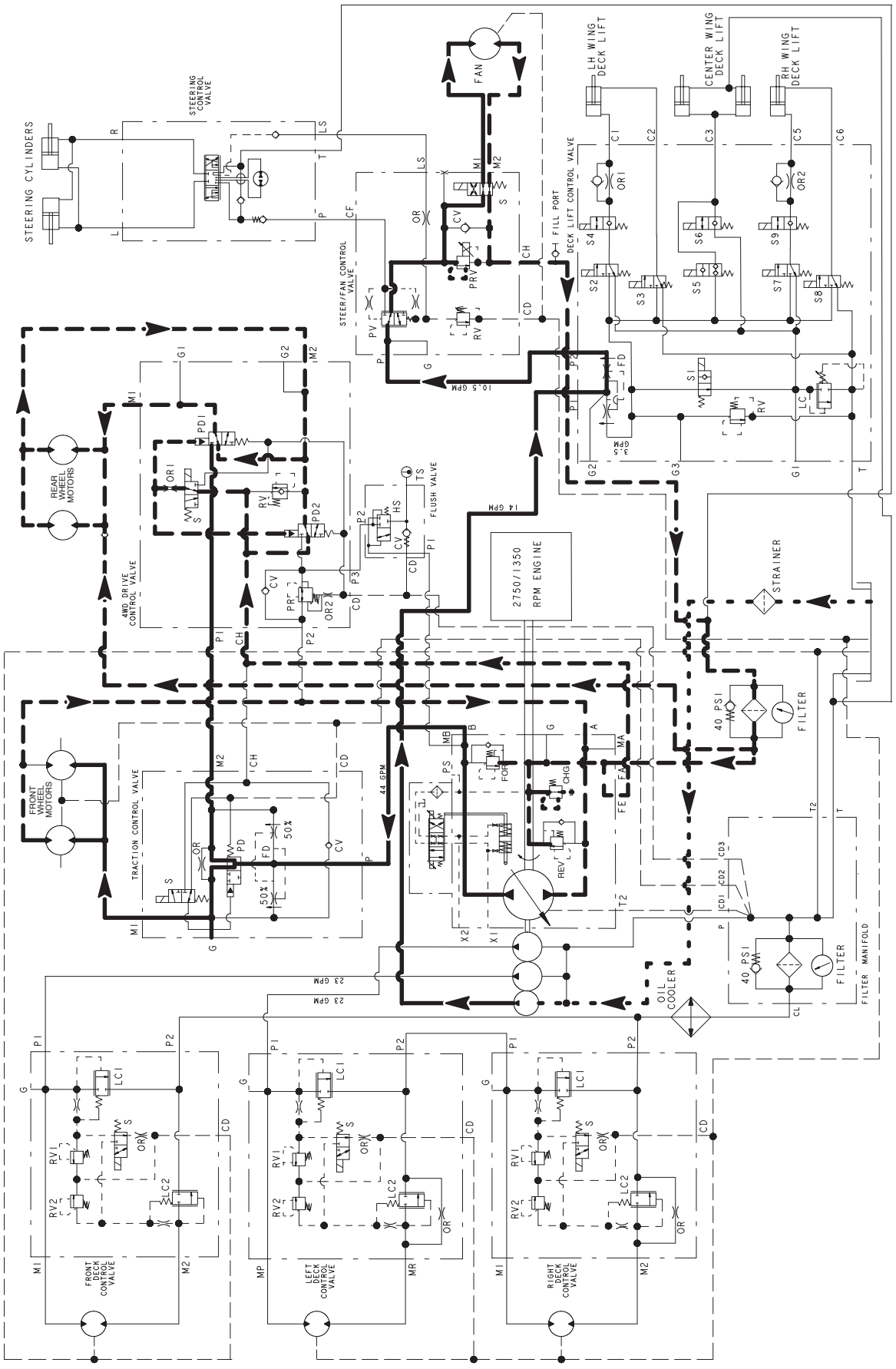
To keep the traction circuit oil properly cooled, a flush valve is incorporated into the traction circuit. When in the forward direction, the flush valve spool is shifted by forward pressure and allows a small amount of hydraulic fluid to bleed off for cooling of the closed loop traction circuit. The charge system replenishes oil that is bled from the traction circuit due to the flushing valve operation.

When going down a hill, the tractor becomes an over−running load that drives the wheel motors. In this condition, the rear wheel motors could lock up as the oil pumped from the motors increases pressure as it returns to the hydrostat. To prevent wheel lock up, an adjustable relief valve (RV) in the 4WD control valve reduces rear motor pressure created in down hill, dynamic braking conditions.

Reverse Direction

The traction circuit operates essentially the same in reverse low speed as it does in the forward direction. However, the flow through the circuit is reversed. Oil flow from the hydrostat port MA is directed to the front wheel motors and to 4WD control valve port P2. Oil to the front wheel motors drives them in the reverse direction and then returns to the hydrostat through the traction control valve. Oil flow to the 4WD control valve flows through the PR pressure reducing valve which limits the down stream pressure to the rear wheel motors to 650 PSI (45 bar) so the rear wheels will not scuff the turf. This reduced pressure flow passes through the PD2 cartridge and out port M2 to the rear wheel motors. Return oil from the rear motors re−enters the 4WD control valve at port M1, flows through the PD1 cartridge, exits the manifold at port P1 and returns to the hydrostat through the traction control manifold.

When in the reverse direction, the flush valve spool remains in the unshifted position to prevent any traction circuit fluid loss.



Traction Circuit: High Speed (Forward Shown)

- Working Pressure
- Low Pressure (Charge)
- Return or Suction Flow

Traction Circuit: High Speed

A variable displacement, bi−directional piston pump is directly coupled to the engine flywheel to provide hydraulic flow for the traction circuit. The piston pump swash plate movement is controlled by an electronic proportional servo assembly. Pushing the traction pedal rotates a potentiometer that sends a signal to the machine TEC−5002 controller. The controller in turn sends a corresponding PWM (Pulse Width Modulation) output signal to the hydrostat electronic control to rotate the pump swash plate accordingly to control the pump's output. The oil from the hydrostat is directed to the front and rear wheel motors through the traction, 4WD and traction flush control manifolds.

Operating pressure on the high pressure side of the closed loop traction circuit is determined by the amount of load developed at the fixed displacement wheel motors. As the load increases, circuit pressure can increase to relief valve settings: 4330 PSI (299 bar) in the forward direction and 5330 PSI (368 bar) in reverse. If pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the closed loop traction circuit.

Traction circuit pressure (forward and reverse) can be measured at test ports located on the hydrostat.

The traction circuit provides operation in either low speed (four wheel assist) or high speed (two wheel drive).

The traction pump and wheel motors use a small amount of hydraulic fluid for internal lubrication. Fluid is designed to leak across the pump and motor parts and into the component case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced. The charge circuit is designed to replace this traction circuit leakage.

The gear pump section (P3) that supplies oil to the steering, lift and cooling fan circuits, also provides charge oil for the traction circuit. The gear pump is driven directly off the traction pump. It provides a constant supply of charge oil to the traction circuit to make up for oil that is lost to internal leakage in the traction pump and wheel motors. Charge pump flow is directed through the charge oil filter before entering the hydrostat. This filter has a bypass valve that allows charge oil flow to the closed traction loop if the filter becomes plugged.

The charge pressure is limited to 330 PSI (22.8 bar) by a relief valve located in the hydrostat. Charge pressure can be measured at the charge pressure test port on the hydrostat.

Forward Direction

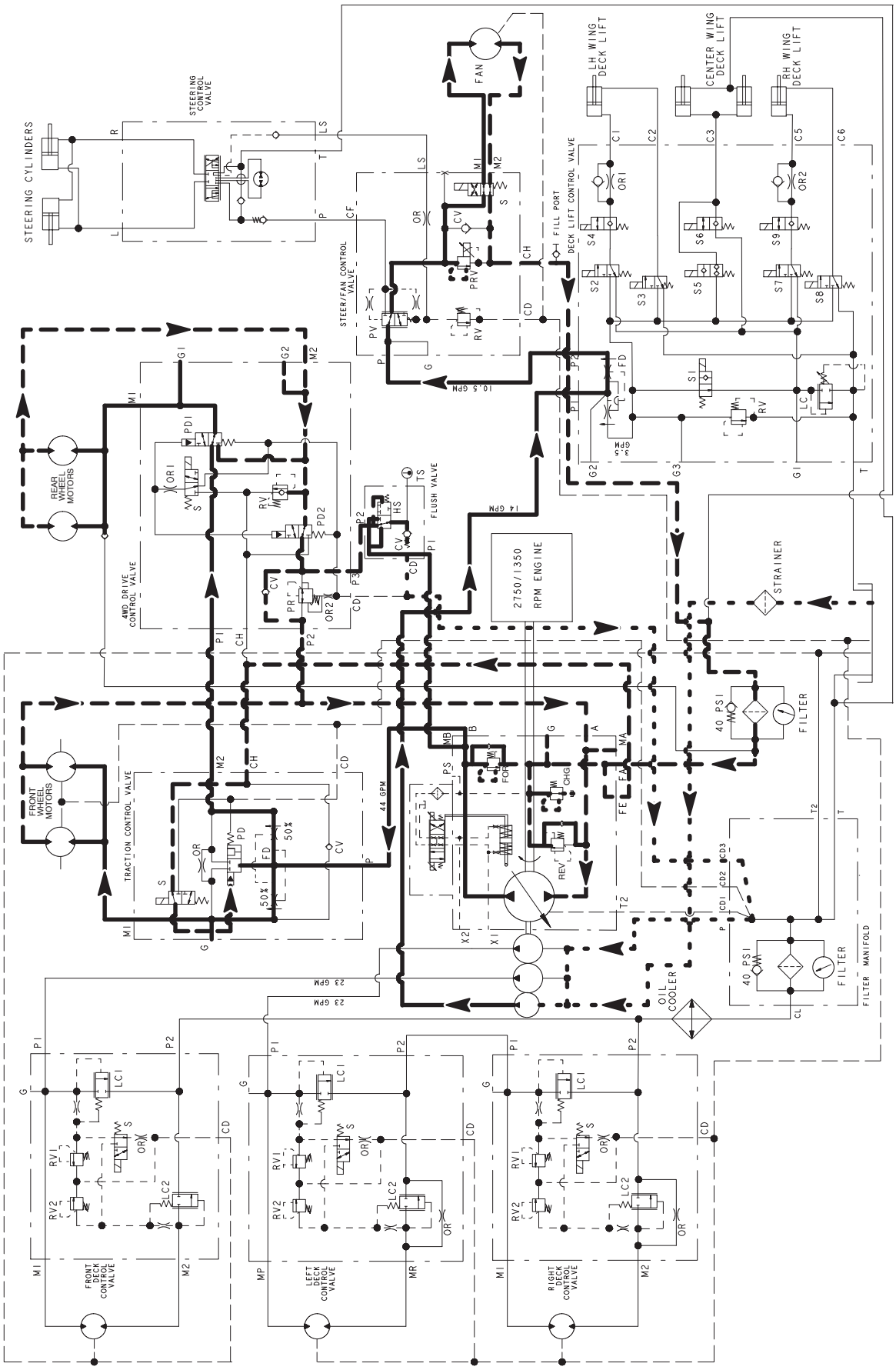
With the Hi−Lo speed switch in the high range position, solenoid valve (S) in the 4WD control manifold is energized. The solenoid valve spool shifts to direct charge pressure that shifts the PD1 and PD2 control valve spools. The shifted PD1 valve prevents hydraulic flow from the hydrostat to the rear wheel motors. With flow blocked to the rear wheel motors, all hydrostat flow is directed to the front wheel motors to allow a higher, transport speed in the forward direction.

Without flow to the rear wheel motors, the rotating rear wheels drive the rear wheel motors so they act like a pump. Inlet oil to the rear wheel motors is provided by a check valve that allows charge oil into the rear wheel motor circuit. Oil leaving the rear wheel motors enters the 4WD control manifold at port M2 and is directed back to the rear wheel motors through the PD1 cartridge and manifold port M1. To allow for rear wheel loop cooling when in forward Transport operation, a small amount of oil exits through the shifted PD2 cartridge and returns to the charge circuit.

Reverse Direction

With the Hi−Lo speed switch in the high range position, solenoid valve (S) in the 4WD control manifold is energized. The solenoid valve spool shifts to direct charge pressure that shifts the PD1 and PD2 control valve spools. Oil flow from the hydrostat port MA enters the 4WD control manifold at port P2, flows through the PR pressure reducing valve and is stopped at the shifted PD2 valve. With flow blocked to the rear wheel motors, all hydrostat flow is directed to the front wheel motors to allow a higher, transport speed in the reverse direction.

Without flow to the rear wheel motors, the rotating rear wheels drive the rear wheel motors so they act like a pump. Inlet oil to the rear wheel motors is provided by a check valve at the 4WD control manifold CH port that allows charge oil into the rear wheel motor circuit. This charge oil is routed through the shifted PD2 cartridge and out manifold port M2 to the rear wheel motors. Return flow from the rear wheel motors enters the 4WD control manifold at port M1, through the shifted PD1 cartridge and and is then directed back to the rear wheel motors as they turn in the reverse direction.



Traction Circuit: Traction Control (Traction Assist Switch Depressed in Low Speed)

Working Pressure
Low Pressure (Charge)
Return or Suction
Flow

Traction Circuit: Traction Control

A flow divider is incorporated into the traction circuit to provide a proportioned flow to the front and rear wheel motors for a true four–wheel drive system. When the Hi–Lo speed switch is in the Low position and the traction pedal is pressed for the forward direction, the operator can engage the traction flow divider when low traction situations could lead to wheel spin. The engaged flow divider splits traction pump flow equally between the front and rear wheel motors to reduce the chance that excessive flow goes to a spinning wheel.

The TEC–5001 controller does not allow Traction Assist to be activated while the tractor is in the high speed range in either forward or reverse. The controller also prevents Traction Assist in the reverse direction when in low speed range.

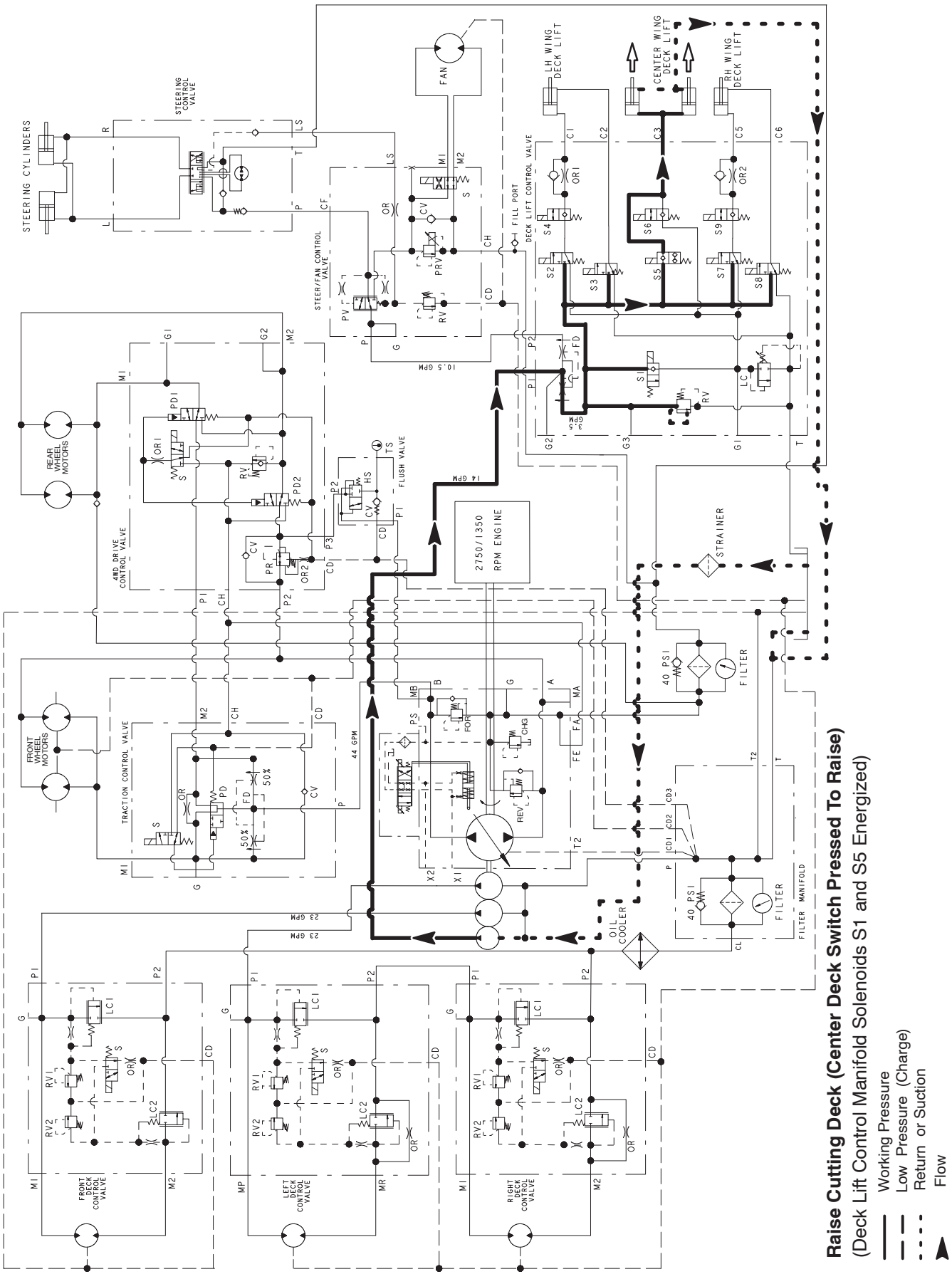
To further enhance traction control, the lift/lower circuit is equipped with a counterbalance system. Counterbalance is achieved by applying a constant pressure to the base end of the lift cylinders to lift the cutting decks slightly. This action causes some of the cutting deck weight to be transferred to the traction unit to improve traction. An adjustable counterbalance valve (LC) located in the deck lift control manifold controls the amount of counterbalance pressure in the lift circuit.

Traction Assist Switch in OFF Position

In low speed range with the Traction Assist switch in the OFF position, solenoid valve (S) in the traction control manifold is de–energized allowing the PD cartridge spool to be in the neutral position. With the traction pedal in the forward direction, hydraulic oil from the hydrostat port MB enters the traction control manifold at port P, flows through the FD cartridge and enters the PD cartridge. Flow at the PD cartridge splits into two circuits depending on downstream pressure. The flow leaving the PD cartridge splits between the M1 manifold port for the front wheel motors and the M2 manifold port for the rear wheel motors.

Traction Assist Switch in ON Position

In low speed range with the traction pedal in the forward direction and the momentary Traction Assist switch depressed and held in the ON position, solenoid valve (S) in the traction control manifold is energized allowing charge pressure to shift the PD cartridge spool. The shifted PD cartridge blocks oil flow from the hydrostat, thereby forcing hydrostat oil flow through the FD proportional flow control valve. The flow from the hydrostat is split approximately equally between the front and rear wheel motors as long as the Traction Assist switch is depressed.


Raise Cutting Deck (Center Deck Switch Pressed To Raise)
(Deck Lift Control Manifold Solenoids S1 and S5 Energized)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
STEERING CYLINDERS
STEERING CONTROL VALVE
FAN
LH WING DECK LIFT
CENTER WING DECK LIFT
RH WING DECK LIFT
FILL PORT
DECK LIFT CONTROL VALVE
STEER/FAN CONTROL VALVE
10.5 GPM
REAR WHEEL MOTORS
4WD DRIVE CONTROL VALVE
FLUSH VALVE
14 GPM
2750/1350 RPM ENGINE
STRAINER
40 PSI
FILTER
FRONT WHEEL MOTORS
TRACTION CONTROL VALVE
44 GPM
23 GPM
OIL COOLER
FILTER MANIFOLD
FRONT DECK CONTROL VALVE
LEFT DECK CONTROL VALVE
RIGHT DECK CONTROL VALVE

Raise Cutting Deck

A three section gear pump is coupled to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the lift control manifold, the steering/cooling fan control manifold and the traction charge circuit. Hydraulic flow from pump section (P3) is split between the lift/lower circuit and the steering/cooling fan/charge circuit by a proportional flow divider located in the lift control manifold. This flow divider splits pump flow approximately 25% for the lift/lower circuit (4 GPM/15.1 LPM) and 75% for the steering/cooling fan/charge circuit (10 GPM/37.9 LPM).

An adjustable counterbalance valve (LC) in the lift control manifold maintains back pressure on the deck lift cylinders to allow some of the cutting deck weight to be transferred to the traction unit to improve traction. A relief valve (RV) located in the lift control manifold limits lift/lower circuit pressure to 1350 PSI (93 bar).

Each of the cutting decks (center, right and left) can be raised independently with the use of three switches on the armrest console (Fig. 11). Pressing the rear of a switch provides an input for the TEC−5001 controller to raise a cutting deck. The controller provides electrical outputs to solenoids in the lift control manifold to allow appropriate valve shift to cause a deck to raise.

When the cutting decks are in a stationary position, all solenoids in the lift control manifold are de−energized. In this position, the flow from the gear pump that is proportioned for the lift/lower circuit is by−passed through the solenoid valve S1, the counterbalance logic cartridge LC and returns to the hydraulic reservoir.

NOTE: The operator must be in the operator seat to raise a cutting deck.

Center Cutting Deck Raise

To raise the center cutting deck, the rear of the center console switch is depressed. The switch signal is an input to the TEC−5001 controller which provides an electrical output to solenoid valves S1 and S5 in the lift control manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the barrel end of the center deck lift cylinder. Shifted S1 prevents oil flow from returning directly to the reservoir. Shifted S5 allows an oil path to the barrel end of the lift cylinder to extend the lift cylinder and raise the center cutting deck. Oil from the extending cylinder returns to the hydraulic reservoir.

When the deck switch is released, the lift/lower control solenoids are de−energized and the center deck lift cylinders and center cutting deck are held in position.

Right Cutting Deck Raise

To raise the right wing deck, the rear of the right console switch is pushed as an input to the TEC−5001 controller. The controller provides an electrical output to solenoid valves S1 and S7 in the lift control manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the rod end of the right deck lift cylinder. Shifted S1 prevents oil flow from returning directly to the reservoir. Shifted S7 allows an oil path through the check valve at S9 (de−energized), the check valve at OR2 and to the barrel end of the lift cylinder to extend the lift cylinder and raise the right cutting deck. Oil from the extending cylinder is directed through S9 (de−energized) and returns to the hydraulic reservoir.

When the deck switch is released, the lift/lower control solenoids are de−energized and the lift cylinder and right cutting deck are held in position.

Left Cutting Deck Raise

To raise the left wing deck, the rear of the left console switch is pushed as an input to the TEC−5001 controller. The controller provides an electrical output to solenoid valves S1 and S2 in the lift control manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the barrel end of the left deck lift cylinder. Shifted S1 prevents oil flow from returning directly to the reservoir. Shifted S2 allows an oil path through the check valve at S4 (de−energized), the check valve at OR1 and to the barrel end of the lift cylinder to extend the lift cylinder and raise the left cutting deck. Oil from the extending cylinder is directed through S3 (de−energized) and returns to the hydraulic reservoir.

When the deck switch is released, the lift/lower control solenoids are de−energized and the lift cylinder and left cutting deck are held in position.

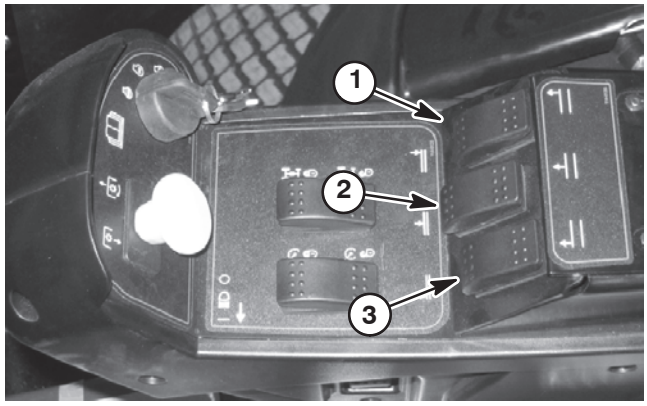
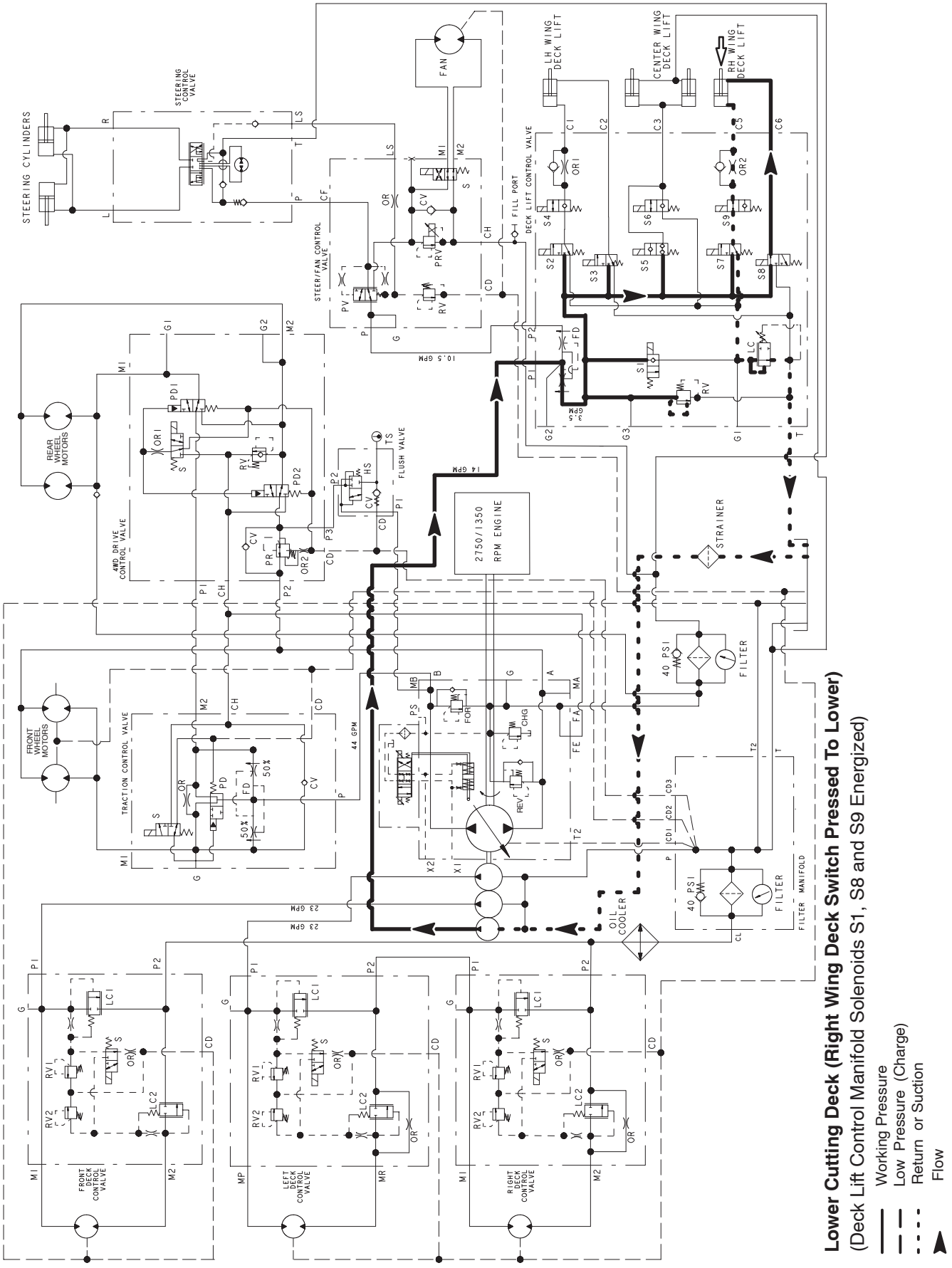


Figure 11

1. Right deck switch
2. Center deck switch
3. Left deck switch



Lower Cutting Deck (Right Wing Deck Switch Pressed To Lower)
(Deck Lift Control Manifold Solenoids S1, S8 and S9 Energized)

Working Pressure
Low Pressure (Charge)
Return or Suction
Flow

Lower Cutting Deck

A three section gear pump is coupled to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the lift control manifold, the steering/cooling fan control manifold and the traction charge circuit. Hydraulic flow from pump section (P3) is split between the lift/lower circuit and the steering/cooling fan/charge circuit by a proportional flow divider located in the lift control manifold. This flow divider splits pump flow approximately 25% for the lift/lower circuit and 75% for the steering/cooling fan/charge circuit.

An adjustable counterbalance valve (LC) in the lift control manifold maintains back pressure on the deck lift cylinders to allow some of the cutting deck weight to be transferred to the traction unit to improve traction. A relief valve (RV) located in the lift control manifold limits lift/lower circuit pressure to 1350 PSI (93 bar).

Each of the cutting decks (center, right and left) can be lowered independently with the use of three (3) switches on the armrest console (Fig. 11). Pressing the front of a switch provides an input for the TEC−5001 controller to lower a cutting deck. The controller provides electrical outputs to solenoids in the lift control manifold to allow appropriate valve shift to cause a deck to lower.

When the cutting decks are in a stationary position, all solenoids in the lift control manifold are de−energized. In this position, the flow from the gear pump that is proportioned for the lift/lower circuit is by−passed through the solenoid valve S1, the counterbalance logic cartridge LC and returns to the hydraulic reservoir.

NOTE: The operator must be in the operator seat in order to lower a cutting deck.

Center Cutting Deck Lower

To lower the center cutting deck, the front of the center console switch is depressed. The switch signal is an input to the TEC−5001 controller which provides an electrical output to solenoid valve S6 in the lift control manifold. Energized solenoid valve S6 shifts to allow a passage for oil flow from the rod end of the center deck lift cylinders. The weight of the cutting deck causes the center deck lift cylinders to retract and lower the center cutting deck.

When the deck switch is released, the lift/lower control solenoid is de−energized and the lift cylinders and center cutting deck are held in position.

Right Cutting Deck Lower

To lower the right wing deck, the front of the right console switch is pushed as an input to the TEC−5001 controller. The controller provides an electrical output to solenoid valves S1, S8 and S9 in the lift control manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the rod end of the right deck lift cylinder. Shifted S1 prevents oil flow from returning directly to the reservoir. Shifted S8 allows an oil path to the shaft end of the lift cylinder to retract the lift cylinder and lower the right cutting deck. Oil from the retracting cylinder flows through orifice OR2 to control the drop speed of the cutting deck. Flow is then directed through the shifted S9, counterbalance valve (LC) and returns to the hydraulic reservoir.

When the deck switch is released, the lift/lower control solenoids are de−energized and the lift cylinder and right cutting deck are held in position.

Left Cutting Deck Lower

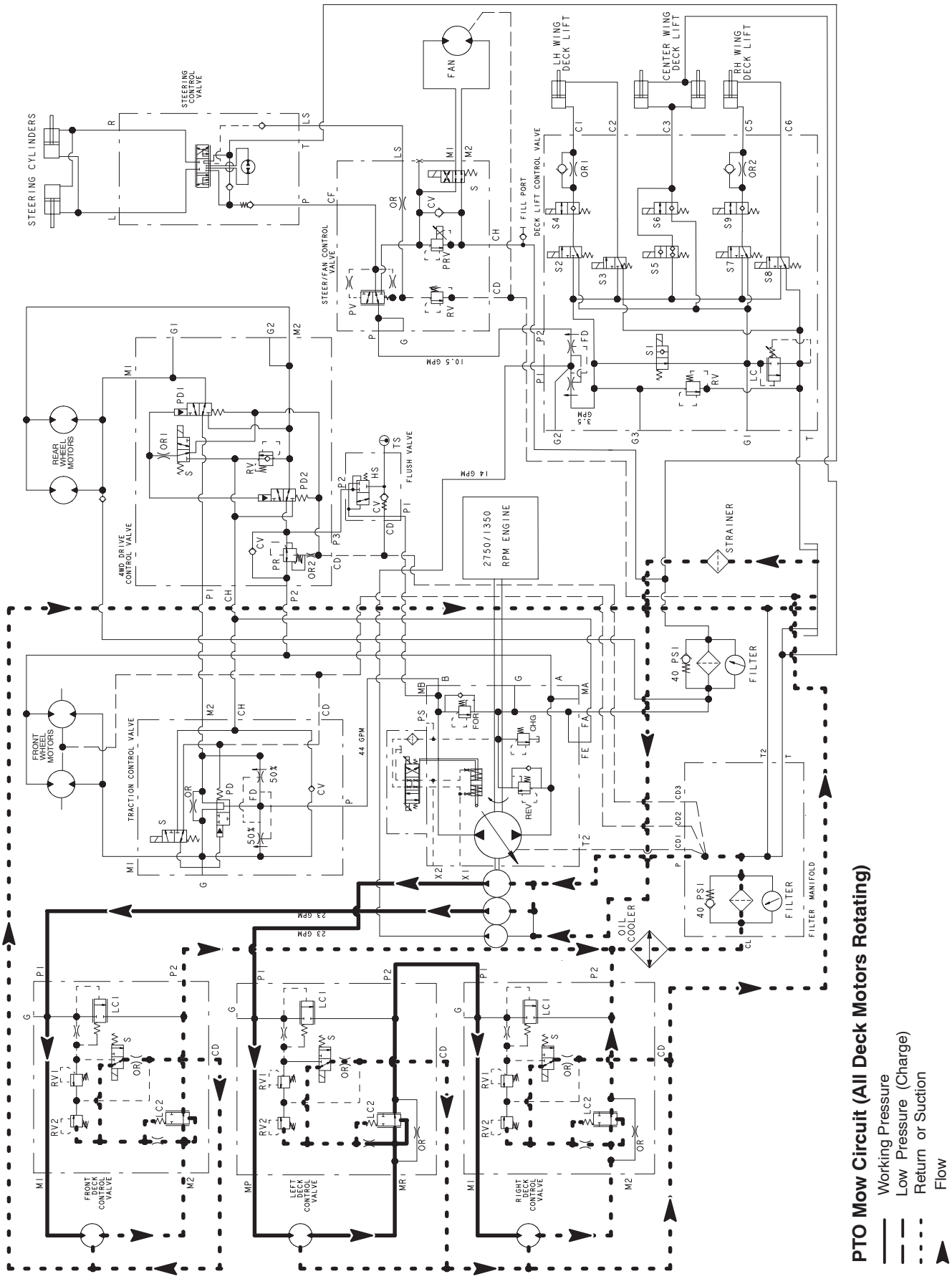
To lower the left wing deck, the front of the left console switch is pushed as an input to the TEC−5001 controller. The controller provides an electrical output to solenoid valves S1, S3 and S4 in the lift control manifold. The energized solenoid valves shift to allow a passage for circuit oil flow to the rod end of the left deck lift cylinder. Shifted S1 prevents oil flow from returning directly to the reservoir. Shifted S3 allows an oil path to the shaft end of the lift cylinder to retract the lift cylinder and lower the left cutting deck. Oil from the retracting cylinder flows through orifice OR1 to control the drop speed of the cutting deck. Flow is then directed through the shifted S3, counterbalance valve (LC) and returns to the hydraulic reservoir.

When the deck switch is released, the lift/lower control solenoids are de−energized and the lift cylinder and left cutting deck are held in position.

Cutting Deck Float

Cutting deck float allows the fully lowered cutting decks to follow ground surface contours. Lift control manifold solenoid valves S4 (left deck), S6 (center deck) and S9 (right deck) are energized when the decks are fully lowered. These energized solenoids provide an oil passage to and from the lift cylinders to allow cylinder and cutting deck movement while mowing. Counterbalance pressure will affect deck float operation.

NOTE: If a deck is already fully lowered when the ignition switch is moved from OFF to RUN, the deck will not be in float until the deck lift/lower switch is momentarily pressed to lower.


PTO Mow Circuit (All Deck Motors Rotating)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
STEERING CYLINDERS
STEERING CONTROL VALVE
FAN
LH WING DECK LIFT
CENTER WING DECK LIFT
RH WING DECK LIFT
DECK LIFT CONTROL VALVE
FILL PORT
STEER/FAN CONTROL VALVE
10.5 GPM
3.5 GPM
14 GPM
REAR WHEEL MOTORS
4WD DRIVE CONTROL VALVE
FLUSH VALVE
2750/1350 RPM ENGINE
STRAINER
FRONT WHEEL MOTORS
TRACTION CONTROL VALVE
44 GPM
40 PSI
FILTER
23 GPM
OIL COOLER
FILTER MANIFOLD
FRONT DECK CONTROL VALVE
LEFT DECK CONTROL VALVE
RIGHT DECK CONTROL VALVE

PTO Mow Circuit

A three section gear pump is coupled to the piston (traction) pump. Hydraulic flow for the PTO mow circuit is supplied by two (2) sections of the gear pump. The gear pump section (P1) closest to the piston pump supplies hydraulic flow in series to the right and left decks, while the next gear pump section (P2) supplies the center deck. Each of the three (3) cutting decks is controlled by a hydraulic control manifold equipped with a solenoid control valve (S), logic cartridges (LC1) and (LC2), a brake relief cartridge (RV2) and a circuit relief cartridge (RV1).

PTO Not Engaged

When the PTO switch is OFF or if the deck is raised with the PTO switch ON, the PTO manifold solenoid valve (S) is not energized and the solenoid spool is in the neutral position. The solenoid valve spool in neutral allows a small amount of hydraulic flow to return to tank through a manifold sensing line which causes a pressure increase that shifts logic cartridge LC1. The pump flow is routed through shifted LC1 and out manifold port P2. Logic cartridge LC2 remains in the unshifted position to prevent any return flow from the deck motor to keep the motor from rotating.

Return flow from the front and right deck control manifolds is routed through the oil cooler, oil filter and then to the gear pump input. Return flow from the left deck control manifold provides supply for the right deck.

PTO Engaged

When the PTO switch is turned ON and the decks are lowered, the PTO control manifold solenoid valve (S) is energized by the TEC–5002 controller. The shifted solenoid valve spool prevents any sense line flow through the spool which causes the logic cartridge LC1 to be in its neutral position. Gear pump flow entering the manifold is routed out manifold port M1 and to the cutting deck motor. The return flow from the deck motor re–enters manifold port M2. The shifted solenoid valve spool allows a small amount of hydraulic flow to return to tank through a manifold sensing line which causes a pressure increase that shifts logic cartridge LC2. Hydraulic flow is routed through shifted LC2, out manifold port P2, through the oil cooler and filter and then is routed to the gear pump input. The deck motor continues to rotate as long as solenoid valve (S) is energized.

Deck motor case drain leakage returns directly to the hydraulic reservoir.

PTO Circuit Relief

Maximum mow circuit pressure is limited for each deck by a relief valve (RV1) in the hydraulic control manifold. The center and left deck relief valves are set at 3000 PSI (207 bar) and the right deck relief valve is set at 2000 PSI (138 bar).

Relief valve (RV1) and logic cartridge (LC1) work together as a two stage relief. When increased circuit resistance is met or if a cutting blade should strike an object, the pressure increase is felt at the relief valve. If the pressure should exceed the relief valve setting, the relief valve will open, creating a small amount of hydraulic flow to return to tank through a manifold sensing line. This flow causes a pressure increase that shifts logic cartridge LC1 and diverts circuit flow away from the deck motor to manifold port P2 (Fig. 12). When circuit pressure lowers, relief valve (RV1) closes which returns logic cartridge LC1 back to its neutral position allowing flow to return to the deck motor.

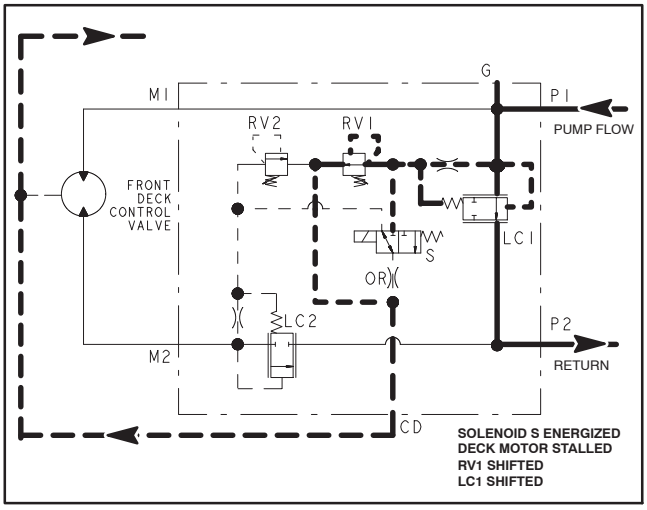


Figure 12

PTO Mow Circuit Cutting Deck Blade Braking

When the operator turns the PTO switch OFF or if a deck is raised with the PTO switch ON, PTO control manifold solenoid valve (S) is de−energized causing logic cartridge (LC1) to shift (refer to information in PTO Mow Circuit in this section). This shifted cartridge allows oil return out manifold port P2. At the same time, solenoid valve (S) in its neutral position prevents any sense line flow through the spool which causes the logic cartridge LC2 to shift to its neutral position blocking return flow from the deck motor and slowing the cutting blades (Fig. 13).

The inertia of the rotating cutting blades, however, effectively turns the deck motor into a pump causing an increase in pressure as the flow from the motor comes up against the closed logic cartridge (LC2). When this pressure builds to approximately 600 PSI (41 bar), relief valve (RV2) opens which allows a small amount of hydraulic flow to return to tank through a manifold sensing line (Fig. 14). This flow causes a pressure increase that shifts logic cartridge LC2 to once again allow oil flow from the motor (Fig. 15). When return pressure drops below 600 PSI (41 bar), relief valve (RV2) reseats and causes LC2 to close again blocking return flow from the deck motor to further slow the cutting blades. This action of the brake relief valve opening and the logic cartridge shifting occurs several times in a very short time frame as the blades finally come to a stop. Once the blades have stopped, logic cartridge LC2 remains in the neutral position to keep the deck motor from rotating.

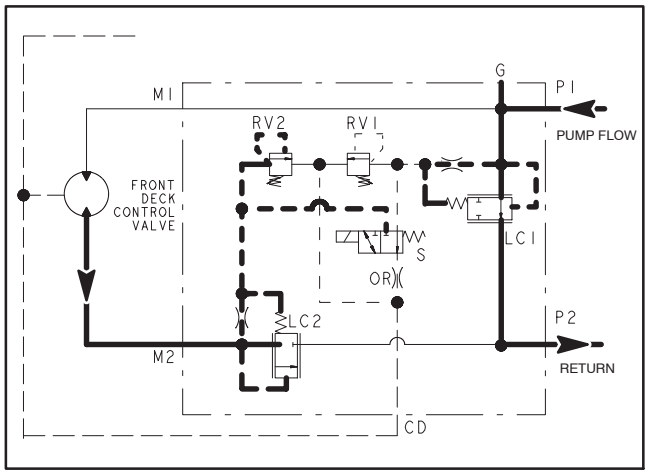


Figure 13

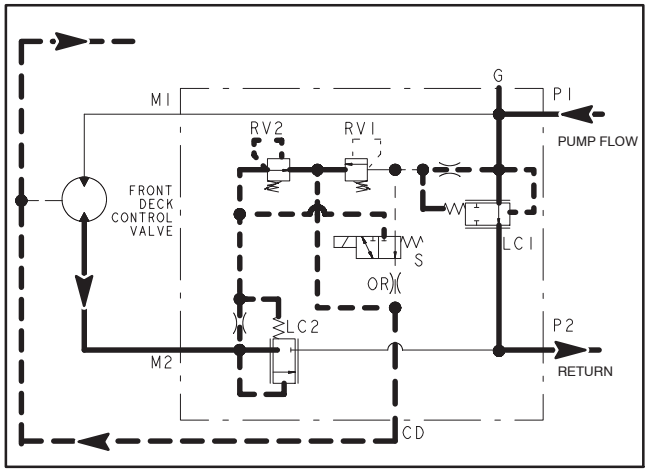


Figure 14

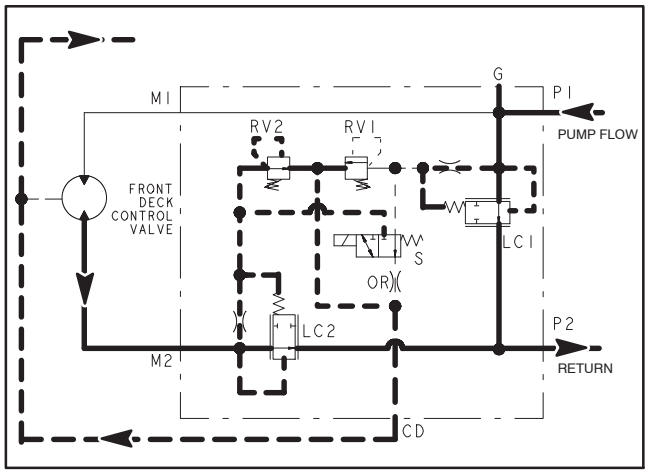
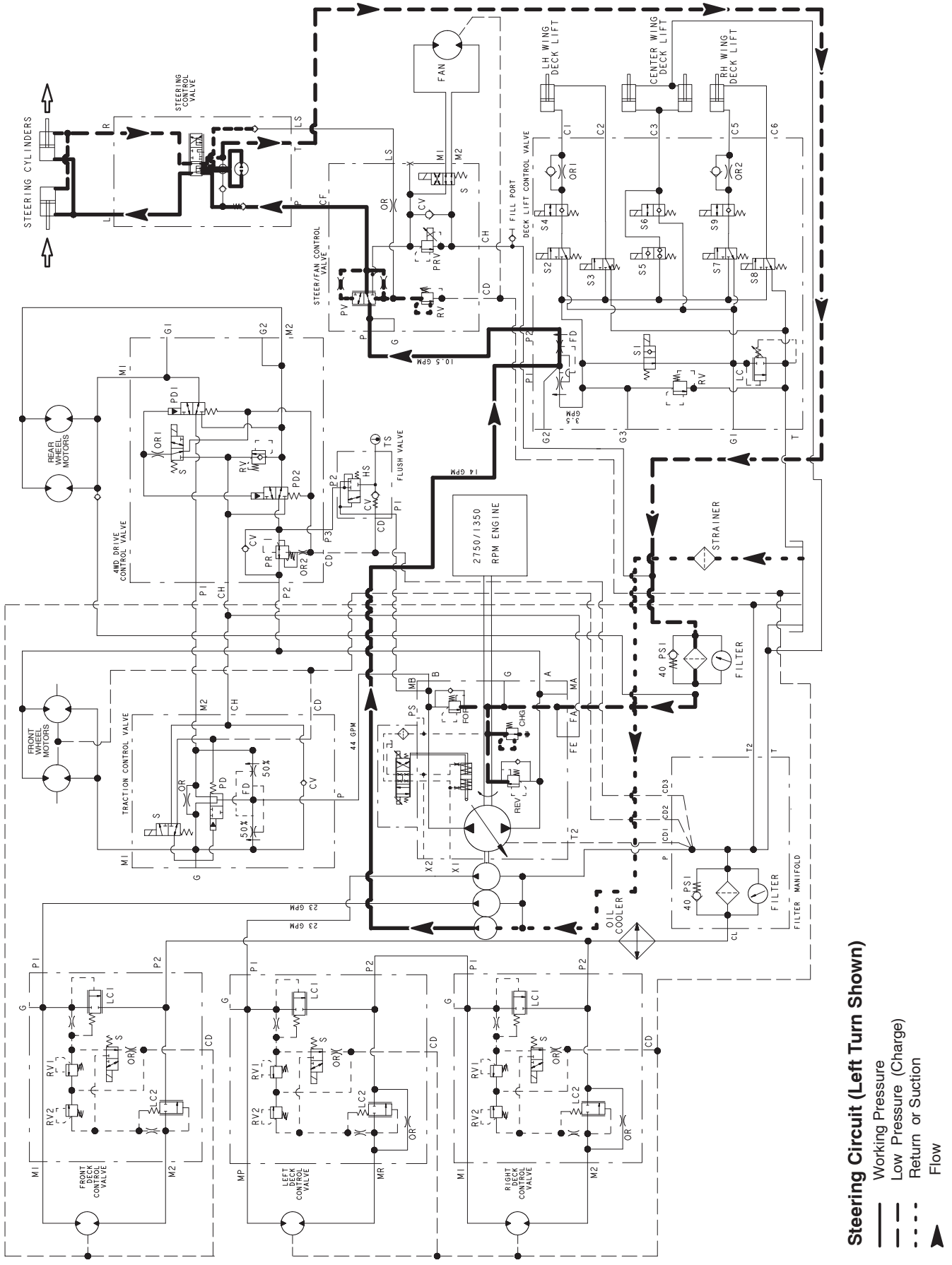


Figure 15

This page is intentionally blank.


STEERING CYLINDERS
STEERING CONTROL VALVE
FAN
LH WING DECK LIFT
CENTER WING DECK LIFT
RH WING DECK LIFT
DECK LIFT CONTROL VALVE
FILL PORT
STEER/FAN CONTROL VALVE
10.5 GPM
REAR WHEEL MOTORS
4WD DRIVE CONTROL VALVE
FLUSH VALVE
14 GPM
2750/1350 RPM ENGINE
STRAINER
40 PSI
FILTER
FRONT WHEEL MOTORS
TRACTION CONTROL VALVE
44 GPM
23 GPM
OIL COOLER
FILTER MANIFOLD
FRONT DECK CONTROL VALVE
LEFT DECK CONTROL VALVE
RIGHT DECK CONTROL VALVE
Steering Circuit (Left Turn Shown)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow

Steering Circuit

A three section gear pump is coupled to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the steering/cooling fan control manifold, the lift control manifold and the traction charge circuit. Hydraulic flow from pump section (P3) is split between the steering/cooling fan/charge circuit and the lift/lower circuit by a proportional flow divider located in the lift control manifold. This flow divider splits pump flow approximately 75% for the steering/cooling fan/charge circuit (10.5 GPM/39.7 LPM) and 25% for the lift/lower circuit (3.5 GPM/13.2 LPM).

The steering/cooling fan control manifold controls the operation of the steering control valve and the gear motor that drives the engine cooling fan. Priority valve (PV) in the manifold controls the oil flow to the steering control valve which is a closed center, load sensing valve. The steering control valve senses the oil flow that is needed for steering and the priority valve (PV) will supply the correct amount. Oil not used by steering is provided to the cooling fan motor.

With the steering wheel in the neutral, at rest position and the engine running, hydraulic oil from the lift control manifold flow divider enters the steering/cooling fan control manifold port P, flows through the priority valve (PV) and to the steering control valve where it dead heads at the spool. Oil is also sent to both ends of the (PV) spool. On one end of the spool, oil is directed to the steering relief valve (RV) and also is directed through the OR orifice and out the LS manifold port to the steering control valve. This flow provides steering load sense pressure and is directed through a small passage in the steering control valve spool and sleeve before returning to the charge circuit. While this load sense pressure is returning to the charge circuit, the priority valve (PV) spool shifts to direct pump flow to the engine fan motor circuit. Without steering input, no oil is flowing through the steering control valve.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the spool valve so that the load sense flow is blocked off. Without load sense flow, pressures on the ends of manifold priority valve (PV) start to equalize causing (PV) to move toward its neutral position which allows the needed oil to the steering control valve. Oil is routed out manifold port CF, into steering valve port P, through the steering control spool, is drawn through the rotary meter section and out the L port to the steering cylinders. The rotary meter ensures that the oil flow to the cylinders is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinders flows back through steering valve R port, the spool valve, out the T port and is then used for traction circuit charge oil.

The steering wheel and steering control valve return to the neutral position when turning is completed.

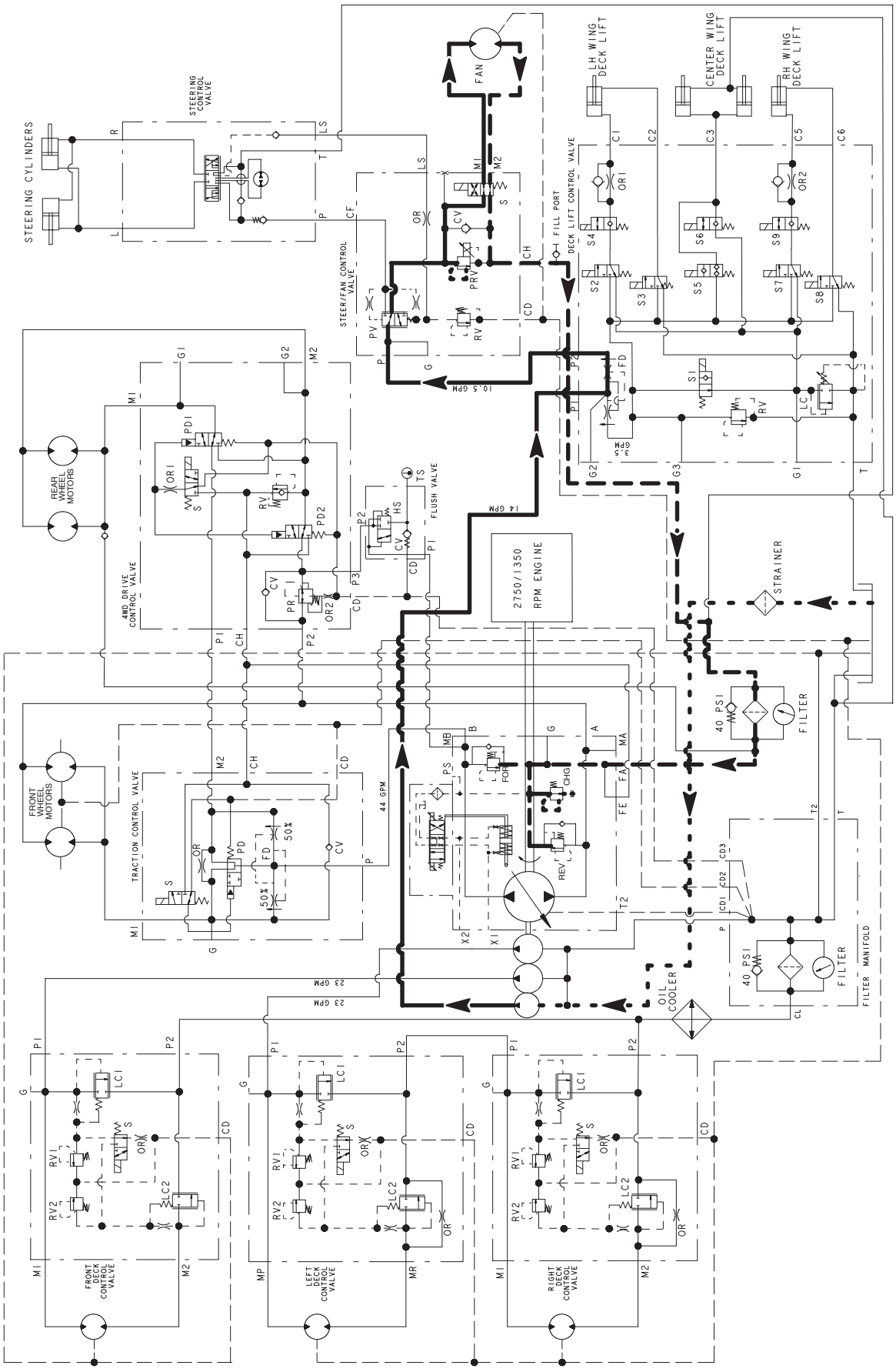
Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve so that the load sense flow is blocked off. Without load sense flow, pressures on the ends of manifold priority valve (PV) start to equalize causing (PV) to move toward its neutral position which allows the needed oil to the steering control valve. Oil is routed out manifold port CF, into steering valve port P, through the steering control spool, is drawn through the rotary meter section and out the R port to the steering cylinders. The rotary meter ensures that the oil flow to the cylinders is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinders flows back through the steering valve L port, the spool valve, out the T port and is then used for traction circuit charge oil.

The steering wheel and steering control valve return to the neutral position when turning is completed.

Steering Relief Operation

When the steering cylinders reach the end of their stroke or if a rear wheel should encounter an obstruction (e.g. a curb) while steering, the pressure in the steering circuit will rise. Relief valve (RV) in the steering/cooling fan control manifold senses this pressure increase. When this pressure builds to approximately 2100 PSI (145 bar), relief valve (RV) opens and allows hydraulic flow to return to tank. This action causes flow across the relief valve side orifice of priority valve (PV) which shifts the spool in (PV) to send oil away from the steering circuit to the fan motor circuit. Relief valve (RV) controls the action of priority valve (PV) and allows the priority valve to divert only enough oil flow to the steering circuit to maintain relief pressure.



Engine Cooling Fan Circuit (Forward Direction Shown)

- Working Pressure
- Low Pressure (Charge)
- Return or Suction
- Flow

Engine Cooling Fan Circuit

A three section gear pump is coupled to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the steering/cooling fan control manifold, the lift control manifold and the traction charge circuit. Hydraulic flow from pump section (P3) is split between the steering/cooling fan/charge circuit and the lift/lower circuit by a proportional flow divider located in the lift control manifold. This flow divider splits pump flow approximately 75% for the steering/cooling fan/charge circuit (10.5 GPM/39.7 LPM) and 25% for the lift/lower circuit (3.5 GPM/13.2 LPM).

The steering/cooling fan control manifold controls the operation of the steering control valve and the gear motor that drives the engine cooling fan. Priority valve (PV) in the manifold controls the oil flow to the steering control valve which is a closed center, load sensing valve. The steering control valve senses the oil flow that is needed for steering and the priority valve (PV) will supply the correct amount. Oil not used by steering is provided to the fan motor. The steering/cooling fan control manifold controls the speed and direction of the fan motor based on electrical output from the TEC–5002 controller.

With the steering wheel in the neutral, at rest position and the engine running, hydraulic oil from the lift control manifold flow divider enters the steering/cooling fan control manifold port P, flows through the priority valve (PV) and to the steering control valve where it dead heads at the spool. Oil is also sent to both ends of the (PV) spool. On one end of the spool, oil is directed to the steering relief valve (RV) and also is directed through the OR orifice and out the LS manifold port to the steering control valve. This flow provides steering load sense pressure and is directed through a small passage in the steering control valve spool and sleeve before returning to the charge circuit. While this load sense pressure is returning to the charge circuit, the priority valve (PV) spool shifts to direct pump flow to the cooling fan motor circuit. Without steering input, no oil is flowing through the steering control valve so all circuit oil is available for the cooling fan motor.

Oil flow from the priority valve (PV) to the cooling fan is controlled by the proportional relief valve (PRV). The (PRV) adjusts fan circuit pressure and flow based on a PWM (Pulse Width Modulation) signal from the TEC–5002 controller. The controller uses engine coolant and hydraulic oil temperatures to determine the proper PWM signal for the (PRV) valve. The fan circuit flow determines the speed of the cooling fan.

If the fan motor is stalled for any reason, the priority valve (PRV) has a secondary function as a circuit relief to limit fan motor pressure to 3300 PSI (228 bar).

When the engine is shut off, the over–running inertia load of the fan blades keeps driving the fan motor and turns it into a pump. The check valve (CV) in the steering/cooling fan control manifold will open to keep the motor circuit full of oil so the fan motor will not cavitate.

Forward Direction Fan Operation

Oil flow from the priority valve (PV) is sent through the de–energized solenoid valve (S), out manifold port M1 and then to rotate the cooling fan motor. Return flow from the motor enters the manifold at port M2, through the de–energized solenoid valve (S), out manifold port CH and is then used for traction circuit charge oil.

Reverse Direction Fan Operation

The TEC–5002 controller can reverse the cooling fan to clean debris from the radiator, oil cooler and rear intake screen. If hydraulic oil and/or engine coolant temperatures increase to an unsuitable level, the PWM signal to the (PRV) valve is sent to slow the cooling fan. The controller then energizes solenoid valve (S) in the steering/cooling fan control manifold to reverse cooling fan motor oil flow so that it runs in the reverse direction. The controller determines the length of time that the fan should be run in reverse before fan rotation is returned to the forward direction.

Special Tools

Order special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

Use to take various pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each: 1000 PSI (70 Bar), 5000 PSI (350 Bar) and 10000 PSI (700 Bar) gauges. Use gauges as recommended in Testing section of this chapter.

Toro Part Number: **TOR47009**



Figure 16

Hydraulic Tester (Pressure and Flow)

This tester requires O−ring Face Seal (ORFS) adapter fittings for use on this machine (see Hydraulic Test Fitting Kit − TOR4079 in this section).

1. INLET HOSE: Hose connected from the system circuit to the inlet side of the hydraulic tester.

2. LOAD VALVE: A simulated working load is created in the circuit by turning the valve to restrict flow.

3. LOW PRESSURE GAUGE: Low range gauge (0 to 1000 PSI) to provide accurate reading at low pressure.

   A protector valve cuts out when pressure is about to exceed the normal range for the gauge. The cutout pressure is adjustable.

4. HIGH PRESSURE GAUGE: High range gauge (0 to 5000 PSI) which accommodates pressures beyond the capacity of the low pressure gauge.

5. FLOW METER: This meter measures actual oil flow in the operating circuit with a gauge rated at 15 GPM.

6. OUTLET HOSE: A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Toro Part Number: **TOR214678**

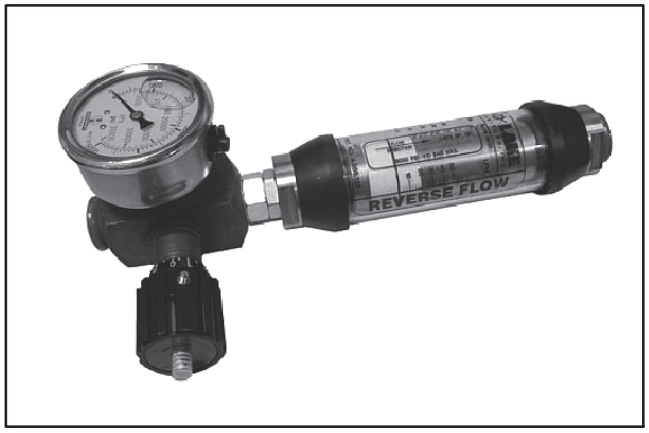


Figure 17

Hydraulic Test Fitting Kit

This kit includes a variety of O−ring Face Seal fittings to enable you to connect test gauges into the system.

The kit includes: tee's, unions, reducers, plugs, caps and male test fittings.

Toro Part Number: **TOR4079**

TORO TEST FITTING KIT (NO. TOR4079)

FITTING	TOOL NUMBER
	Swivel Nut Run Tee (2 ea.) Size — Toro No. No. 4 — TOR4079-3 No. 6 — TOR4079-12 No. 8 — TOR4079-4 No. 10 — TOR4079-5
	Plug (2 ea.) Size — Toro No. No. 4 — TOR4079-13 No. 6 — TOR4079-14 No. 8 — TOR4079-15 No. 10 — TOR4079-16
	Cap (2 ea.) Size — Toro No. No. 4 — TOR4079-17 No. 6 — TOR4079-18 No. 8 — TOR4079-19 No. 10 — TOR4079-20

FITTING	TOOL NUMBER
	Union (1 ea.) Size — Toro No. No. 6 to No. 8 — TOR4079-8 No. 10 to No. 8 — TOR4079-2 No. 8 to No. 8 — TOR4079-9
	Reducer (1 ea.) Size — Toro No. No. 10 to No. 8 — TOR4079-7 No. 12 to No. 8 — TOR4079-6
	Test Cap Fitting (2 ea.) Size — Toro No. No. 4 — TOR4079-10 No. 6 — TOR4079-11 No. 8 — TOR4079-21 No. 10 — TOR4079-1
	Test Fitting (2 ea.) Size — Toro No. 7/16−20 ORB — TOR4079-22 1/8" Pipe Thd. — TOR4079-23

Figure 18

Measuring Container

Use this container for doing hydraulic motor efficiency testing (motors with case drain lines only). Measure efficiency of a hydraulic motor by restricting the outlet flow from the motor and measuring leakage from the case drain line while the motor is pressurized by the hydraulic system.

The table in Figure 20 provides gallons per minute (GPM) conversion for measured milliliter or ounce motor case drain leakage.

Toro Part Number: **TOR4077**



Figure 19

GPM	Milliliters in 15 sec.	Ounces in 15 sec.
.1	95	3.2
.2	189	6.4
.3	284	9.6
.4	378	12.8
.5	473	16.0
.6	568	19.2
.7	662	22.4
.8	756	25.6
.9	852	28.8
1.0	946	32.0

Figure 20

Rear Wheel Hub Puller

The rear wheel hub puller allows safe removal of the wheel hub from the rear wheel motor shaft.

Toro Part Number: **TOR6100**

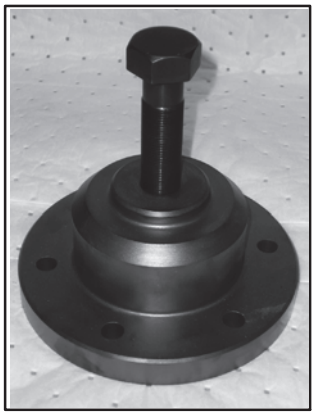


Figure 21

Troubleshooting

The charts that follow contain information to assist in troubleshooting hydraulic circuit problems. There may possibly be more than one cause for a machine malfunction.

Refer to the Testing section of this Chapter for precautions and specific hydraulic test procedures.

General Hydraulic Problems

Problem	Possible Causes
Hydraulic system operates hot.	Engine RPM is too low. Hydraulic reservoir oil level is low. Hydraulic oil is contaminated or the wrong type. Brakes are applied or sticking. Piston pump by–pass valve is open or damaged. Cooling system is not operating properly. Charge pressure is low. Traction circuit pressure is incorrect. Pump(s) or motor(s) are damaged.
Hydraulic oil in reservoir foams.	Hydraulic reservoir oil level is low. Wrong type of oil is in the hydraulic system. Air is leaking in suction line.
Hydraulic oil leak(s).	Fitting(s), hose or tube loose or damaged. Missing or damaged O-ring.

Traction Problems

Problem	Possible Causes
Machine operates in one direction only.	System charge check valve and/or system relief valve is defective. Pilot direction valve in 4WD control manifold is damaged or sticking. Traction control potentiometer is faulty.
Traction pedal is sluggish.	Traction control pedal assembly is stuck or binding. Charge pressure is low. Piston pump servo control valve is damaged.
Machine travels too far before stopping when the traction pedal is released.	Traction control pedal assembly is binding or out of adjustment. Piston pump servo control valve is damaged. Traction pedal does not return to neutral.
Traction power is lost or unit will not operate in either direction.	Hydraulic reservoir oil level is low. Brakes are applied or sticking. Charge pressure is low. Piston pump bypass valve is open or damaged. Traction control potentiometer is damaged or disconnected.
Four wheel drive will not engage.	An electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve on 4WD control manifold is faulty. Cartridge valve in 4WD control manifold is damaged or sticking.
Four wheel drive will not disengage.	An electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve on 4WD control manifold is faulty. Cartridge valve in 4WD control manifold is damaged or sticking.

PTO Problems

Problem	Possible Causes
Cutting decks do not operate. **NOTE:** Decks have to be fully lowered and traction speed needs to be in MOW for decks to operate.	An electrical problem exists (see Chapter 5 – Electrical System). Gear pump is worn or damaged.
One cutting deck motor will not operate.	An electrical problem exists (see Chapter 5 – Electrical System). Cutting deck problem exists (see Chapter 8 – Cutting Decks). System pressure to the affected deck motor is low. Woodruff key on affected deck motor is damaged (motor rotates but deck belt and blades don't rotate). Solenoid valve in deck PTO control manifold is faulty. Cartridge valve in deck PTO control manifold is damaged or sticking. Deck motor or gear pump section is damaged.
All cutting deck motors operate slowly.	Engine RPM is low. Cutting deck problem exists (see Chapter 8 – Cutting Decks). Deck motor or gear pump section is damaged.
Cutting deck stops under load.	Relief valve in deck PTO control manifold is by–passing. Cutting deck problem exists (see Chapter 8 – Cutting Decks). Deck motor has internal leakage (by–passing oil). Cutting deck gear pump section is inefficient.

Steering Circuit Problems

Problem	Possible Cause
Steering inoperative or sluggish.	Steering components (e.g. tie rods, steering cylinder ends) are worn or binding. Steering cylinder is binding. Oil level in hydraulic reservoir is low (other hydraulic systems affected as well). Steering relief valve (RV) in steering/cooling fan control valve is stuck or damaged. Flow divider (FD) in deck lift control valve is faulty. Proportional valve (PV) in steering/cooling fan control valve is faulty. Steering cylinder leaks internally. Steering control valve is worn or damaged. Gear pump section (P3) is worn or damaged (NOTE: A worn or damaged gear pump section (P3) will also affect the traction (charge) and lift circuits).

Lift/Lower Problems

Problem	Possible Causes
Cutting deck will not raise.	Engine RPM is too low. Hydraulic oil level in reservoir is low. Lift arm pivots are binding. Lift cylinder is damaged. Relief valve in lift control manifold is stuck. Pilot valve in lift control manifold is damaged or sticking. Proportional flow divider in lift control manifold is faulty. Gear pump section for lift control manifold is worn or damaged.
Cutting deck raises, but will not stay up. **NOTE:** Lift cylinders cannot provide an absolutely perfect seal. The lift arms will eventually lower if left in the raised position during storage.	Lift circuit lines or fittings are leaking. Lift cylinder is damaged.
Side cutting deck drop too fast.	Orifice in lift control valve is missing or damaged. Check valve in lift control valve is faulty.
Side cutting deck drop too slow.	Orifice in lift control valve is plugged or faulty. Lift arm pivots are binding. Lift cylinder is damaged.
Cutting deck will not lower.	Lift arm pivots are binding. Lift cylinder is damaged. Counterbalance pressure is excessive. Lift control valve is worn or damaged. Pilot valve in lift control manifold is damaged or sticking.

Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks (see the Special Tools section in this Chapter).

Before Performing Hydraulic Tests

IMPORTANT: All obvious areas such as oil supply, filter, binding linkages, loose fasteners or improper adjustments must be checked before assuming that a hydraulic component is the source of the problem.

Precautions for Hydraulic Testing

CAUTION

Failure to use gauges with recommended pressure (PSI/bar) rating as listed in test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.

CAUTION

All testing should be performed by two (2) people. One person should be in the seat to operate the machine and the other should read and record test results.

CAUTION

Before opening the hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. See Relieving Hydraulic System Pressure in the General Information section of this chapter.

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Do not use hands to search for leaks; use paper or cardboard. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved and all rotating machine parts must be stopped. Stop engine; lower or support attachments.

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination will cause excessive wear of hydraulic components.

2. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.

3. The engine must be in good operating condition. Use a phototac when performing a hydraulic test. Engine speed can affect the accuracy of the tester readings.

4. The inlet and the outlet hoses for tester with pressure and flow capabilities must be properly connected and not reversed to prevent damage to the hydraulic tester or components.

5. When using hydraulic tester with pressure and flow capabilities, open tester load valve completely before starting the engine to minimize the possibility of damaging components.

6. Install fittings finger tight and far enough to make sure that they are not cross-threaded before tightening them with a wrench.

7. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.

8. Check oil level in the hydraulic reservoir. After connecting test equipment, make sure tank is full.

9. Check control linkages for improper adjustment, binding or broken parts.

10. After installing test gauges, run engine at low speed and check for any hydraulic oil leaks.

11. All hydraulic tests should be made with the hydraulic oil at normal operating temperature.

12. Before returning machine to use, make sure that hydraulic reservoir has correct fluid level. Also, check for hydraulic leaks after test equipment has been removed from hydraulic system.

Which Hydraulic Tests Are Necessary?

Before beginning any hydraulic test, identify if the problem is related to the traction circuit, PTO (mow) circuit, lift circuit or steering/engine cooling fan circuit. Once the faulty system has been identified, perform tests that relate to that circuit.

1. If a traction circuit problem exists, consider performing one or more of the following tests: Traction Circuit Charge Pressure, Traction Circuit Relief Pressure, Rear Traction Circuit (RV) Relief Pressure, Traction Circuit Reducing Valve (PR) Pressure and/or Counterbalance Pressure Tests.

2. If a PTO (mow) circuit problem exists, consider performing one or more of the following tests: Cutting Deck Circuit Pressure.

3. If a lift circuit problem exists, consider performing one or more of the following tests: Lift/Lower Circuit Relief Pressure, Counterbalance Pressure and/or Gear Pump (P3) Flow Tests.

4. If a steering/engine cooling fan circuit problem exists, consider performing one or more of the following tests: Steering Circuit Relief Pressure, Steering Cylinder Internal Leakage and/or Gear Pump (P3) Flow Tests.

Traction Circuit Charge Pressure Test (Using Pressure Gauge)

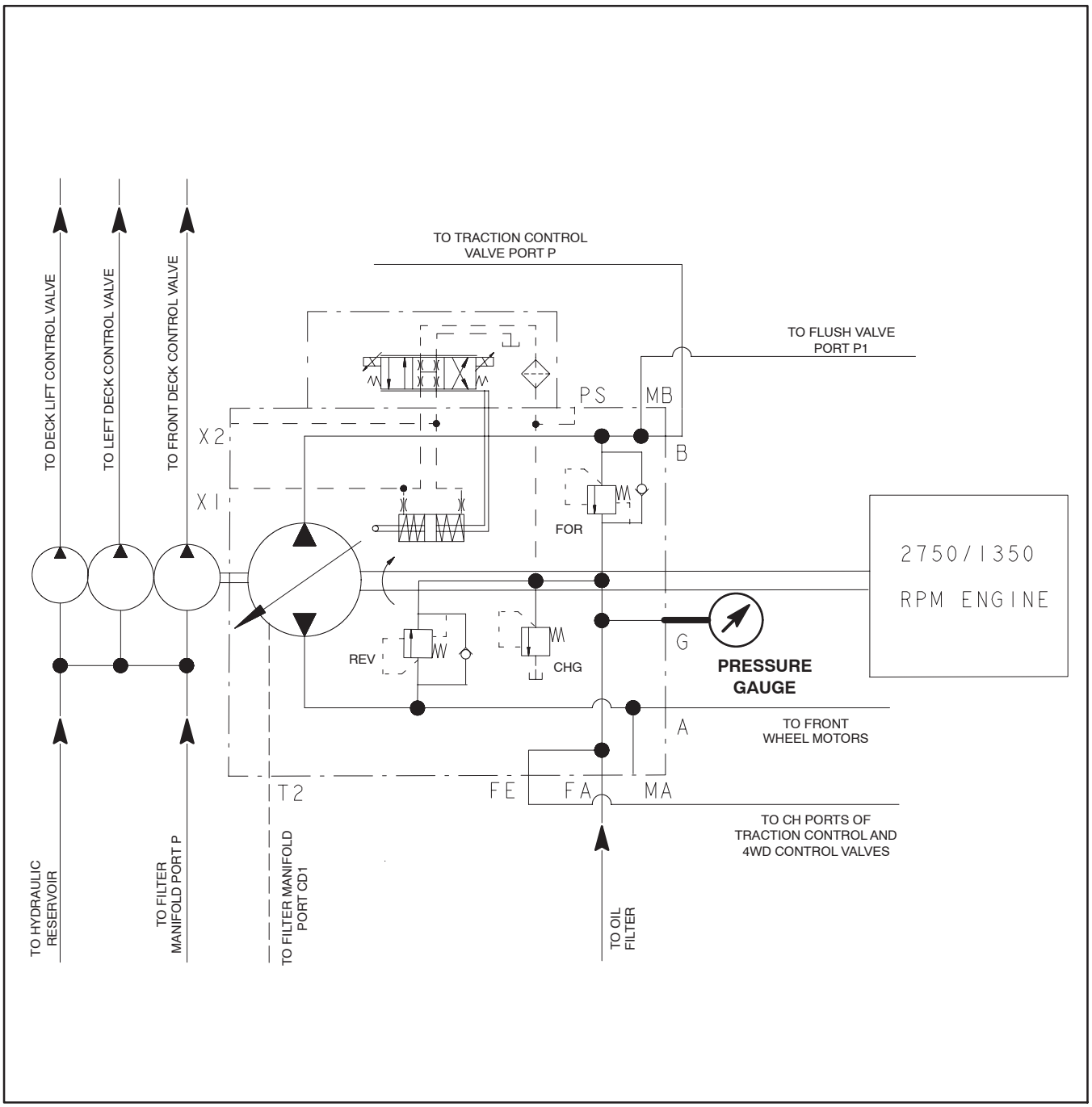


Figure 22

The traction circuit charge pressure test should be performed to make sure that the traction charge circuit is functioning correctly.

Procedure for Traction Circuit Charge Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 1000 PSI (70 Bar) pressure gauge onto charge pressure test port fitting on hydrostat (Fig. 23).

4. After installing pressure gauge, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

5. Operate the engine at full engine speed **(2750 RPM)** with no load on the hydraulic system.

GAUGE READING TO BE 315 to 345 PSI (21.8 to 23.7 bar).

6. Stop engine and record test results.

7. If there is no pressure, or pressure is low, check the following items:

A. Restriction in gear pump intake line or reservoir strainer.

B. Inspect charge pressure relief valve located in the hydrostat (Fig. 23). The charge pressure relief valve is adjusted with shims. If charge pressure is low, shim(s) can be added between relief valve cap and spring. If charge pressure is high, shim(s) can be removed from between relief valve cap and spring.

C. Consider a leaking check/relief valve in the hydrostat.

D. Leakage in the traction control manifold, the mow/transport manifold and/or the steering/cooling fan manifold will affect charge circuit pressure. Consider that damaged cartridge seals in these manifolds will cause low charge circuit pressure.

E. If necessary, check for internal damage or worn parts in gear pump (P3). A worn or damaged gear pump (P3) will also affect deck lift/lower, steering and engine cooling fan operation.

8. Also, with the pressure gauge still connected to the charge pressure test port, take a gauge reading while operating the machine in forward and reverse. Start the engine, release parking brake and put throttle at full engine speed **(2750 RPM)**. Push the traction pedal forward, then reverse.

GAUGE READING TO BE 315 to 345 PSI (21.8 to 23.7 bar).

9. If charge pressure is good under no load (step 5), but drops below specification when under traction load (step 8), the piston (traction) pump and/or wheel motor(s) should be suspected of wear and inefficiency. When the pump and/or traction motor(s) are worn or damaged, the charge pump is not able to keep up with internal leakage in traction circuit components.

10. Disconnect pressure gauge from test port.

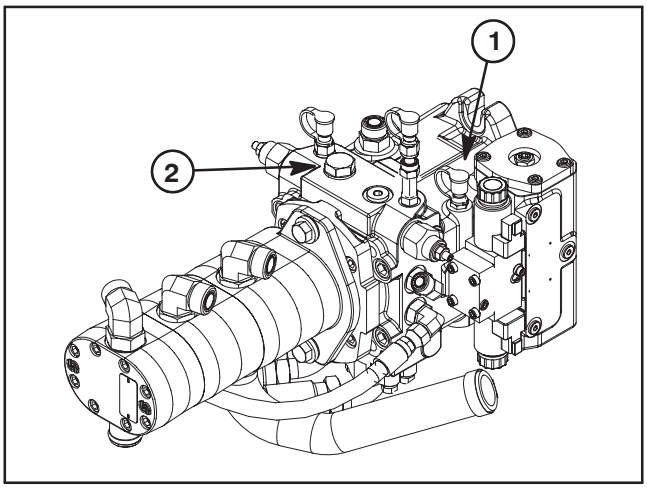


Figure 23

1. **Hydrostat port G**
2. **Charge relief valve**

Traction Circuit Relief Pressure Test (Using Pressure Gauge)

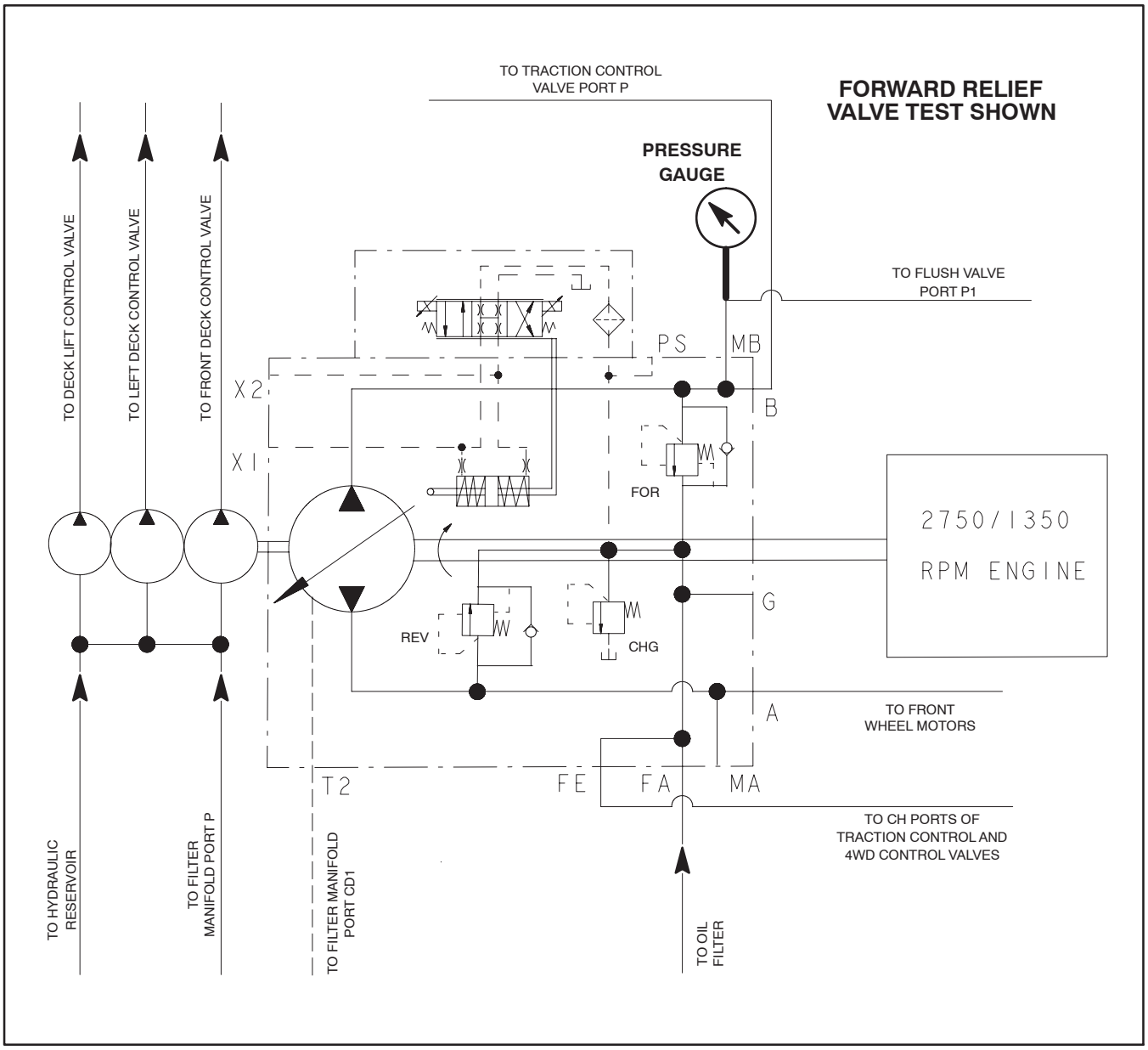


Figure 24

The traction circuit relief pressure test should be performed to make sure that forward and reverse traction circuit relief pressures are correct.

Procedure for Traction Circuit Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

CAUTION

Perform Traction Circuit Relief Pressure Test in an open area, away from people and obstructions.

2. Drive machine to an open area, lower cutting decks, turn the engine off and apply the parking brake.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 10,000 PSI (700 Bar) pressure gauge to traction circuit test port for function to be checked (Fig. 25).

4. After installing pressure gauge, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

5. Sit on seat and operate the engine at full speed **(2750 RPM)**. Release parking brake.

6. Apply service brakes fully and slowly depress the traction pedal in the appropriate direction (forward or reverse). While pushing traction pedal, look at pressure reading on gauge:

GAUGE READING TO BE:
4230 to 4430 PSI (292 to 305 bar) in forward
5230 to 5430 PSI (361 to 374 bar) in reverse

7. Release traction pedal and stop engine. Record test results.

8. If traction pressure is low, inspect traction pump relief valves (Fig. 25). Clean or replace valves as necessary. These cartridge type valves are factory set and are not adjustable. If relief valves are in good condition, traction pump or wheel motors should be suspected of wear and inefficiency.

9. Disconnect pressure gauge from test port.

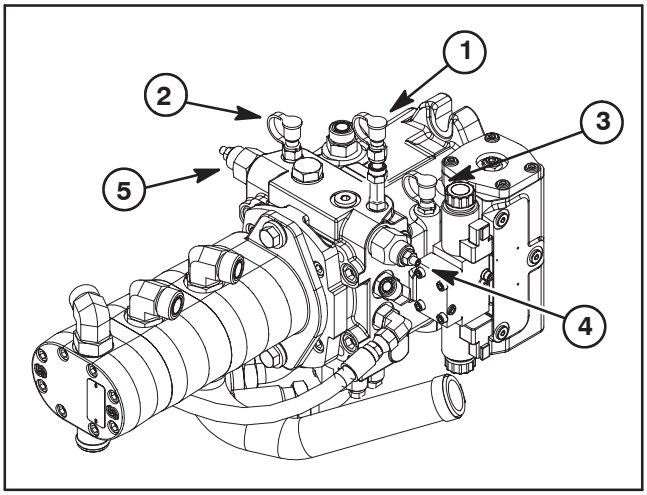


Figure 25

1. **Forward test port**
2. **Reverse test port**
3. **Charge pressure port**
4. **Forward relief valve**
5. **Reverse relief valve**

Rear Traction Circuit (RV) Relief Pressure Test (Using Pressure Gauge)

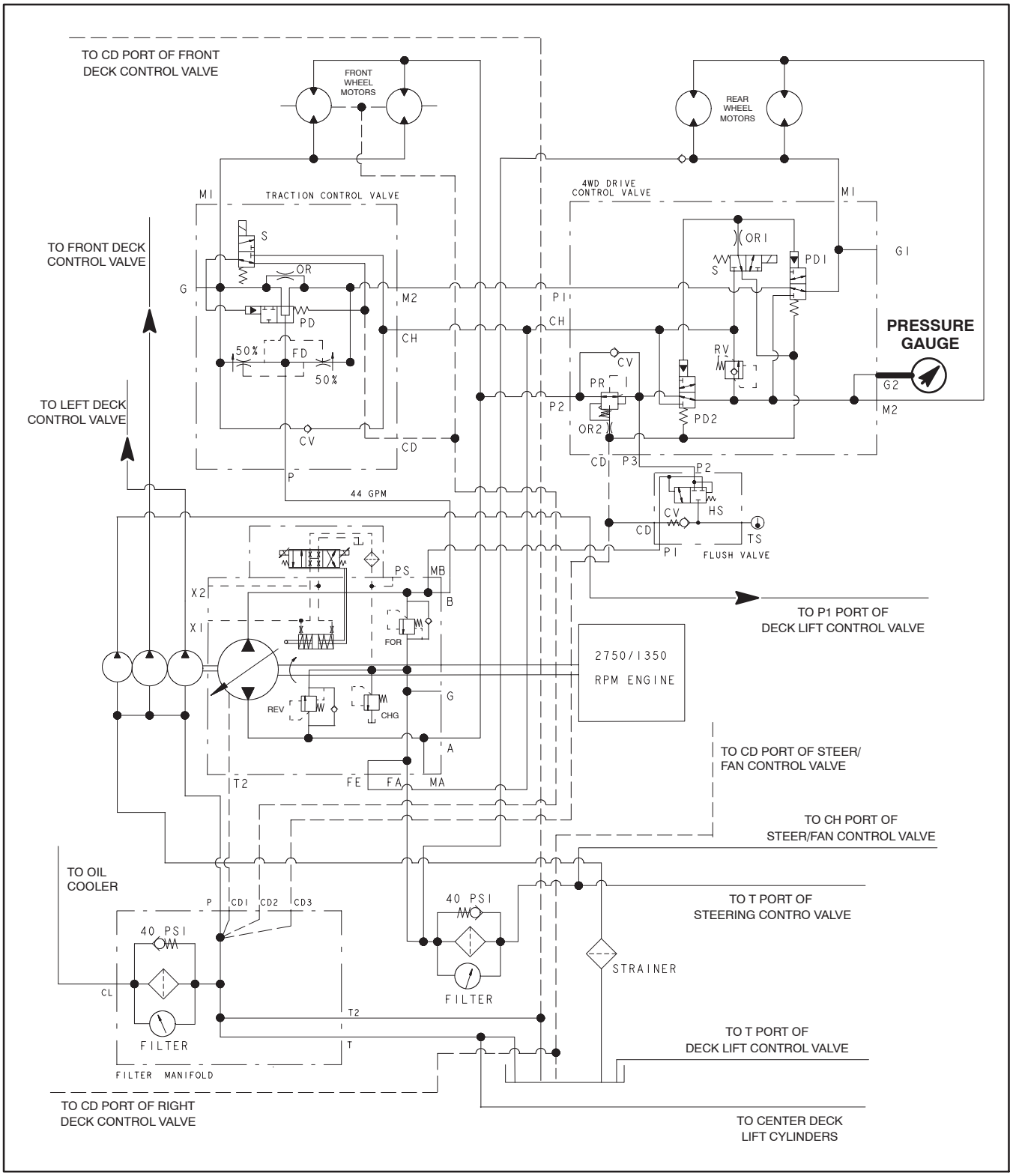


Figure 26

Procedure for Rear Traction Circuit (RV) Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 5000 PSI (350 Bar) gauge to test port G2 on 4WD control manifold on right side of machine (Fig. 27).

4. After installing pressure gauge, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

5. Operate the engine at full engine speed **(2750 RPM)**.

6. Operate the machine in 4WD with the cutting decks lowered. Drive down a slope in a forward direction, decrease pressure on the traction pedal and monitor the pressure gauge. Pressure should increase until the relief valve (RV) lifts. Record test results.

GAUGE READING TO BE:
1200 PSI (83 bar) (approximate).

7. If necessary, adjust the relief valve (RV) so that pressure is correct (see Adjustable Pressure Valve in the Adjustments section of this chapter). Relief valve (RV) is located on the rear side of the 4WD control manifold (Fig. 27).

8. Disconnect pressure gauge from manifold test port.

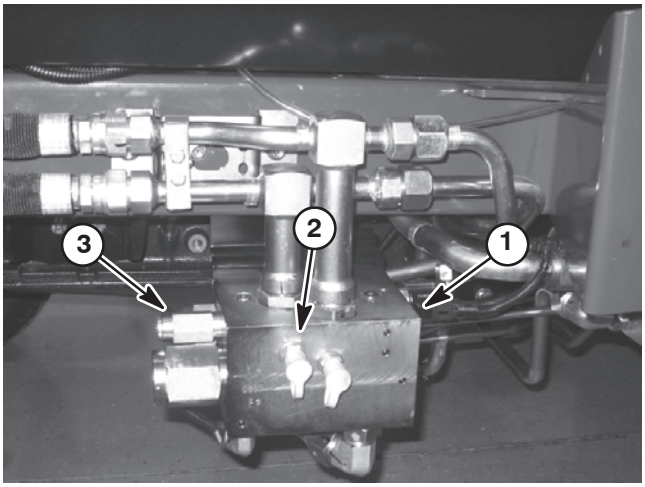


Figure 27

1. **4WD control manifold**
2. **Test port G2**
3. **Relief valve RV**

Traction Circuit Reducing Valve (PR) Pressure Test (Using Pressure Gauge)

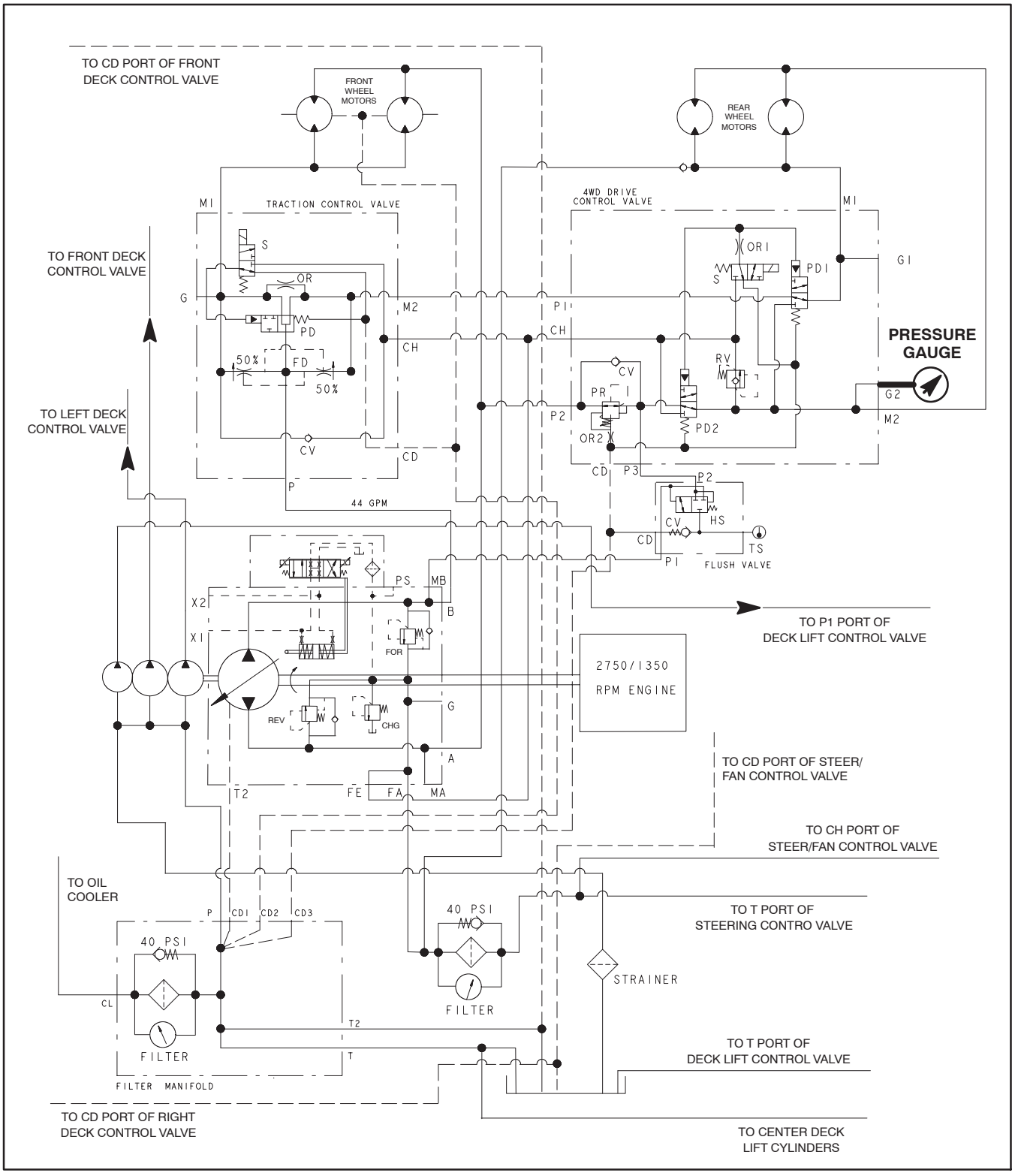


Figure 28

Procedure for Traction Circuit Reducing Valve (PR) Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 1000 PSI (70 Bar) pressure gauge to test port G2 on 4WD control manifold on right side of machine (Fig. 29).

4. After installing pressure gauge, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

5. Operate the engine at full engine speed **(2750 RPM)**.

6. Sit on seat and release parking brake. Apply service brakes fully and slowly depress the traction pedal in the **reverse** direction. While pushing traction pedal, look at pressure reading on gauge:

GAUGE READING TO BE:
650 PSI (45 bar) (approximate).

7. Stop engine and record test results.

8. If necessary, adjust the pressure reducing valve (PR) so that pressure is correct (see Adjustable Pressure Valve in the Adjustments section of this chapter). The pressure reducing valve (PR) is located on the lower, rear side of the 4WD control manifold (Fig. 29).

NOTE: Do not remove the reducing valve from the hydraulic manifold for adjustment.

9. Disconnect pressure gauge from test port.

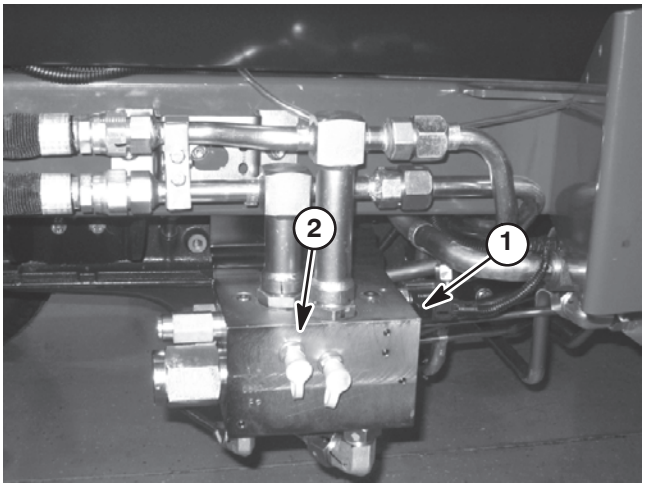


Figure 29

1. 4WD manifold
2. Test port G2

Counterbalance Pressure Test (Using Pressure Gauge)

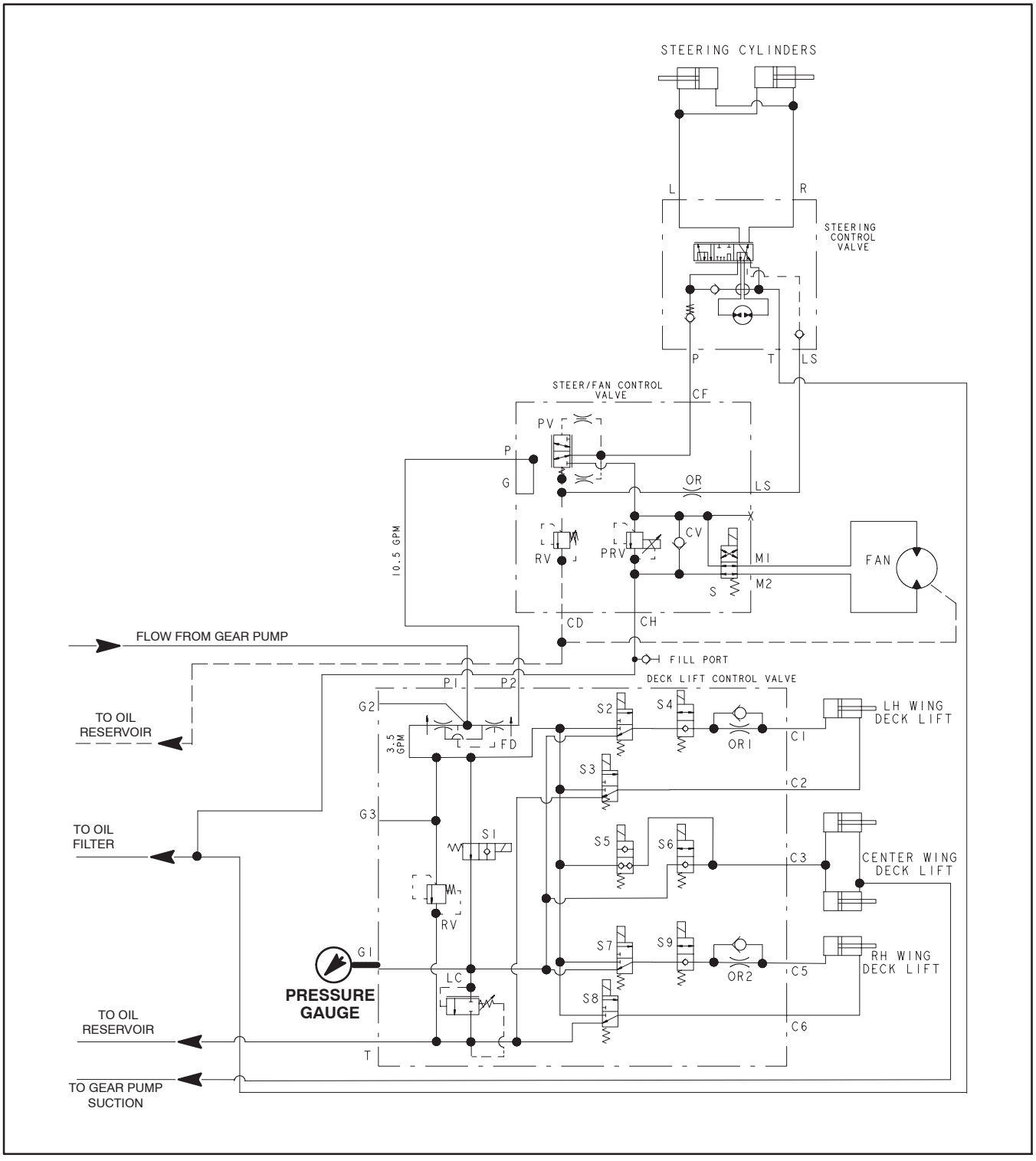


Figure 30

Procedure for Counterbalance Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 1000 PSI (70 Bar) pressure gauge to test port G1 on lift control manifold (Fig. 31).

4. After installing pressure gauge, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

5. Operate the engine at full engine speed **(2750 RPM)** with no load on the system. **Do not engage the cutting decks**.

GAUGE READING TO BE:
360 to 380 PSI (24.9 to 26.2 bar).

6. Stop engine and record test results.

7. If necessary, adjust the counterbalance valve so that pressure is correct (see Adjustable Pressure Valve in the Adjustments section of this chapter). The counterbalance valve is located on the rear side of the lift control manifold (Fig. 31).

8. Disconnect pressure gauge from test port.

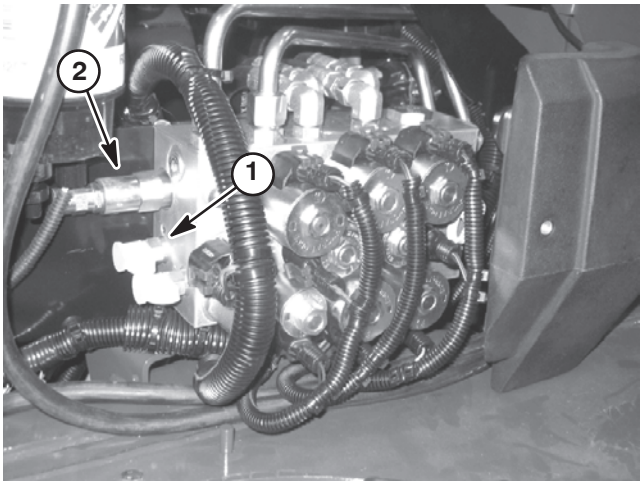


Figure 31

1. Counterbalance test port **2. Counterbalance valve**

Cutting Deck Circuit Pressure Test (Using Pressure Gauge)

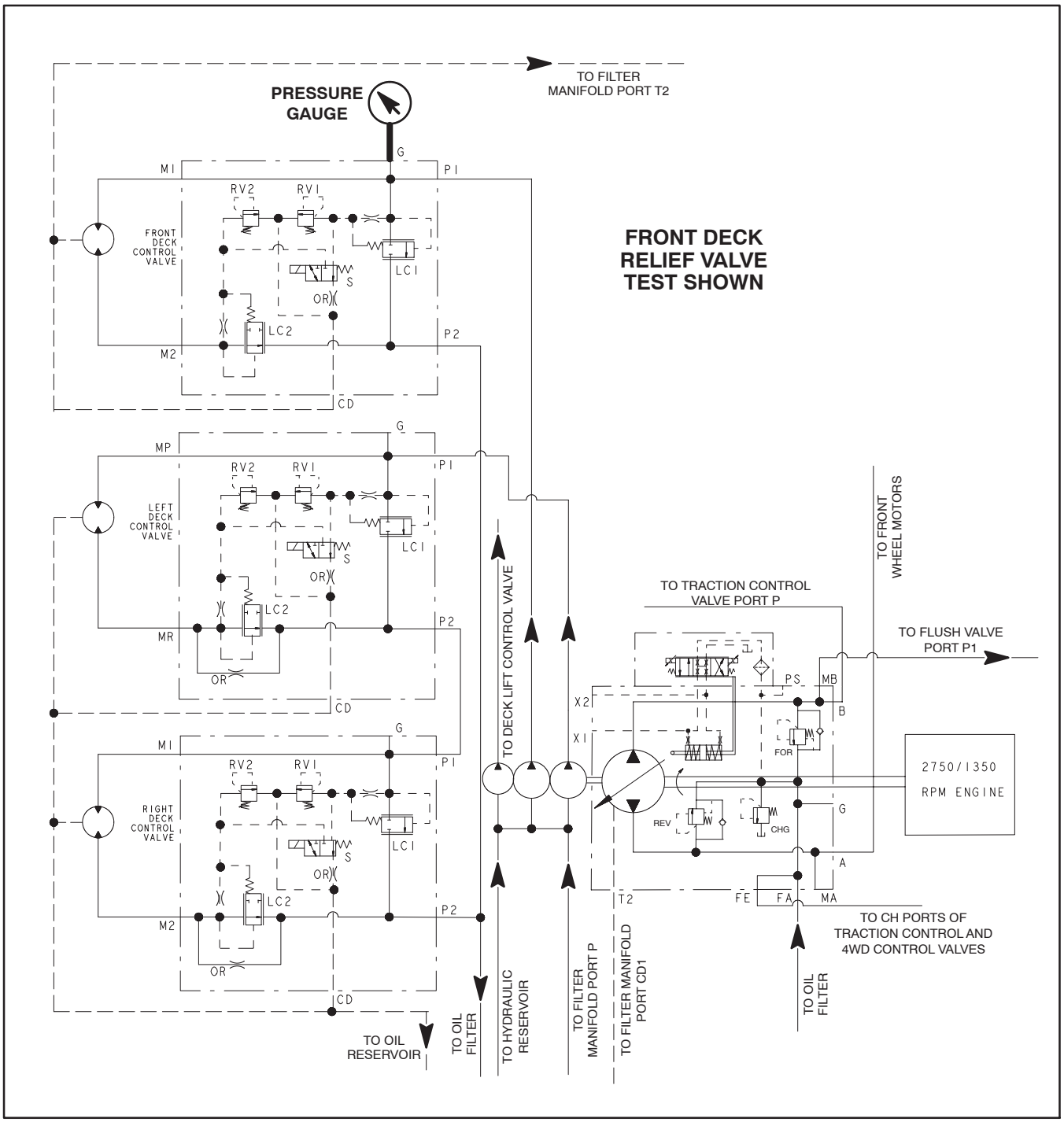


Figure 32

The cutting deck circuit pressure test should be performed to make sure that the cutting deck circuit pressures are correct.

Procedure for Cutting Deck Circuit Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Install 5000 PSI (350 Bar) pressure gauge with hydraulic hose attached to deck manifold test port G for the deck to be tested (Fig. 33, 34 and 35).

4. After installing pressure gauge, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

CAUTION

Keep away from cutting decks during test to prevent personal injury from the cutting blades.

5. Sit on seat and operate the engine at full speed **(2750 RPM)**. Release parking brake and engage the cutting decks.

6. Watch pressure gauge carefully while mowing with the machine.

7. Cutting deck circuit pressure should be from **1000 to 3200 PSI (69 to 220 bar) (1000 to 2100 PSI (69 to 144 bar) for RH wing deck)** and will vary depending on mowing conditions.

8. Disengage cutting decks and shut off engine. Record test results.

9. Disconnect pressure gauge with hose from manifold test port.

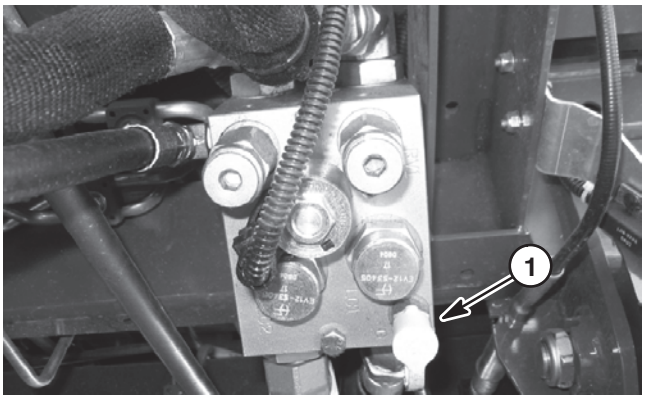


Figure 33

1. **Center deck circuit pressure test port G**

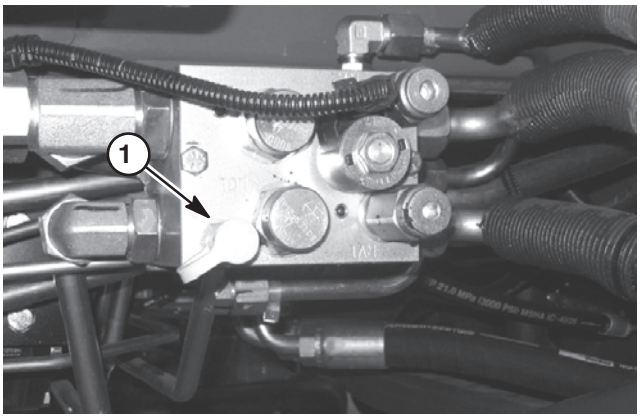


Figure 34

1. **Right wing deck circuit pressure test port G**

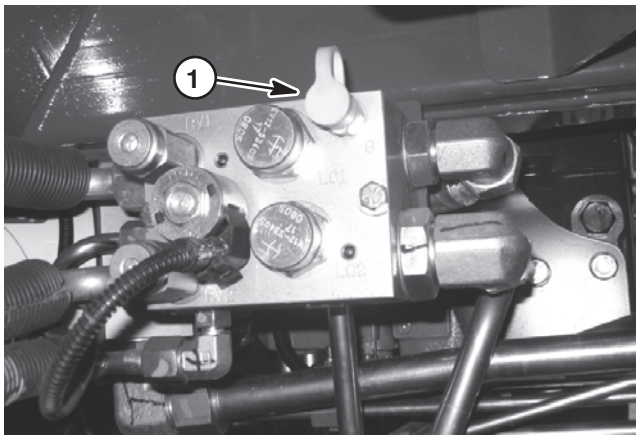


Figure 35

1. **Left wing deck circuit pressure test port G**

Lift/Lower Circuit Relief Pressure Test (Using Pressure Gauge)

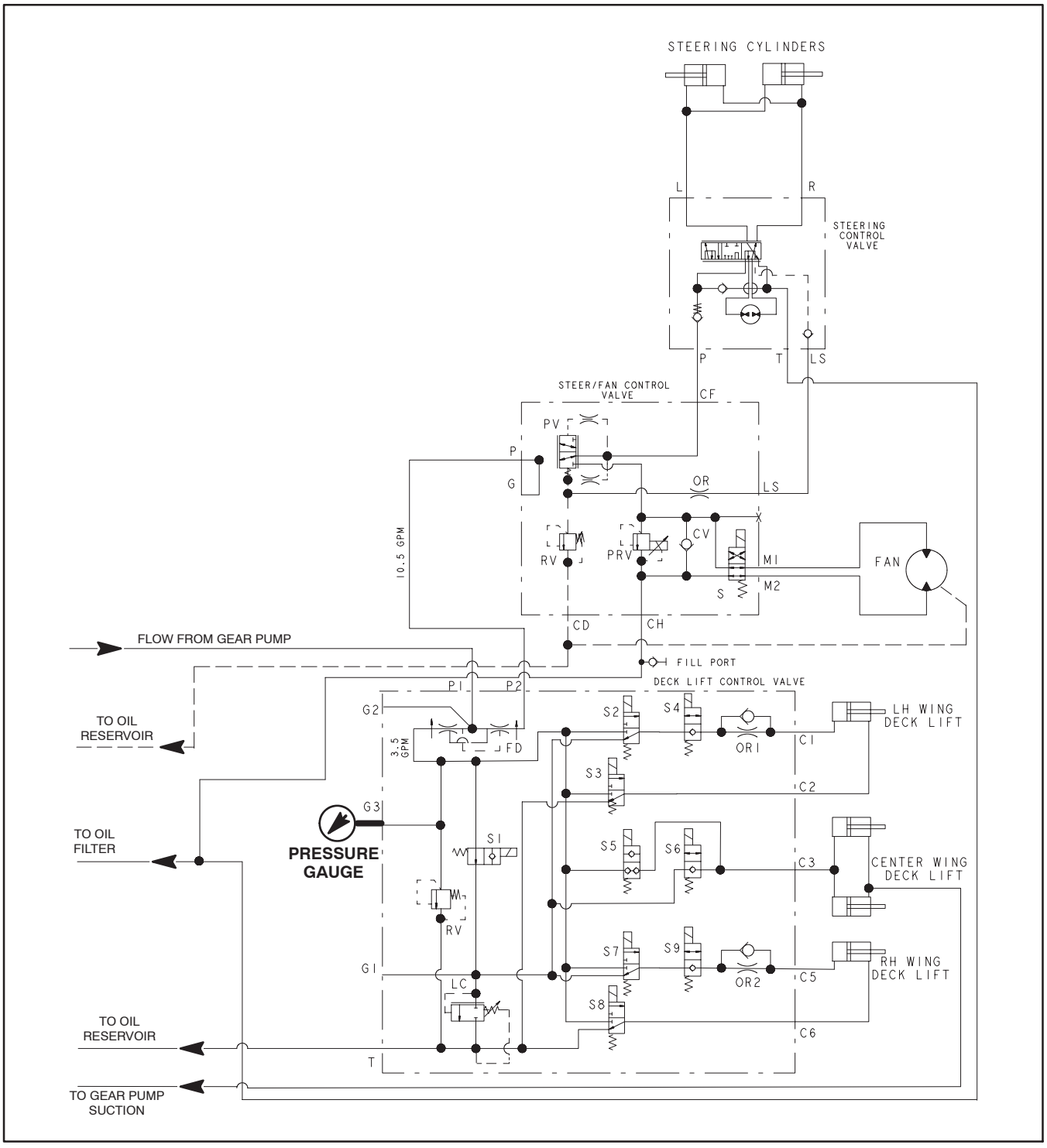


Figure 36

The lift/lower circuit relief valve pressure test should be performed to make sure that the lift circuit relief pressure is correct.

Procedure for Lift/Lower Circuit Relief Pressure Test

NOTE: Before attempting to check or adjust lift pressure, make sure that counterbalance pressure is correctly adjusted.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 5000 PSI (350 Bar) pressure gauge to test port G3 on lift control manifold (Fig. 37). Route gauge hose to allow operator to view the gauge.

4. After installing pressure gauge, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

5. Sit on the seat and operate the engine at full speed **(2750 RPM)**.

6. While sitting on the seat, press and hold one of the deck lift switches to fully raise a cutting deck. Momentarily hold the switch with the deck fully raised while looking at the gauge.

GAUGE READING TO BE:
1350 PSI (93 bar) (approximate).

7. Stop engine and record test results.

NOTE: Do not remove relief valve from the hydraulic manifold for adjustment.

8. If relief pressure is too high, remove cap on relief valve (RV) in lift control manifold (Fig. 37). Adjust valve by rotating adjustment socket counterclockwise to decrease relief pressure (see Adjustable Pressure Valve in the Adjustments section of this chapter). A 1/8 turn on the socket will make a measurable change in relief pressure. Recheck relief pressure and readjust as needed. Install and tighten cap on relief valve after adjustment.

9. If relief pressure is too low, check for restriction in gear pump intake line or reservoir strainer. Check the lift cylinder for internal leakage. If cylinder is not leaking, remove cap on relief valve (RV) in lift control manifold (Fig. 37) and adjust valve by rotating adjustment socket clockwise to increase relief pressure (see Adjustable Pressure Valve in the Adjustments section of this chapter). A 1/8 turn on the socket will make a measurable change in relief pressure. Recheck relief pressure and readjust as needed. If pressure is still too low, gear pump (P3) or lift cylinder(s) should be suspected of wear, damage or inefficiency. Install and tighten cap on relief valve after adjustment.

10. Disconnect pressure gauge from test port.

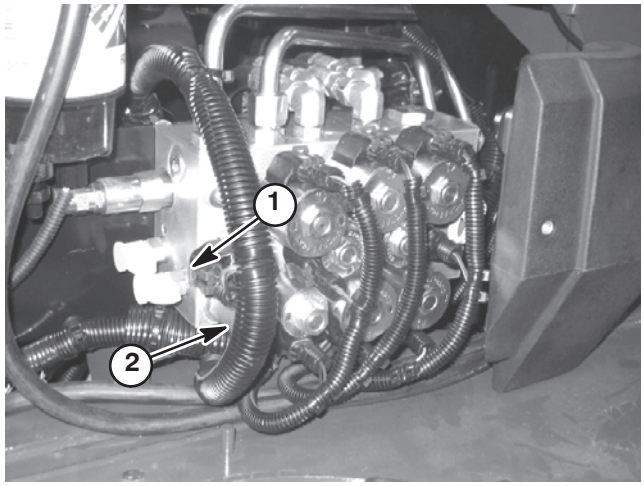


Figure 37

1. Lift circuit test port G3
2. Relief valve RV

Steering Circuit Relief Pressure Test (Using Pressure Gauge)

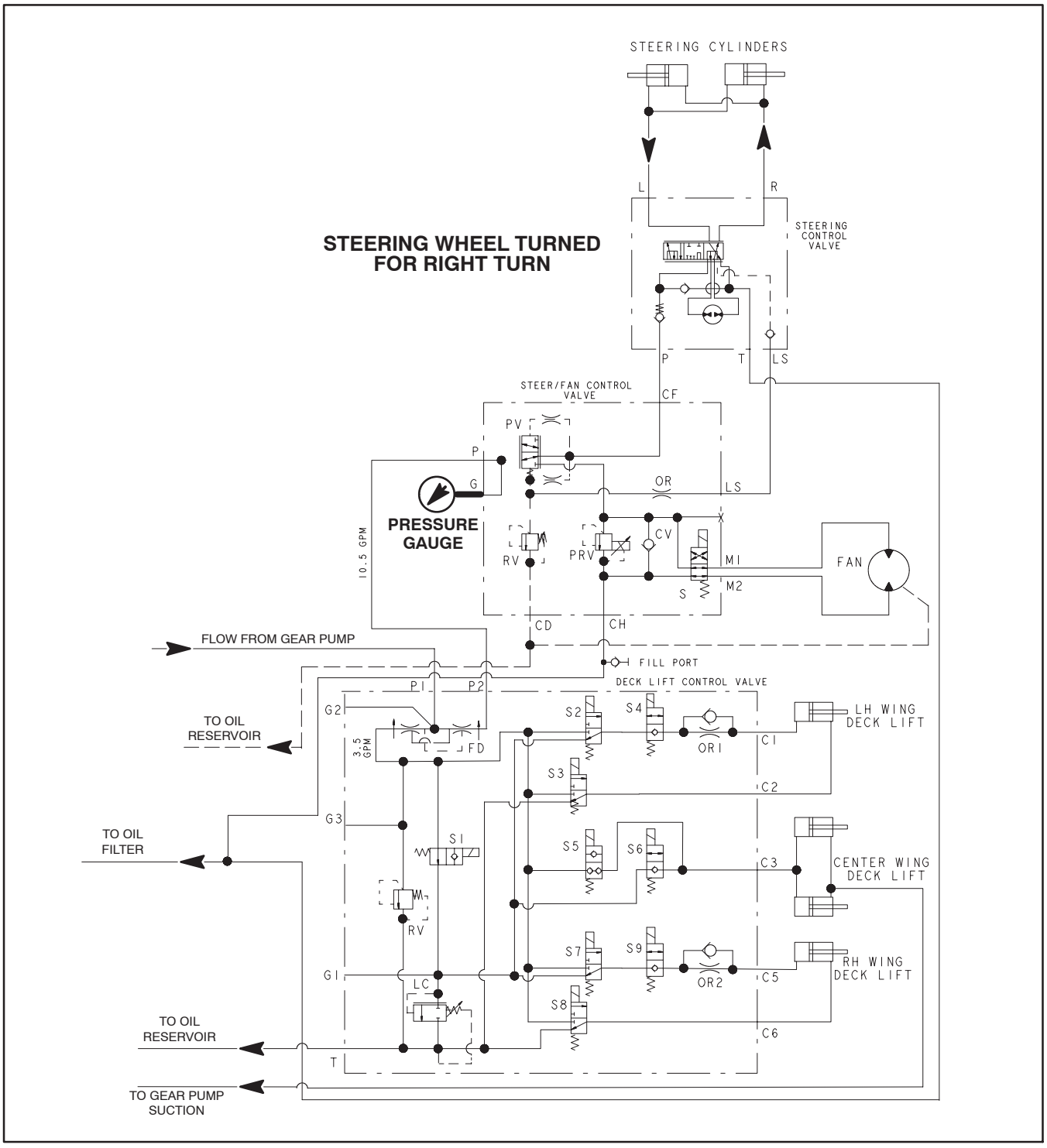


Figure 38

The steering circuit relief valve pressure test should be performed to make sure that the steering circuit relief pressure is correct.

Procedure for Steering Circuit Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Connect a 5000 PSI (350 Bar) pressure gauge onto steering circuit pressure test port G on the steering/cooling fan control manifold (Fig. 39).

4. After installing pressure gauge, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

5. Operate the engine at full engine speed **(2750 RPM)**.

IMPORTANT: Hold steering wheel at full lock only long enough to get a system pressure reading. Holding the steering wheel against the stop for an extended period may damage steering components.

6. Turn steering all the way in one direction and momentarily hold the steering wheel against resistance.

GAUGE READING TO BE:
2000 to 2200 PSI (138 to 151 bar).

7. Stop engine and record test results.

NOTE: If steering relief pressure is incorrect and lift/lower problems also exist, gear pump (P3) should be suspected of wear and inefficiency. If steering wheel continues to turn at end of cylinder travel (with lower than normal effort), the steering cylinder or steering control valve should be suspected of wear or damage.

8. If relief pressure specification is **not** met, adjust relief valve (RV) in steering/cooling fan control manifold (Fig. 40) so that pressure is correct (see Adjustable Pressure Valve in the Adjustments section of this chapter).

9. Disconnect pressure gauge from manifold test port.

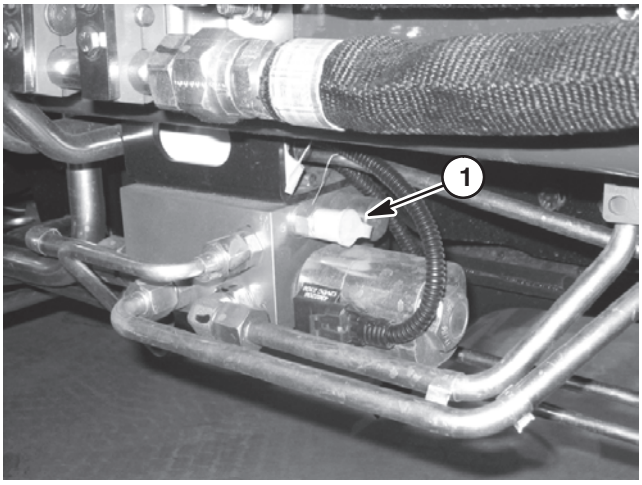


Figure 39

1. Steering circuit pressure test port

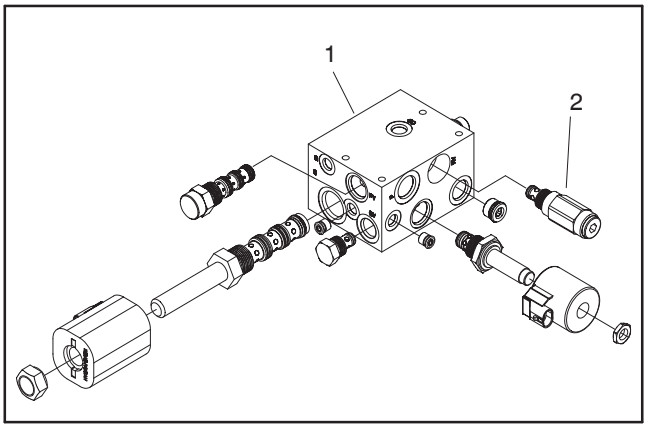


Figure 40

1. Steering/fan manifold
2. Steering relief valve

Steering Cylinder Internal Leakage Test

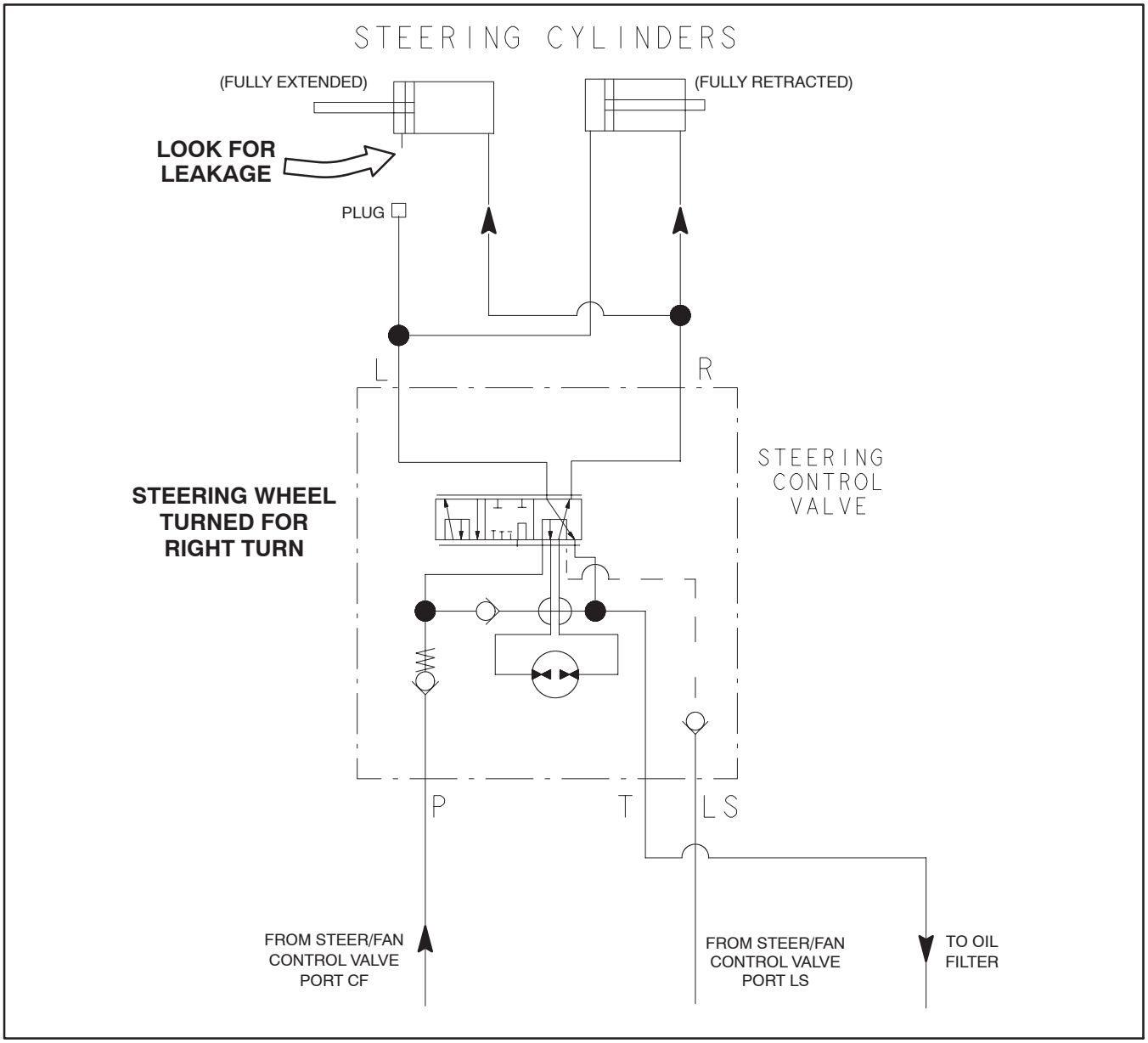


Figure 41

The steering cylinder internal leakage test should be performed if a steering problem is identified. This test will determine if a steering cylinder is faulty.

NOTE: Steering circuit operation will be affected by rear tire pressure, binding of steering cylinders, extra weight on the vehicle and/or binding of rear axle steering components. Make sure that these items are checked before proceeding with steering cylinder internal leakage test.

Procedure for Steering Cylinder Internal Leakage Test

1. Make sure hydraulic oil is at normal operating temperature.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Turn the steering wheel so the steering cylinder rod of the cylinder to be tested is fully extended.

4. Thoroughly clean the area around the hydraulic hose at the rod end of the steering cylinder to be tested.

5. Place a drain pan under the steering cylinder. Remove hydraulic hose from the fitting on the rod end of the steering cylinder to be tested. Install a steel plug in the disconnected hose.

6. Remove all hydraulic oil from drain pan. Make sure that empty drain pan remains under the open fitting of the steering cylinder.

7. With the engine off, turn the steering wheel in the same direction needed to extend the cylinder. Observe the open fitting on the extended steering cylinder as the steering wheel is turned. If oil comes out of the fitting while turning the steering wheel, the steering cylinder has internal leakage and must be repaired or replaced (see Steering Cylinder and Steering Cylinder Service in the Service and Repairs section of this chapter). Check drain pan for any evidence of oil that would indicate cylinder leakage.

8. After testing is completed, remove plug from the hydraulic hose. Connect hose to the steering cylinder fitting.

9. If a steering problem exists and the steering cylinder tested acceptably, the steering control valve requires service (see Steering Control Valve and Steering Control Valve Service in the Service and Repairs section of this chapter).

10. Check oil level in hydraulic reservoir and adjust if needed.

Gear Pump (P3) (Steering, Cooling Fan, Lift/Lower and Traction Charge) Flow Test (Using Tester with Pressure Gauges and Flow Meter)

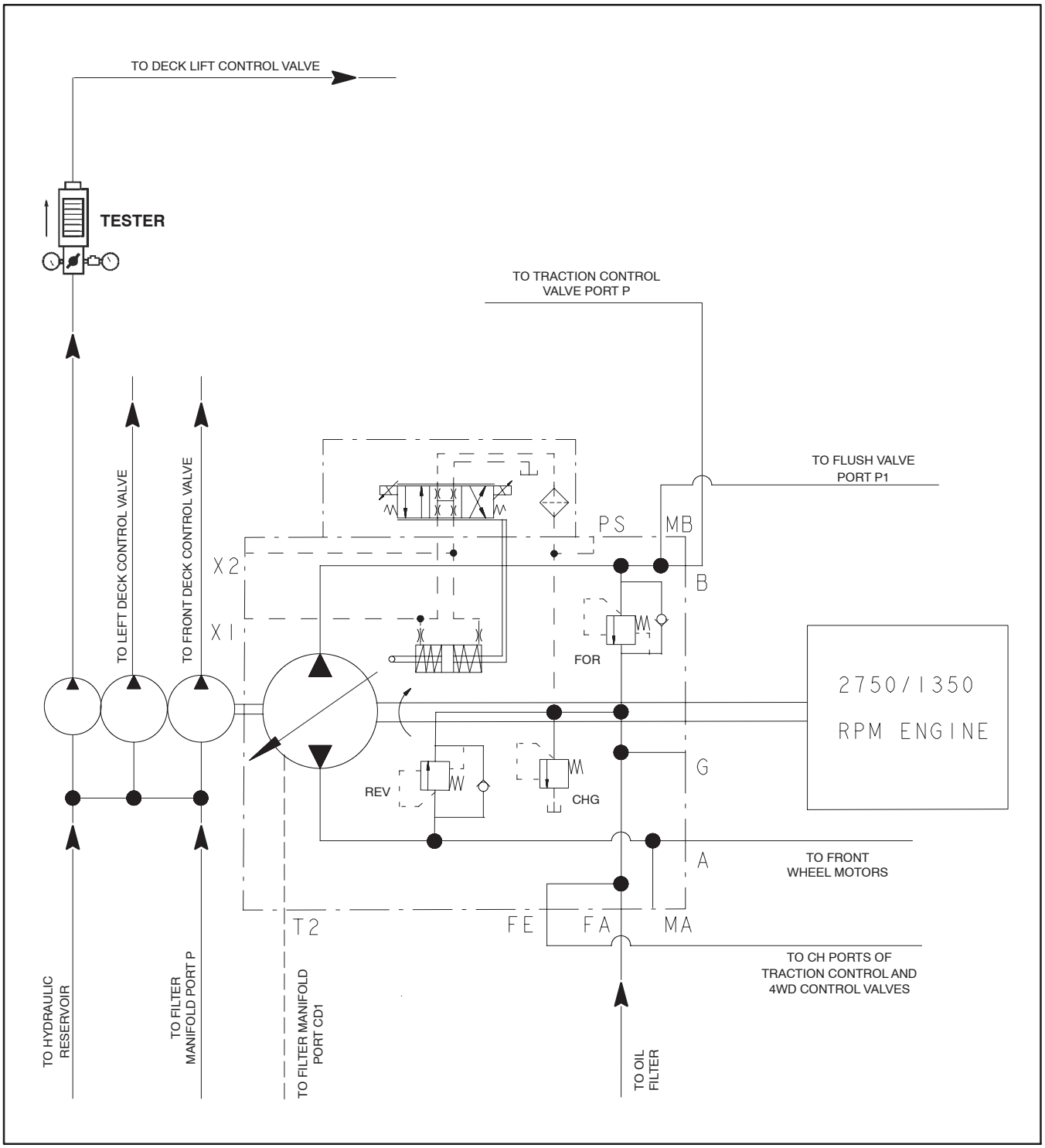


Figure 42

The gear pump (P3) flow test should be performed to make sure that the traction charge circuit, lift/lower circuit and steering/engine cooling fan circuit have adequate hydraulic flow.

Procedure for Gear Pump (P3) Flow Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park machine on a level surface with the cutting decks lowered and off. Make sure engine is off and the parking brake is applied. Raise hood.

CAUTION

Prevent personal injury and/or damage to equipment. Read all WARNINGS, CAUTIONS and Precautions for Hydraulic Testing at the beginning of this section.

3. Disconnect outlet hose from gear pump section (P3) (Fig. 43).

IMPORTANT: Make sure that the oil flow indicator arrow on the flow gauge is showing that the oil will flow from the pump, through the tester and into the hydraulic hose.

4. Install tester with pressure gauges and flow meter in series between the gear pump section (P3) and the disconnected hose. **Make sure the tester flow control valve is open**.

5. After installing tester, start engine and run at idle speed. Check for hydraulic leakage and correct before proceeding with test.

IMPORTANT: The pump is a positive displacement type. If pump flow is completely restricted or stopped, damage to the pump, tester or other components could occur.

6. Operate the engine at full speed **(2750 RPM)**. **DO NOT** engage the cutting decks.

7. While watching tester pressure gauges, slowly close flow control valve on the tester until **1000 PSI (69 bar)** is obtained on gauge. Verify that engine speed continues to be correct **(2750 RPM)**. Record test results.

GAUGE READING TO BE:
A pump in good condition should have a flow of approximately **14 GPM (53 LPM)** at **1000 PSI (69 bar)**.

8. Open tester flow control valve and stop engine.

9. If the measured pump flow is lower than **12.5 GPM (47.3 LPM)** or a pressure of **1000 PSI (69 bar)** could not be obtained, check for restriction in gear pump intake line. If intake line is not restricted, remove gear pump and repair or replace pump (P3) as necessary.

10. Remove tester from machine. Connect hydraulic hose to gear pump (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

11. Check oil level in hydraulic reservoir and adjust if needed.

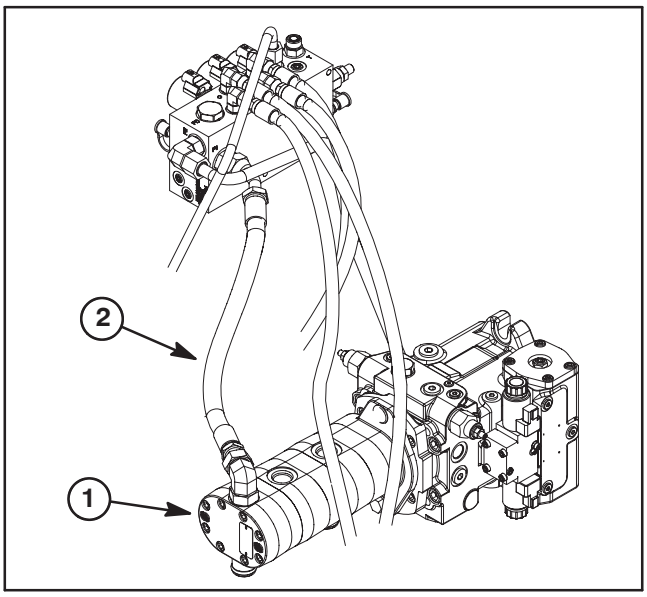


Figure 43

1. **Pump section (P3)**
2. **Outlet hose**

Adjustments

Adjustable Pressure Valve

The mow/transport and lift control manifolds include adjustable pressure valves. An adjustment may be required to these valves if testing determines that the circuit pressure setting is incorrect (see TESTING in this chapter). Use the following process if an adjustment is required:

NOTE: Do not remove the valve from the hydraulic manifold for adjustment.

IMPORTANT: Do not remove cap from valve or make valve adjustment when engine is running. Hydraulic oil under pressure may be ejected from valve without cap in place.

1. Make sure that engine is not running. Remove cap from hydraulic valve with an allen wrench.

2. To **increase** pressure setting, turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in pressure.

3. To **decrease** pressure setting, turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in pressure.

4. Install cap on valve.

5. Recheck valve pressure using correct test procedure and readjust if needed.

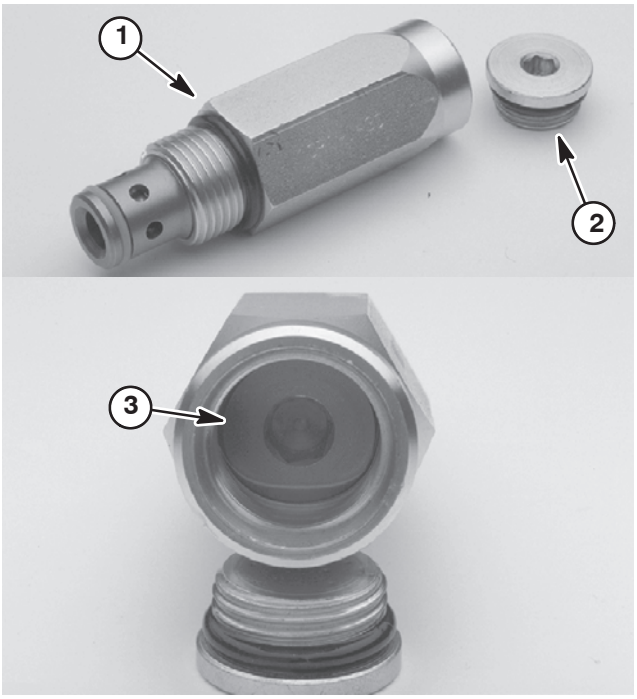


Figure 44

1. **Hydraulic valve**
2. **Valve cap**
3. **Adjustment socket**

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, apply parking brake, lower cutting decks or attachments and stop engine. Remove key from the ignition switch.

2. Clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure hydraulic components, hoses connections and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic equipment.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in RUN and the engine OFF. Make sure all electrically operated control valves are actuated. Return ignition switch to OFF after pressure has been relieved. Remove key from the ignition switch.

3. Put caps or plugs on any hydraulic lines, hydraulic fittings or components left open or exposed to prevent hydraulic system contamination.

4. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.

5. Note the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removal. Mark parts if necessary to make sure they will be aligned properly when reinstalling hydraulic hoses and tubes.

After Repair or Replacement of Components

1. Check oil level in the hydraulic reservoir and add correct oil if necessary. Drain and refill hydraulic system reservoir and change oil filter if component failure was severe or system is contaminated (see Flush Hydraulic System in this section).

2. Lubricate O−rings and seals with clean hydraulic oil before installing hydraulic components.

3. Make sure all caps or plugs are removed from hydraulic tubes, hydraulic fittings and components before reconnecting.

4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Hose and Tube Installation and Hydraulic Fitting Installation in the General Information section of this chapter).

5. After repairs, check control linkages or cables for proper adjustment, binding or broken parts.

6. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Charge Hydraulic System in this section).

7. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

Check Hydraulic Lines and Hoses

WARNING

Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and cause serious injury. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury. Gangrene may result from such an injury.

IMPORTANT: Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings or deterioration. Make all necessary repairs before operating the machine.

Flush Hydraulic System

IMPORTANT: Flush the hydraulic system any time there is a severe component failure or the system is contaminated (oil appears milky, black or contains metal particles).

1. Park machine on a level surface. Lower cutting decks, stop engine and apply parking brake. Remove key from the ignition switch.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the ignition switch in RUN and the engine OFF. Make sure all electrically operated control valves are actuated. Return ignition switch to OFF after pressure has been relieved. Remove key from the ignition switch.

IMPORTANT: Make sure to thoroughly clean around all hydraulic connections that will be disconnected for draining.

2. Drain hydraulic reservoir.

3. Drain complete hydraulic system. Drain all hoses, tubes and components while the system is warm.

4. Remove and replace both hydraulic oil filters.

5. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir Inspection in this section).

6. Reconnect all hydraulic hoses, tubes and components that were disconnected while draining system.

NOTE: Use only hydraulic fluids specified in the Operator's Manual. Other fluids may cause system damage.

7. Fill hydraulic reservoir with **new** hydraulic fluid.

IMPORTANT: Before unplugging the wire harness power connector from the engine ECM, make sure that the ignition switch is in the OFF position and the key is removed from the switch. If the power connector is removed from the engine ECM while electrical power is on, the ECM may be damaged.

8. Make sure that the ignition switch is OFF and the key is removed from the switch. Unplug the wire harness power connector from the engine ECM to prevent the engine fuel solenoid from being energized (Fig. 45). This will keep the engine from starting while cranking the engine.

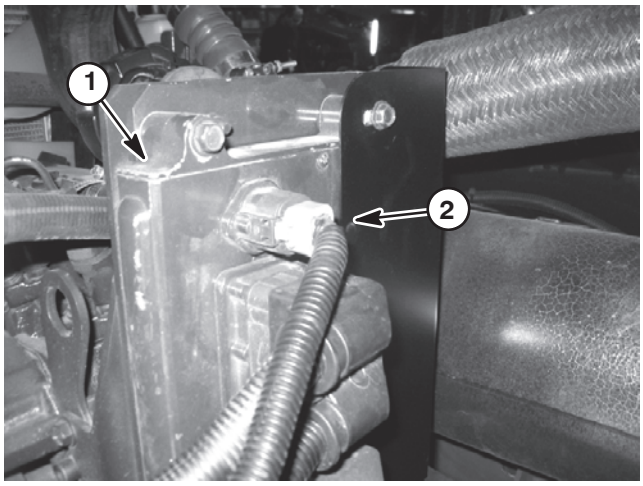


Figure 45

1. **Engine ECM**
2. **Power connector**

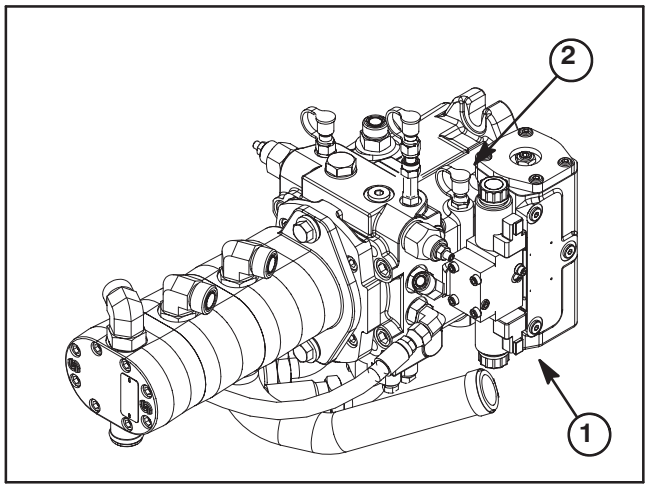


Figure 46

1. **Hydrostat**
2. **Charge test port**

9. Connect a 1000 PSI (70 Bar) pressure gauge onto charge pressure test port fitting on hydrostat (Fig. 46).

10. Turn ignition key switch to START and engage starter for thirty (30) seconds to prime the traction and gear pumps. Wait two (2) minutes to allow the starter to cool and then repeat this step again.

11. Repeat step 10 until the pressure gauge attached to charge pressure test port indicates that pressure in the charge circuit is increasing.

12. Make sure that the ignition switch is OFF and the key is removed from the switch.

IMPORTANT: Before plugging the wire harness power connector to the engine ECM, make sure that the ignition switch is in the OFF position and the key is removed from the switch. If the harness power connector is plugged into the engine ECM while electrical power is on, the ECM will be damaged.

13. Connect the wire harness power connector to the engine ECM (Fig. 45).

14. Disconnect pressure gauge from charge pressure test port (Fig. 46).

15. Start engine and let it run at low idle **(1350 RPM)** for a minimum of 2 minutes. Increase engine speed to high idle **(2750 RPM)** for a minimum of 1 minute under no load.

16. Raise and lower cutting decks several times. Turn steering wheel fully left and right several times.

17. Shut off engine and check entire machine for hydraulic oil leaks. Check oil level in hydraulic reservoir and add correct amount of oil if necessary.

18. Operate machine for 2 hours under normal operating conditions.

19. Check condition of hydraulic oil. If the new fluid shows any signs of contamination, repeat steps 1 through 14 again until oil is clean.

20. Assume normal operation and follow recommended maintenance intervals.

Charge Hydraulic System

NOTE: When initially starting the hydraulic system with new or rebuilt components such as motors, pumps or lift cylinders, it is important that the hydraulic system be charged properly. Air must be purged from the system and its components to reduce the chance of damage.

IMPORTANT: Change hydraulic oil filter whenever hydraulic components are repaired or replaced.

1. Position machine on a level surface. Remove key from the ignition switch.

2. Make sure all hydraulic connections, lines and components are tight.

3. If component failure was severe or the system is contaminated, flush and refill hydraulic system and reservoir (see Flush Hydraulic System in this section).

4. Make sure hydraulic reservoir is full. Add correct hydraulic oil if necessary.

IMPORTANT: Before unplugging the wire harness power connector from the engine ECM, make sure that the ignition switch is in the OFF position and the key is removed from the switch. If the harness power connector is removed from the engine ECM while electrical power is on, the ECM may be damaged.

5. Make sure that the ignition switch is OFF and the key is removed from the switch. Unplug the wire harness power connector from the engine ECM to prevent the engine fuel solenoid from being energized (Fig. 47). This will keep the engine from starting while cranking the engine.

6. Connect a 1000 PSI (70 Bar) pressure gauge onto charge pressure test port fitting on hydrostat (Fig. 48).

7. Make sure traction pedal is in the neutral position. Turn ignition key switch to START and engage starter for thirty (30) seconds to prime the traction and gear pumps. Wait two (2) minutes to allow the starter to cool and then repeat this step again.

8. Repeat step 7 until the pressure gauge attached to charge pressure test port indicates that pressure in the charge circuit is increasing.

9. Make sure that the ignition switch is OFF and the key is removed from the switch.

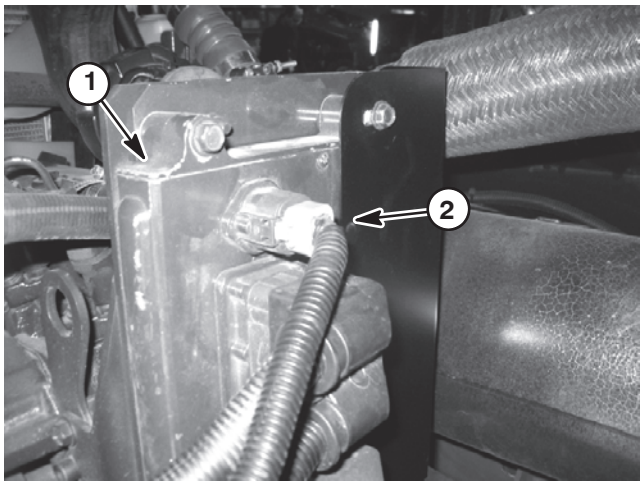


Figure 47

1. **Engine ECM**
2. **Power connector**

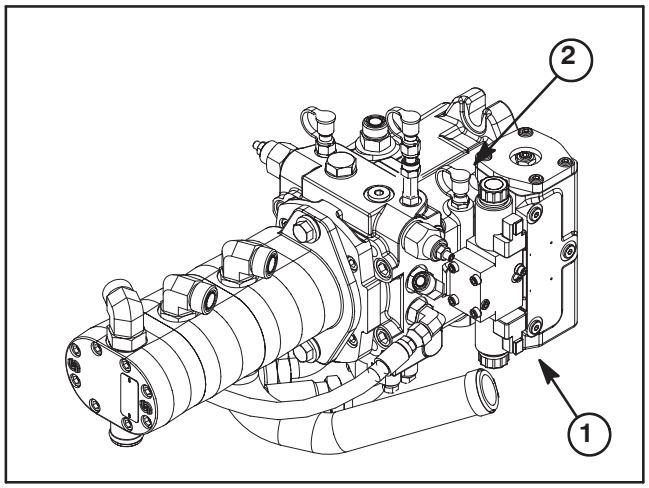


Figure 48

1. **Hydrostat**
2. **Charge test port**

IMPORTANT: Before connecting the wire harness power connector to the engine ECM, make sure that the ignition switch is in the OFF position and the key is removed from the switch. If the harness power connector is plugged into the engine ECM while electrical power is on, the ECM may be be damaged.

10. Connect the wire harness power connector to the engine ECM (Fig. 47).

11. Disconnect pressure gauge from charge pressure test port (Fig. 48).

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 – Safety.

12. Raise one front and one rear wheel off the ground and place appropriate jackstands under the frame to support the machine. Chock remaining wheels to prevent movement of the machine.

13. Make sure traction pedal is in the neutral position. Start engine and run it at low idle speed **(1350 RPM)**. The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in 30 seconds, stop the engine and determine the cause.

14. After the hydraulic system starts to show signs of fill, actuate lift control switches until the lift cylinders extend and retract several times. If the cylinders do not move after fifteen (15) seconds or the gear pump emits abnormal sounds, shut the engine off immediately and determine cause or problem. Inspect for loose filter or suction lines, blocked suction line, faulty charge relief valve or faulty gear pump.

15. If lift cylinders do move in fifteen (15) seconds, proceed to step 16.

16. Operate the traction pedal in the forward and reverse directions. The wheels off the ground should rotate in the proper direction.

    A. If the wheels rotate in the wrong direction, stop engine and inspect hydraulic line placement at piston (traction) pump and wheel motors. Correct hydraulic line installation before proceeding.

    B. If the wheels rotate in the proper direction, stop engine.

17. Use Info Center to check for traction neutral position and interlock switch operation.

18. Remove jackstands from frame and lower machine to the ground. Remove chocks from remaining wheels.

19. If the piston (traction) pump or a wheel motor was replaced or rebuilt, run the machine so all wheels turn slowly for ten (10) minutes.

20. Operate machine by gradually increasing it's work load to full over a ten (10) minute period.

21. Stop the machine. Check hydraulic reservoir and fill if necessary. Check hydraulic components for leaks and tighten any loose connections.

Hydraulic Reservoir

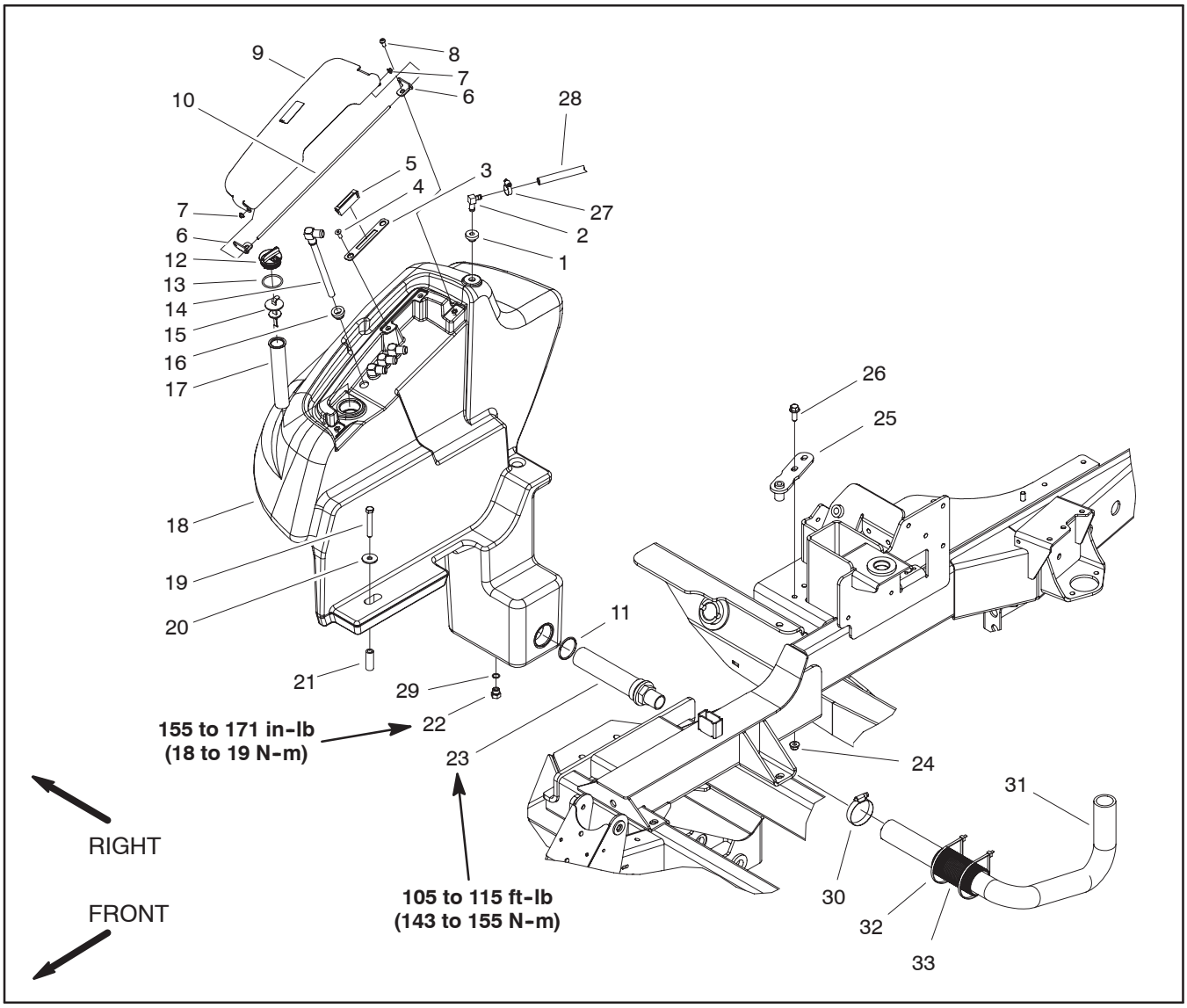


Figure 49

1. Bushing
2. Elbow fitting
3. Latch plate
4. Socket head screw (2 used)
5. Magnetic catch
6. Hinge bracket (2 used)
7. Push nut (2 used)
8. Socket head screw (2 used)
9. Tank cover
10. Rod
11. O-ring
12. Reservoir cap
13. O-ring
14. Stand pipe
15. Dipstick
16. Bushing (4 used)
17. Screen filter
18. Hydraulic reservoir
19. Cap screw
20. Washer
21. Spacer
22. Drain plug
23. Tank strainer
24. Flange nut (2 used)
25. Tank hold down
26. Flange head screw
27. Hose clamp
28. Hose
29. O-ring
30. Hose clamp
31. Suction hose
32. Cable tie (2 used)
33. Hose guard

Removal (Fig. 49)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

3. To prevent contamination of hydraulic system during hydraulic reservoir removal, thoroughly clean exterior of reservoir, fittings and hoses.

4. Remove drain plug and empty reservoir into a suitable container.

5. To allow access to reservoir fasteners, loosen fuel tank and slide it toward left side of machine (see Fuel Tank Removal in the Service and Repairs section of Chapter 3 – Diesel Engine).

6. To ease assembly, label all hydraulic hoses to identify their correct position on the reservoir.

NOTE: Original production clamps used to secure hoses to stand pipes and hydraulic tubes are crimped and will need to be cut in order to remove hoses (Fig. 50). Replacement clamps are traditional worm clamps.

7. Disconnect hydraulic hoses from reservoir fittings. Put caps or plugs on fittings and hoses to prevent contamination.

8. Remove hydraulic reservoir using Figure 49 as a guide.

Inspection

1. Clean hydraulic reservoir and tank strainer with solvent.

2. Inspect reservoir for leaks, cracks or other damage.

Installation (Fig. 49)

1. Install reservoir using Figure 49 as a guide.

   A. Torque drain plug (item 22) from **155 to 171 in-lb (18 to 19 N-m)**.

   B. Torque tank strainer (item 23) from **105 to 115 ft-lb (143 to 155 N-m)**.

2. Remove caps or plugs placed during removal to prevent contamination.

3. Using tags placed during reservoir removal, properly connect hydraulic hoses to reservoir fittings and secure with hose clamps.

4. If hose guard (item 33) was removed, install guard with split orientated up and secure with two (2) cable ties.

5. Slide fuel tank to proper location on machine and secure in place (see Fuel Tank Installation in the Service and Repairs section of Chapter 3 – Diesel Engine).

6. Fill reservoir with new hydraulic fluid.

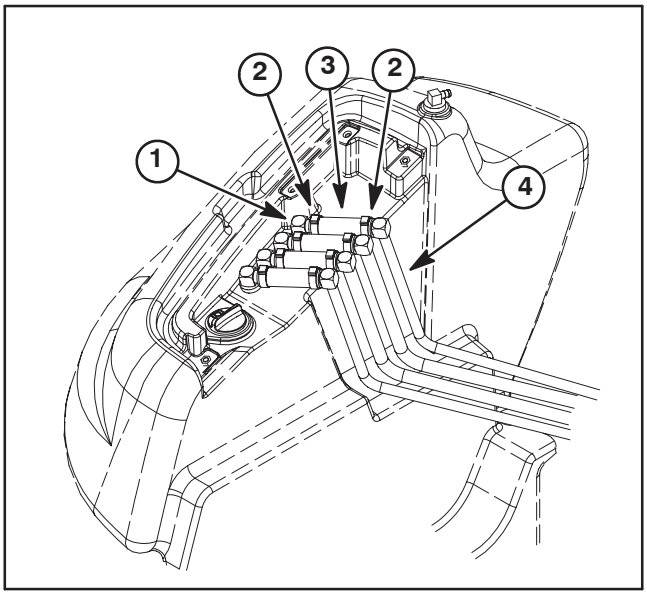


Figure 50

1. **Stand pipe**
2. **Hose clamp**
3. **Hose**
4. **Hydraulic tube**

Gear Pump

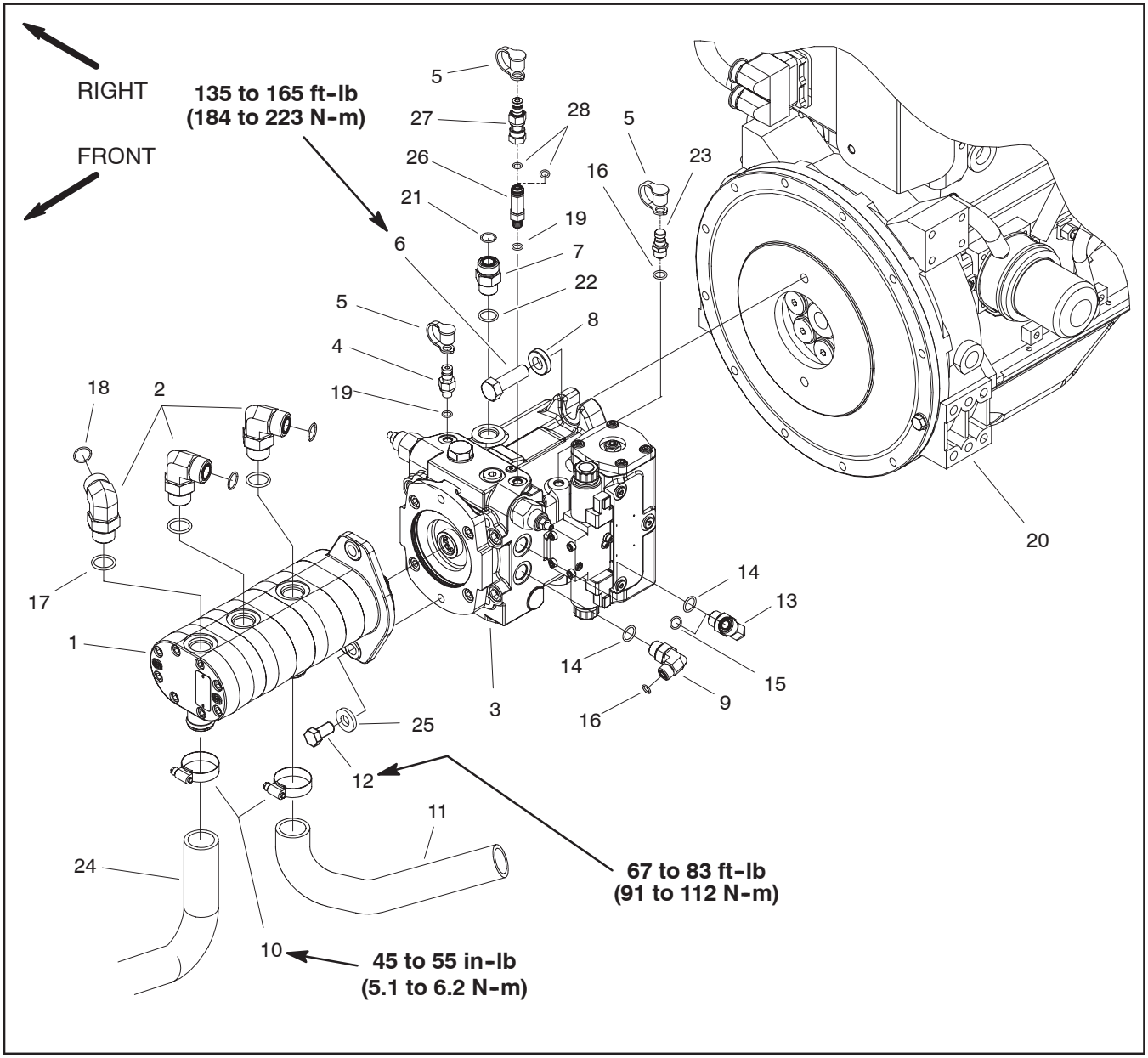


Figure 51

1. Gear pump
2. 90º hydraulic fitting
3. Piston pump
4. Quick fitting
5. Dust cap
6. Cap screw (2 used)
7. Hydraulic adapter
8. Flat washer (2 used)
9. 90º hydraulic fitting
10. Clamp
11. Hose (from filter)
12. Cap screw (2 used)
13. 90º hydraulic fitting
14. O-ring
15. O-ring
16. O-ring
17. O-ring
18. O-ring
19. O-ring
20. Engine
21. O-ring
22. O-ring
23. Diagnostic fitting
24. Hose (from hydraulic tank)
25. Washer (2 used)
26. Tee fitting
27. Test fitting
28. O-ring

Removal (Fig 51)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.

2. Remove hood to gain access to gear pump (see Hood Removal in the Service and Repairs section of Chapter 7 – Chassis).

3. Drain the hydraulic reservoir.

4. To prevent contamination of hydraulic system during pump removal, thoroughly clean exterior of pump and fittings.

5. Label all hydraulic hose connections for assembly purposes.

6. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

7. Disconnect all hydraulic lines from gear pump and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.

CAUTION

Make sure gear pump is properly supported before removing the pump mounting screws. Gear pump assembly weighs approximately 42 pounds (19 kg).

8. Support gear pump assembly to prevent it from falling.

9. Remove two (2) cap screws that secure gear pump to piston pump. Remove gear pump from machine.

10.If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O–rings.

Installation (Fig 51)

1. If fittings were removed from gear pump, lubricate and place new O–rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Position gear pump to piston pump. Align gear pump input shaft splines with piston pump coupler and slide gear pump input shaft into piston pump coupler. Secure gear pump to piston pump with two (2) cap screws. Torque screws from **67 to 83 ft-lb (91 to 112 N-m)**.

3. Remove caps or plugs from hydraulic lines and fittings. Install hydraulic lines to gear pump (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Remove and replace hydraulic filters.

5. Fill hydraulic reservoir with new hydraulic oil.

6. Properly fill hydraulic system (see Charge Hydraulic System in this section).

7. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

8. Install hood (see Hood Installation in the Service and Repairs section of Chapter 7 – Chassis).

Gear Pump Service

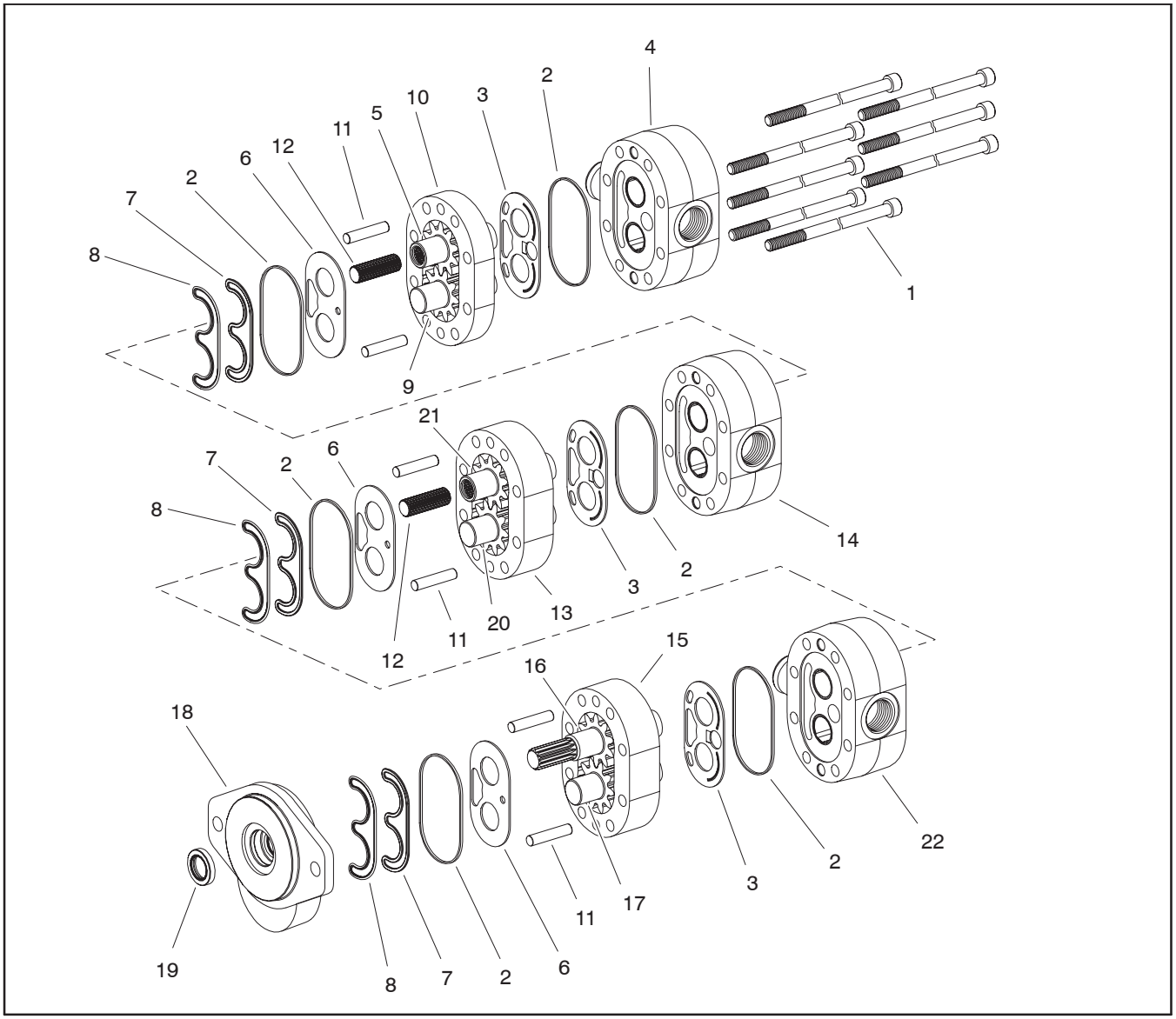


Figure 52

1. **Socket head screw (8 used)**
2. **Seal ring**
3. **Deflecting plate**
4. **Rear cover**
5. **Drive gear**
6. **Deflecting plate**
7. **Load seal**
8. **Pre-load seal**
9. **Idler gear**
10. **Gear housing**
11. **Dowel pin (6 used)**
12. **Drive coupler**
13. **Gear housing**
14. **Bearing plate**
15. **Gear housing**
16. **Drive gear**
17. **Idler gear**
18. **Mounting flange**
19. **Seal**
20. **Idler gear**
21. **Drive gear**
22. **Bearing plate**

NOTE: For gear pump repair procedures, see the Sauer Danfoss D Series Gear Pump Seal Kit Service Instruction Bulletin at the end of this chapter.

This page is intentionally blank.

Traction Circuit

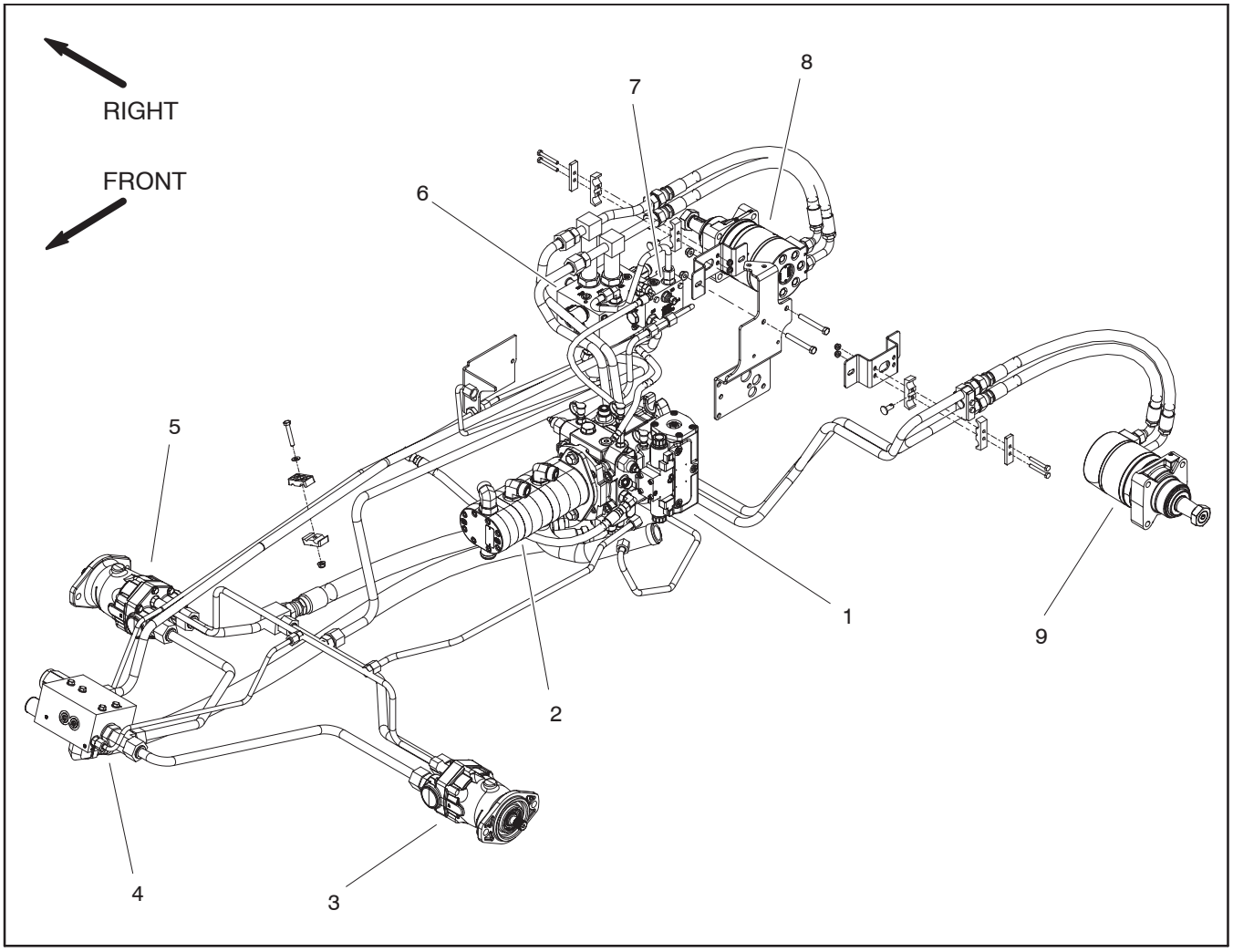


Figure 53

1. **Piston (traction) pump**
2. **Gear pump**
3. **LH front wheel motor**
4. **Traction control manifold**
5. **RH front wheel motor**
6. **4WD control manifold**
7. **Traction flush manifold**
8. **RH rear wheel motor**
9. **LH rear wheel motor**

Figure 53 illustrates the components that are used in the Groundsmaster traction circuit. Procedures for removal, installation and disassembly/assembly of these components are provided on the following pages of this section.

This page is intentionally blank.

Piston (Traction) Pump

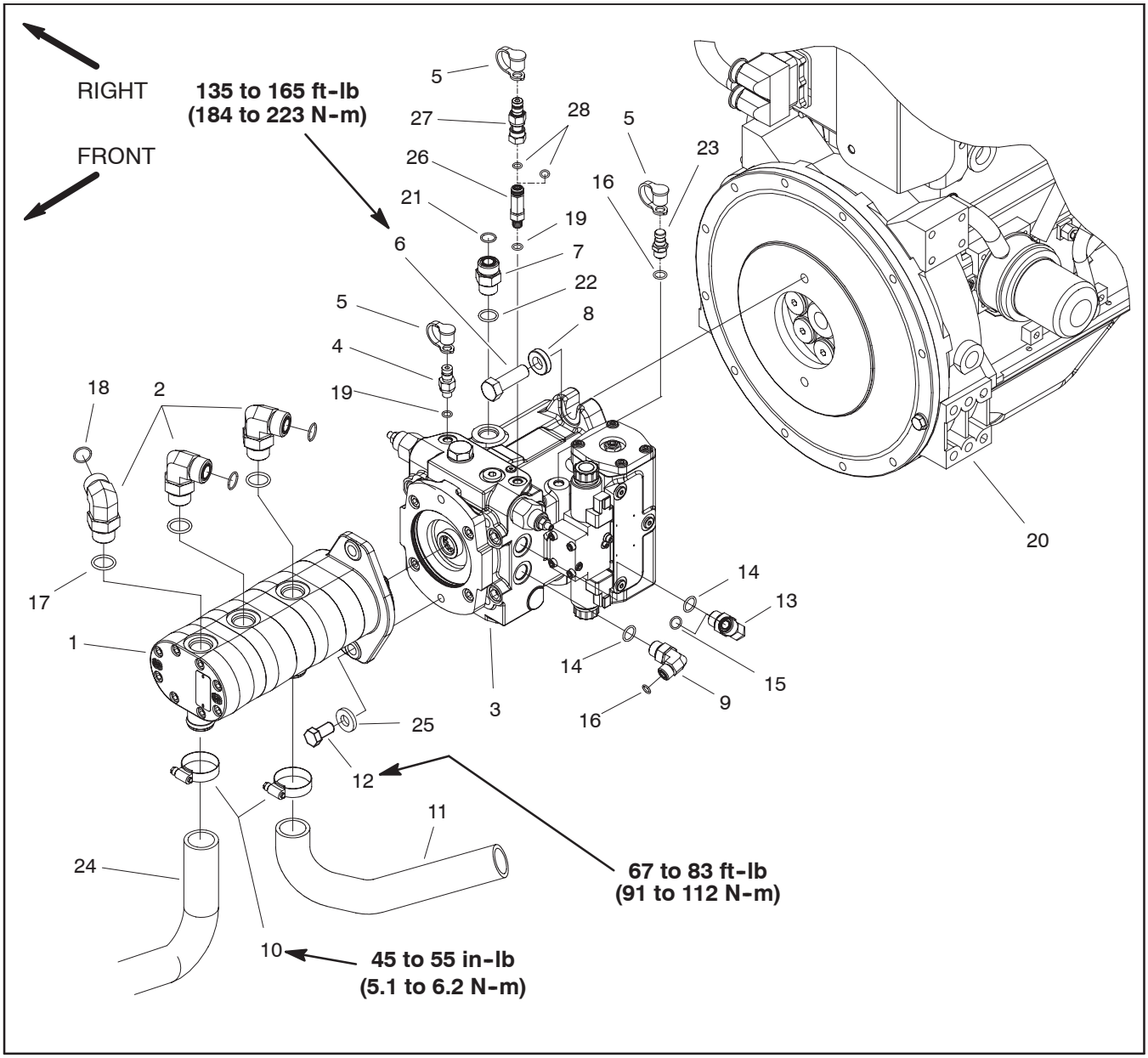


Figure 54

1. Gear pump
2. 90º hydraulic fitting
3. Piston pump
4. Quick fitting
5. Dust cap
6. Cap screw (2 used)
7. Hydraulic adapter
8. Flat washer (2 used)
9. 90º hydraulic fitting
10. Clamp
11. Hose (from filter)
12. Cap screw (2 used)
13. 90º hydraulic fitting
14. O-ring
15. O-ring
16. O-ring
17. O-ring
18. O-ring
19. O-ring
20. Engine
21. O-ring
22. O-ring
23. Diagnostic fitting
24. Hose (from hydraulic tank)
25. Washer (2 used)
26. Tee fitting
27. Test fitting
28. O-ring

Removal (Fig. 54)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.

2. Remove hood to gain access to hydraulic pumps (see Hood Removal in the Service and Repairs section of Chapter 7 – Chassis).

3. Drain the hydraulic reservoir.

4. To prevent contamination of hydraulic system during pump removal, thoroughly clean exterior of pump assembly including hydraulic hoses.

5. For assembly purposes, label wire harness leads for traction pump solenoids. Disconnect wire harness connectors from two (2) solenoids on pump.

6. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

7. Label all hydraulic hose connections for assembly purposes.

8. Put a drain pan below the pump assembly. Remove all hydraulic hoses connected to piston and gear pumps. Put plugs or caps on disconnected hydraulic hoses and fittings to prevent contamination of the system.

9. Remove gear pump from machine (see Gear Pump Removal in this section).

CAUTION

Make sure piston pump is properly supported before removing the pump mounting screws. Piston pump assembly weighs approximately 86 pounds (39 kg).

10. Attach hoist to piston pump to support pump and also to allow safe removal of pump from machine.

11. Remove two (2) cap screws and washers that retain pump assembly to flywheel coupling housing on engine.

12. Carefully slide pump assembly from housing on engine and raise pump out of the machine.

13. If hydraulic fittings are to be removed from piston pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O–rings.

Installation (Fig. 54)

1. If fittings were removed from piston pump, lubricate and place new O–rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Attach hoist to piston pump to support pump and also to allow safe installation of pump into machine.

3. Carefully lower piston pump into the machine and position it to the flywheel coupling housing on engine. Support pump to make sure that side loads are not applied to flywheel coupling and that pump pilot is aligned with coupling housing on engine. Support pump to prevent it from shifting or falling while installing two (2) cap screws and washers securing piston pump to engine housing. Torque screws from **135 to 165 ft–lb (184 to 223 N–m)**.

4. Install gear pump to piston pump (see Gear Pump Installation in this section).

5. Using labels placed during removal, correctly connect two (2) wire harness connectors to solenoids on traction pump.

6. Remove plugs or caps from disconnected hydraulic hoses. Install hoses to correct location on gear and piston pumps (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Remove and replace hydraulic filters.

8. Fill hydraulic reservoir with correct oil.

9. Properly fill hydraulic system (see Charge Hydraulic System in this section).

10. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

11. Install hood (see Hood Installation in the Service and Repairs section of Chapter 7 – Chassis).

Piston (Traction) Pump Service

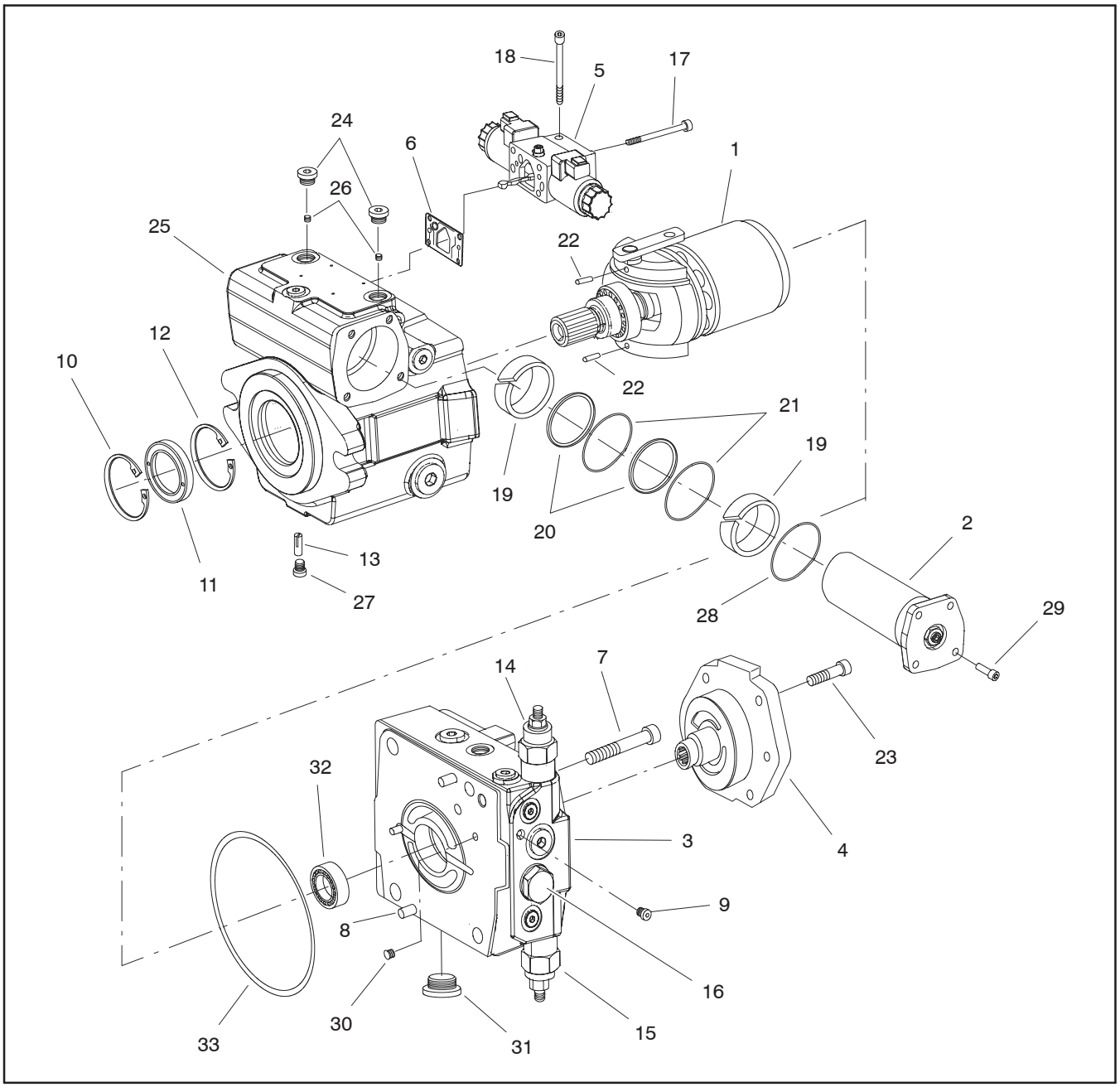


Figure 55

1. Rotary group
2. Stroking piston assembly
3. Port plate assembly
4. Pump support plate assembly
5. EP control assembly
6. Gasket
7. Socket head screw (4 used)
8. Dowel pin (2 used)
9. Plug
10. Retaining ring
11. Shaft seal
12. Retaining ring
13. Joint pin
14. Forward traction relief valve
15. Reverse traction relief valve
16. Charge relief valve
17. Socket head screw (4 used)
18. Socket head screw
19. Guide ring
20. Rod seal
21. O-ring
22. Dowel pin (2 used)
23. Socket head screw (4 used)
24. Plug
25. Pump housing
26. Orifice
27. Plug
28. O-ring
29. Socket head screw (4 used)
30. Clamping pin
31. Plug
32. Bearing
33. O-ring

NOTE: For piston (traction) pump repair procedures, see the Rexroth Variable Pump A10VG Repair Instructions and Repair Manual at the end of this chapter.

IMPORTANT: If a piston (traction) pump failure occurred, refer to Traction Circuit Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

Front Wheel Motors

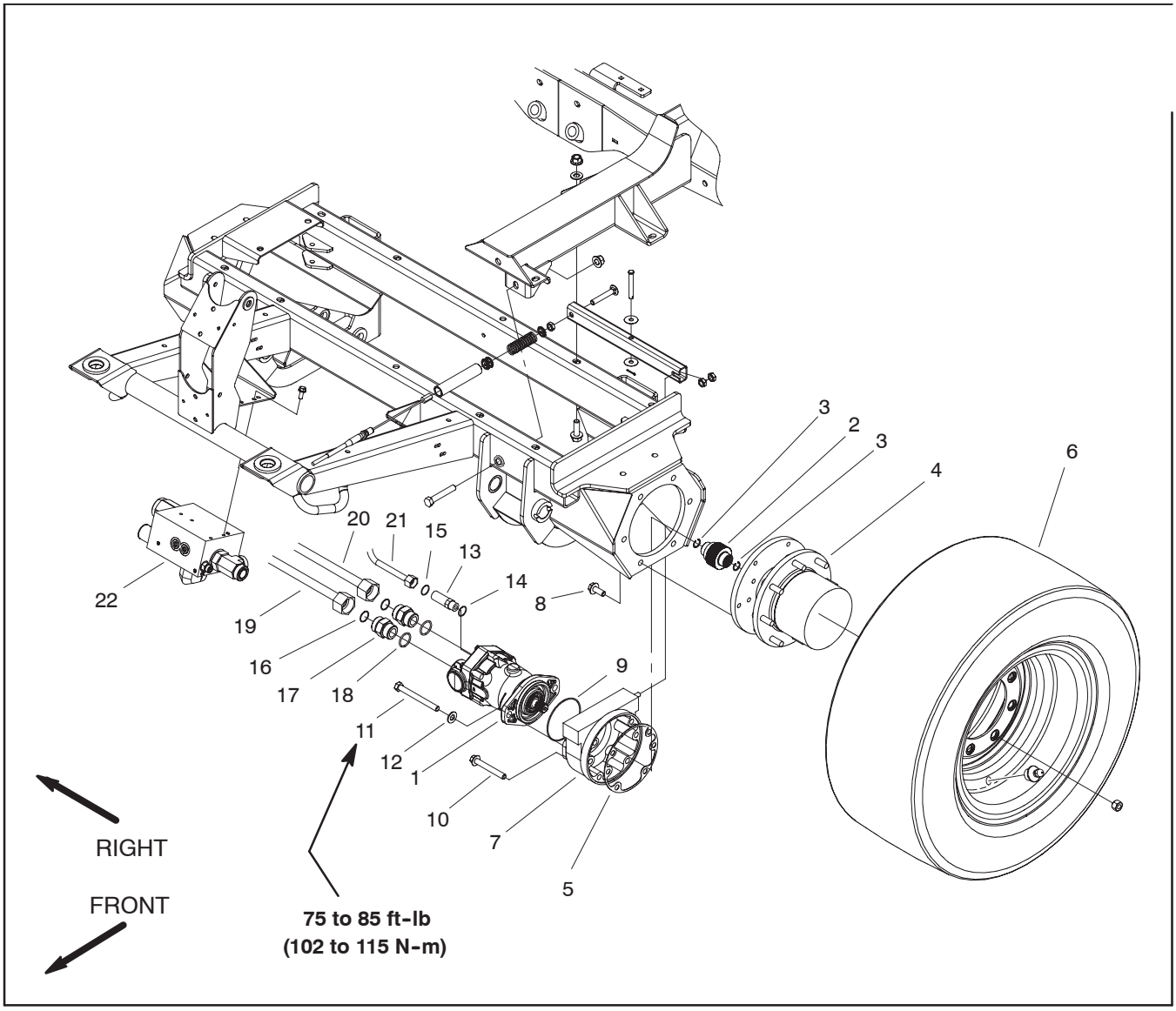


Figure 56

1. Front wheel motor
2. Splined brake shaft
3. Internal retaining ring
4. Planetary assembly
5. Gasket
6. Front wheel assembly
7. Brake assembly (LH shown)
8. Flange head screw (6 per planetary)
9. O-ring
10. Flange head screw (4 per brake)
11. Cap screw (2 used per motor)
12. Flat washer (2 used per motor)
13. Hydraulic fitting
14. O-ring
15. O-ring
16. O-ring
17. Hydraulic fitting (2 used per motor)
18. O-ring
19. Hydraulic tube
20. Hydraulic tube
21. Hydraulic tube
22. Traction control manifold

Removal (Fig. 56)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.

2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

3. To prevent contamination of hydraulic system during motor removal, thoroughly clean exterior of motor, hydraulic tubes and fittings.

4. To allow easier access to hydraulic tube fittings at wheel motor, remove pin that secures lift cylinder to front deck lift arm and lower front of lift cylinder (see Front Deck Lift Cylinder Removal in this section).

5. Disconnect hydraulic tubes from wheel motor. Also, loosen fittings that are at other end of tubes to allow tubes to be shifted for wheel motor removal.

6. Put caps or plugs on disconnected hydraulic lines and fittings to prevent contamination.

IMPORTANT: Before loosening fasteners, support wheel motor to prevent motor from falling during removal.

7. Remove two (2) cap screws and flat washers that secure front wheel motor to brake and planetary assemblies.

8. Slide front wheel motor from brake assembly and remove from machine.

9. Remove and discard O−ring from between wheel motor and brake assembly.

10. If necessary, remove fittings from wheel motor and discard fitting O−rings.

Installation (Fig. 56)

1. If fittings were removed from wheel motor, lubricate and place new O−rings onto fittings. Install fittings into motor ports and tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Lightly oil new O−ring (item 9) and place on wheel motor flange.

3. Position wheel motor to brake assembly making sure that case drain port is above supply line ports (Fig. 57).

4. Align splines on motor shaft and splined brake shaft in brake assembly. Slide motor into brake assembly.

5. Secure motor to brake and planetary assemblies with two (2) cap screws and flat washers. Torque cap screws from **75 to 85 ft−lb (102 to 115 N−m)**.

6. Remove plugs from hydraulic lines and fittings. Attach hydraulic tubes to wheel motor and then tighten all tube fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Fill reservoir with new hydraulic fluid as required.

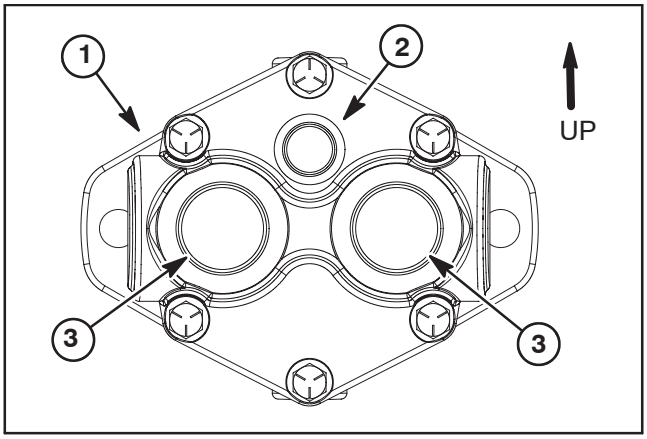


Figure 57

1. **Wheel motor backplate**
2. **Case drain port**
3. **Supply line port**

Front Wheel Motor Service

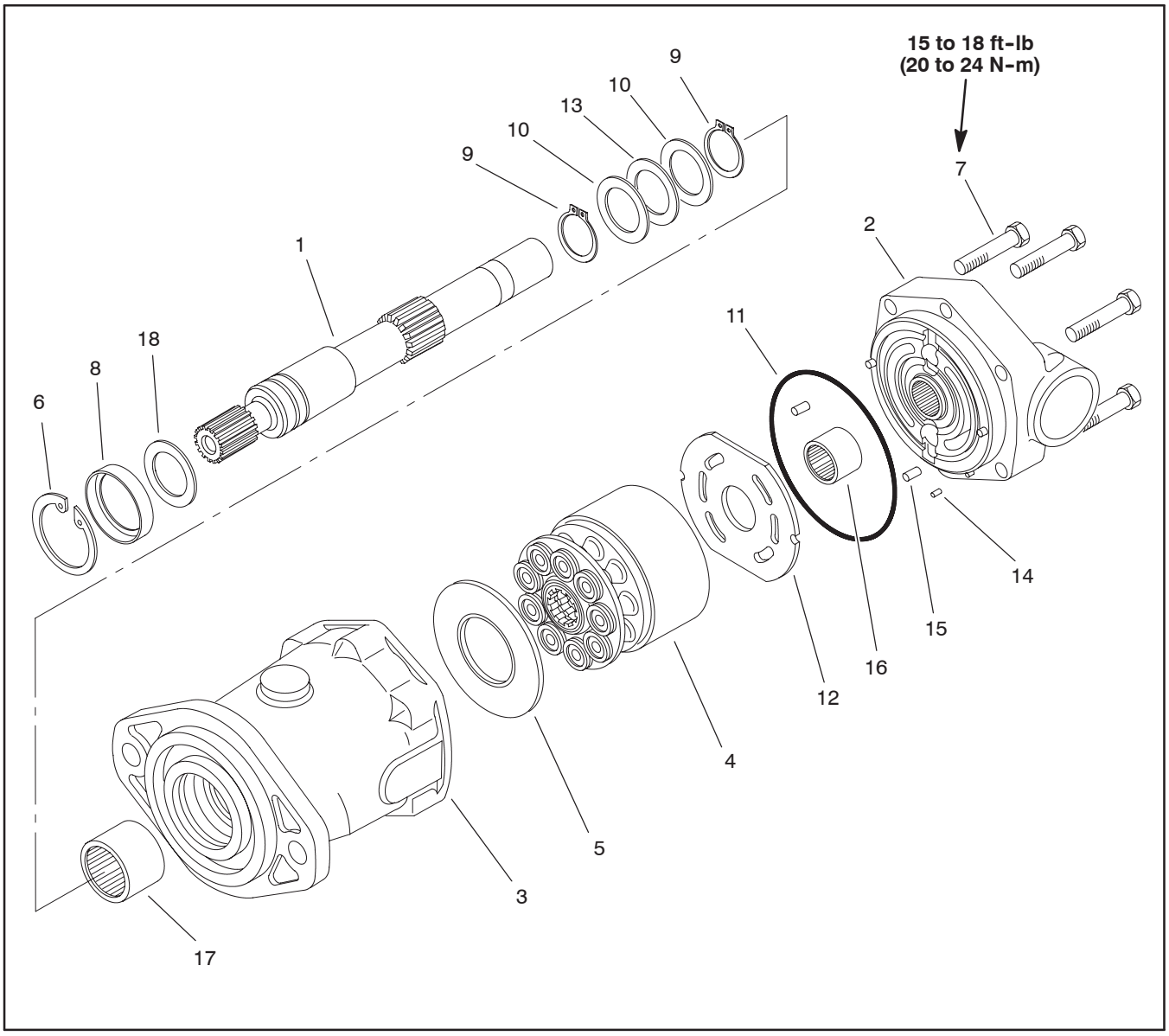


Figure 58

1. **Drive shaft**
2. **Backplate**
3. **Housing assembly**
4. **Rotating assembly**
5. **Cam plate insert**
6. **Retaining ring**
7. **Cap screw (6 used)**
8. **Shaft seal**
9. **Retaining ring**
10. **Thrust race**
11. **O-ring**
12. **Valve plate**
13. **Thrust bearing**
14. **Roll pin**
15. **Roll pin**
16. **Bearing**
17. **Bearing**
18. **Washer**

NOTE: The front wheel motors on Groundsmaster 5900 and 5910 machines are Eaton Model 74348 motors. The front wheel motors are identical. For wheel motor repair procedures, see the Eaton Repair Information: Model 74318 and 74348 Piston Motors at the end of this chapter.

IMPORTANT: If a wheel motor failure occurred, refer to Traction Circuit Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

This page is intentionally blank.

Rear Wheel Motors

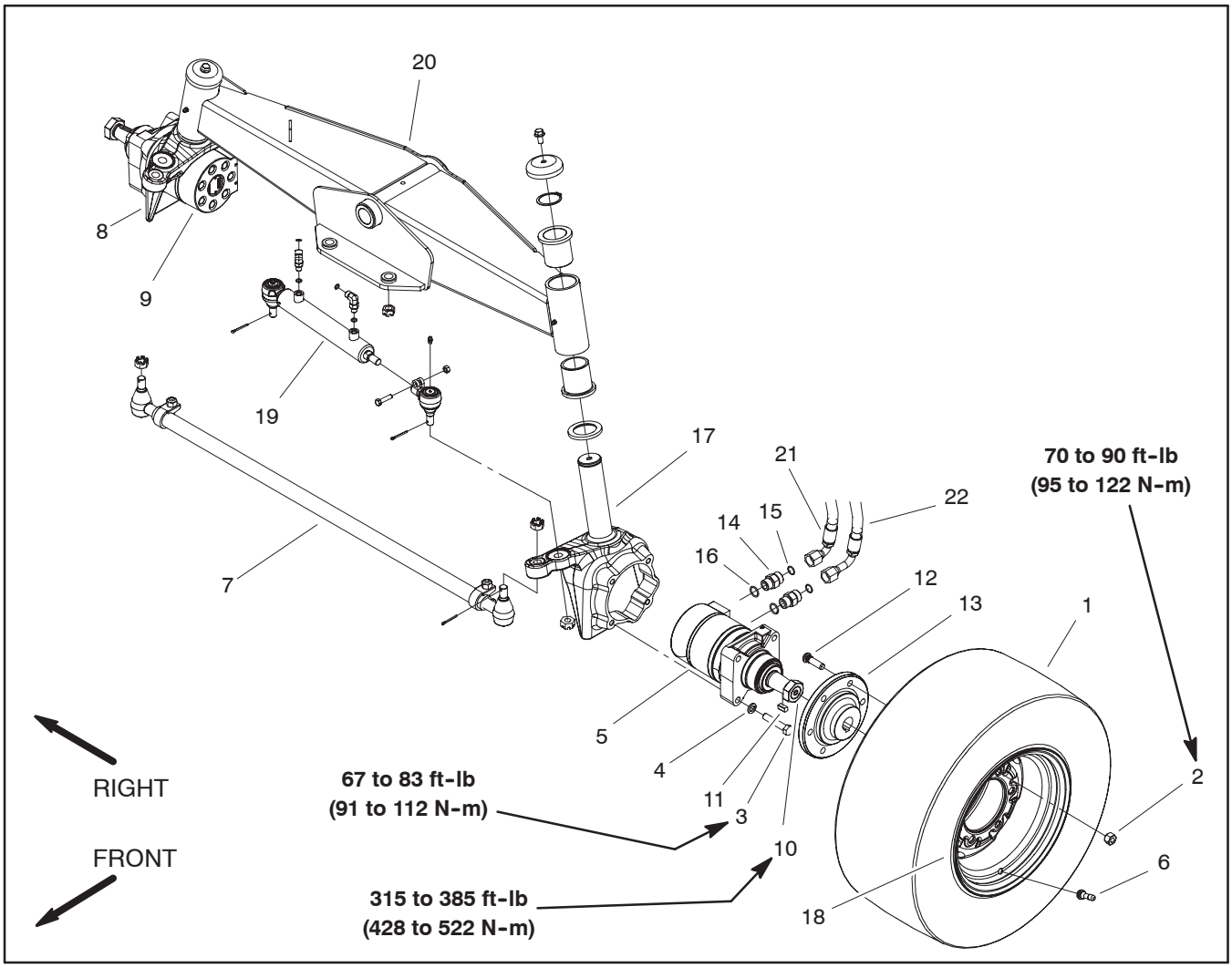


Figure 59

1. Rear tire
2. Lug nut (6 used per wheel)
3. Cap screw (4 used per motor)
4. Lock washer (4 used per motor)
5. LH wheel motor
6. Valve stem
7. Tie rod assembly
8. RH steering spindle
9. RH wheel motor
10. Hex nut
11. Square key
12. Wheel stud (6 used per wheel)
13. Wheel hub
14. Hydraulic fitting
15. O-ring
16. O-ring
17. LH steering spindle
18. Wheel rim
19. Steering cylinder (2 used)
20. Rear axle
21. Hydraulic hose
22. Hydraulic hose

Removal (Fig. 59)

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved. See Relieving Hydraulic System Pressure in the General Information section.

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.

2. Chock front wheels to prevent machine from shifting.

3. Loosen, but do not remove, six (6) wheel lug nuts and hex nut (item 10) that secures wheel hub to wheel motor.

WARNING

Before jacking up the machine, review and follow Jacking Instructions in Chapter 1 - Safety.

4. Jack up machine enough to allow the removal of the rear wheel. Support machine with jack stands.

5. Remove rear wheel assembly from the machine (see Rear Wheel Removal in the Service and Repairs section of Chapter 6 – Chassis).

IMPORTANT: DO NOT hit wheel hub, wheel hub puller or wheel motor with a hammer during removal or installation. Hammering may cause damage to the wheel motor.

6. Make sure that hex nut (item 10) that secures wheel hub to wheel motor is loosened at least two (2) turns. Use hub puller (see Special Tools) to loosen wheel hub from wheel motor.

7. Remove loosened hex nut and wheel hub from motor shaft. Locate and retrieve square key from wheel motor shaft.

8. Thoroughly clean hydraulic hose ends and fittings on rear wheel motor to prevent hydraulic system contamination.

9. Label all hydraulic hoses for assembly purposes. Remove hydraulic hoses from fittings on wheel motor. Allow hoses to drain into a suitable container.

10. Remove hydraulic fittings from wheel motor. Remove and discard O–rings from fittings.

11. Put clean plugs in disconnected hydraulic hoses and wheel motor ports to prevent system contamination.

12. Support the wheel motor to prevent it from falling during removal.

13. Remove four (4) cap screws and lock washers that secure wheel motor to the steering spindle.

14. Remove wheel motor from frame.

Installation (Fig. 59)

IMPORTANT: Because of internal differences in rear wheel motors, DO NOT interchange rear wheel motors on machine (i.e. do not put right side motor on left side of machine). The left side wheel motor has a yellow identification mark on the motor housing. If necessary, use parts catalog and part number on wheel motor to identify RH and LH motors.

1. Position rear wheel motor to steering spindle. Make sure that ports in wheel motor are facing toward the rear of the machine.

2. Secure wheel motor to spindle with four (4) cap screws and lock washers. Torque screws from **67 to 83 ft-lb (91 to 112 N-m)**.

3. Remove plugs from disconnected hydraulic hoses and wheel motor ports.

4. Lubricate and install new O–rings to hydraulic fittings. Install fittings into wheel motor ports (see Hydraulic Fitting Installation in the General Information section of this chapter).

5. Remove caps or plugs placed during removal to prevent contamination.

6. Using labels placed during the removal process, properly connect hydraulic hoses to wheel motor fittings (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Make sure that tapers of wheel motor shaft and wheel hub are thoroughly clean.

8. Position square key to keyslot in wheel motor shaft.

IMPORTANT: Do not reuse hex nut that secures wheel hub to wheel motor after it has been removed.

9. Place wheel hub on motor shaft and secure with new hex nut (item 10).

10. Install wheel assembly to the machine and secure with six (6) lug nuts.

11. Lower the machine to the ground.

WARNING

Failure to properly tighten nut that secures wheel hub or wheel lug nuts could result in failure or loss of wheel and may result in personal injury.

12. Torque hex nut (item 10) from **315 to 385 ft-lb (428 to 522 N-m)**.

13. Torque wheel lug nuts from **70 to 90 ft-lb (95 to 122 N-m)**.

14. Make sure hydraulic tank is full. Add correct oil if necessary.

15. After assembly is completed, verify that hydraulic hoses and fittings do not contact anything through full range of axle motion. Also, check for any hydraulic leaks.

Rear Wheel Motor Service

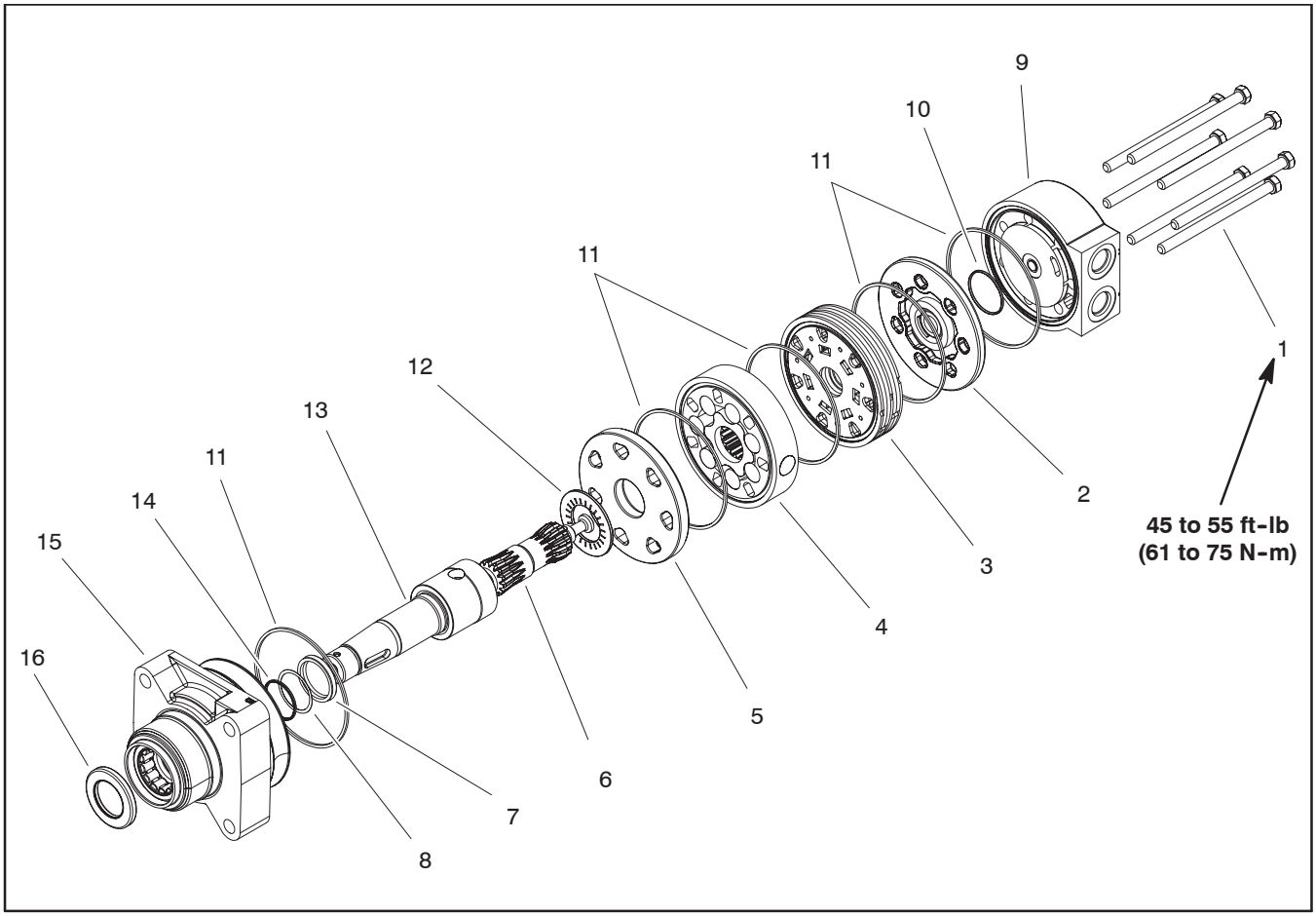


Figure 60

1. Cap screw (7 used)
2. Commutator assembly
3. Manifold
4. Stator assembly
5. Wear plate
6. Drive link
7. Shaft seal
8. Back-up washer
9. End cover
10. Commutator ring
11. Body seal (5 used)
12. Thrust bearing
13. Coupling shaft
14. Back-up ring
15. Housing
16. Dirt and water seal

NOTE: The rear wheel motors on Groundsmaster 5900 and 5910 machines are Parker Torqmotor™ TG Series. Right and left motors are the same basic design but the right side motor has a reverse timed manifold to allow correct rotation direction for forward and reverse. The left side wheel motor has a yellow identification mark on the motor housing.

NOTE: For rear wheel motor repair procedures, see the Parker Torqmotor™ Service Procedure (TC, TB, TE, TJ, TF, TG, TH and TL Series) at the end of this chapter.

IMPORTANT: If a wheel motor failure occurred, refer to Traction Circuit Component Failure in the General Information section for information regarding the importance of removing contamination from the traction circuit.

This page is intentionally blank.

Traction Control Manifold

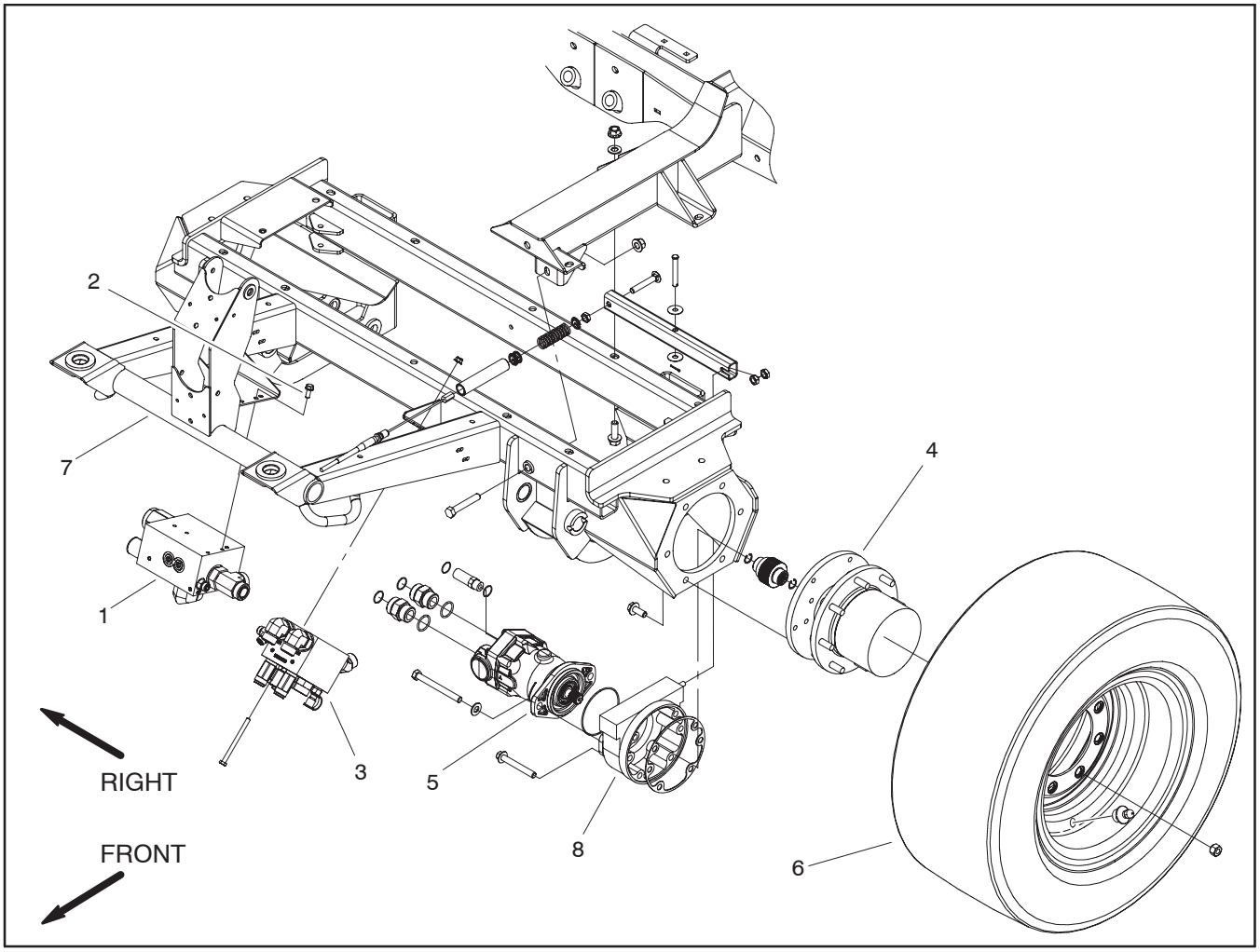


Figure 61

1. **Traction control manifold**
2. **Flange head screw (4 used)**
3. **Front PTO control manifold**
4. **Planetary assembly**
5. **LH front wheel motor**
6. **Front wheel assembly**
7. **Frame assembly**
8. **Brake assembly**

NOTE: The ports on the traction control manifold are marked for easy identification of components. Example: P is the piston pump connection port and S is the location for the solenoid valve (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

Removal (Fig. 61)

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold and fittings.

3. Disconnect wire harness connector from the solenoid valve.

4. Disconnect all hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings to prevent system contamination. Label disconnected hydraulic lines for proper assembly.

5. Remove hydraulic manifold from the frame using Figure 61 as guide.

6. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

Installation (Fig. 61)

1. If fittings were removed from manifold, lubricate and place new O-rings onto fittings. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings. Refer to Figure 62 for straight fitting installation torque. For information on tightening procedures for other manifold fittings, see Hydraulic Fitting Installation in the General Information section of this chapter.

2. Install traction control manifold to the frame using Figure 61 as guide.

3. Remove caps and plugs from fittings and hoses. Using labels placed during removal, properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Connect wire harness connector to the solenoid valve.

5. Make sure hydraulic tank is full. Add correct oil if necessary.

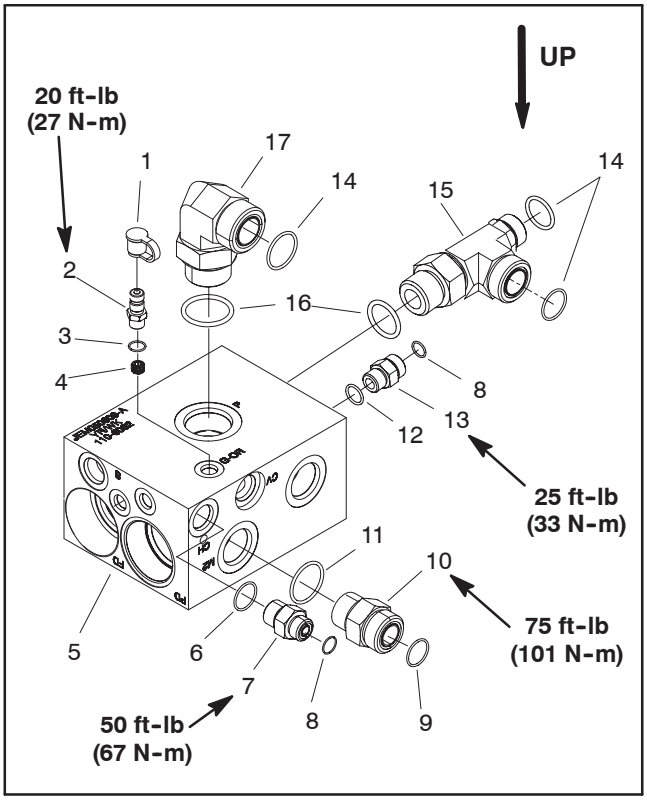


Figure 62

1. Dust cap
2. Quick fitting (G-OR)
3. O-ring
4. Orifice (G-OR)
5. Manifold
6. O-ring
7. Straight fitting (CH)
8. O-ring
9. O-ring
10. Straight fitting (M2)
11. O-ring
12. O-ring
13. Straight fitting (CD)
14. O-ring
15. Tee fitting (M1)
16. O-ring
17. 90° fitting (P)

Traction Control Manifold Service

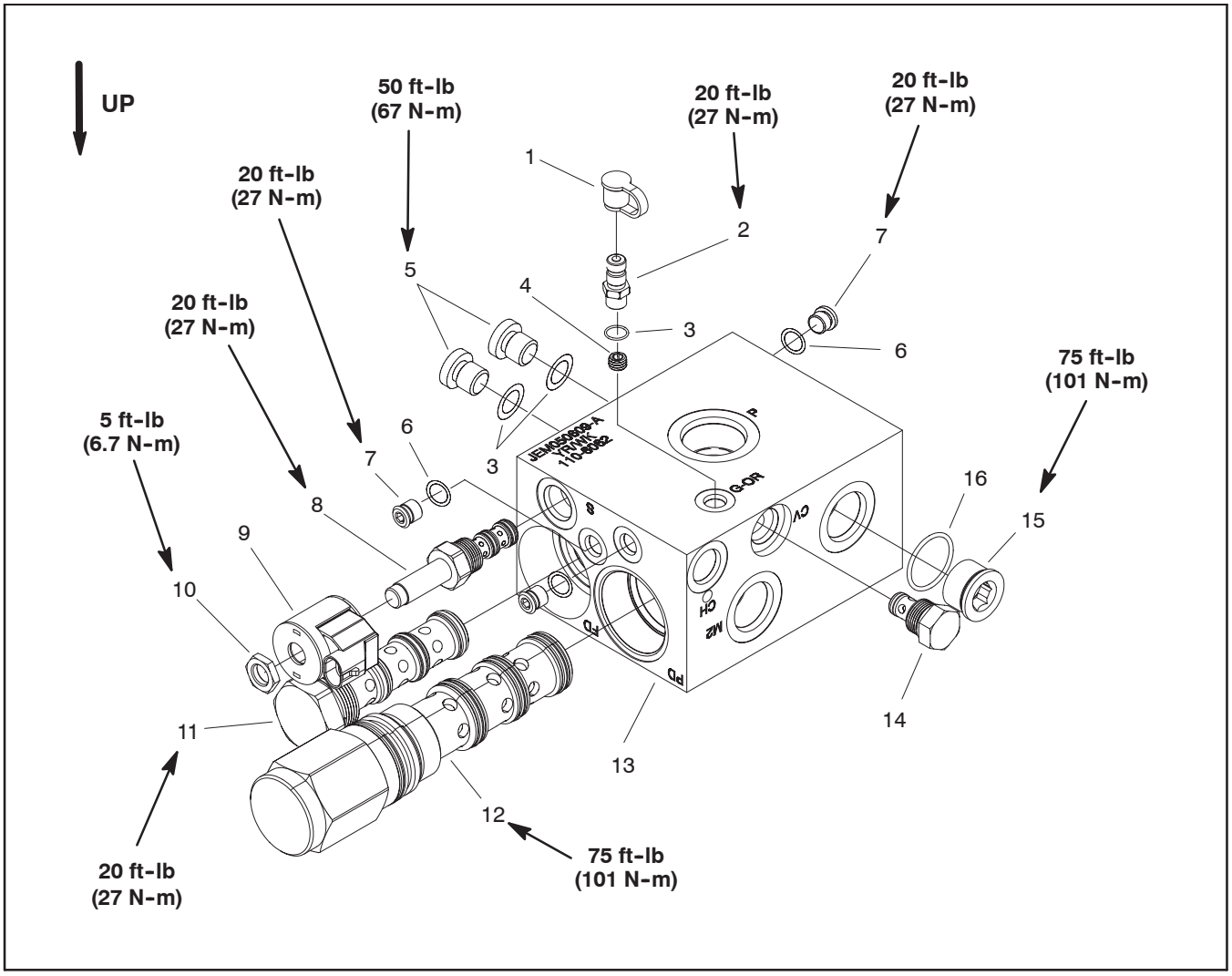


Figure 63

1. Dust cap
2. Quick fitting (G-OR)
3. O-ring
4. Orifice (G-OR)
5. #8 NWD plug
6. O-ring
7. #4 NWD plug (3 used)
8. Solenoid valve (S)
9. Solenoid coil
10. Nut
11. Flow divider (FD)
12. Pilot directional valve (PD)
13. Manifold body
14. Check valve (CV)
15. #12 NWD plug
16. O-ring

NOTE: The ports on the traction control manifold are marked for easy identification of components. Example: P is the piston pump connection port and S is the location for the solenoid valve (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

NOTE: The traction control manifold includes several zero leak NWD plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O–ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing plugs, refer to Figure 63 for plug installation torque.

Valve Cartridge Service

1. Make sure the entire outer surface of the manifold is clean before removing the valve.

2. If cartridge is solenoid operated, remove nut securing solenoid coil to the cartridge valve. Carefully slide solenoid coil off the valve.

IMPORTANT: Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction.

3. Remove cartridge valve with a deep socket wrench. Note correct location for O−rings, sealing rings and backup rings. Remove and discard seal kit.

4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads and contamination. Also, inspect cartridge valve for damaged sealing surfaces and contamination.

A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.

B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air.

5. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful to not damage cartridge. Use compressed air for cleaning.

6. Reinstall the cartridge valve:

A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The O−rings, sealing rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.

IMPORTANT: Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction.

B. Thread cartridge valve carefully into manifold port. The valve should go in easily without binding.

C. Torque cartridge valve using a deep socket to value identified in manifold illustration.

D. If cartridge is solenoid operated, carefully install solenoid coil to the cartridge valve. Torque nut to value identified in manifold illustration. Over−tightening may damage the solenoid or cause the valve to malfunction.

7. If problems still exist, remove valve and clean again or replace valve.

4WD Control Manifold

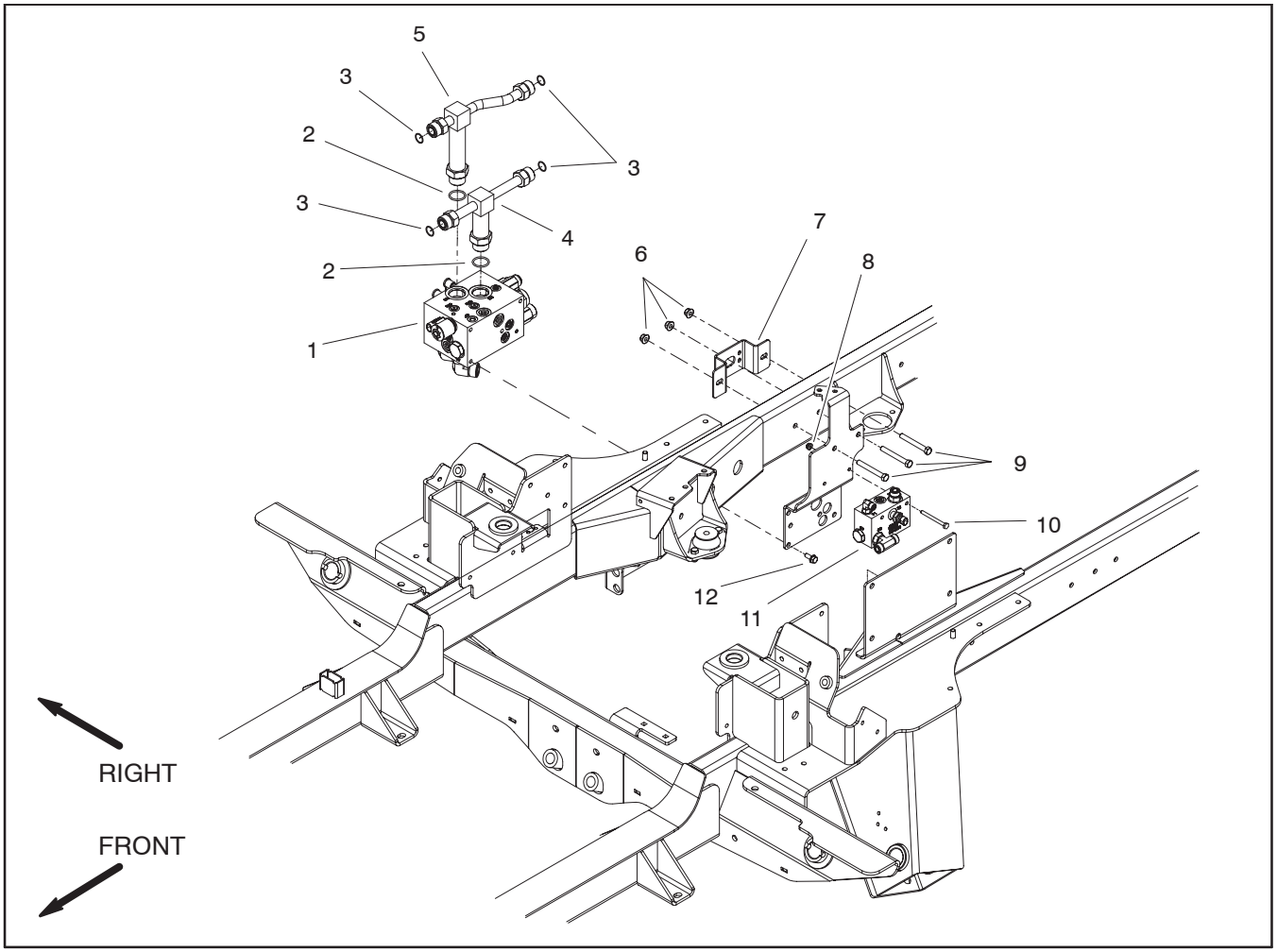


Figure 64

1. **4WD control manifold**
2. **O-ring**
3. **O-ring**
4. **Hydraulic tee fitting**
5. **Hydraulic tee fitting**
6. **Flange nut**
7. **Bulkhead mount plate**
8. **Flange nut (2 used)**
9. **Cap screw**
10. **Cap screw (2 used)**
11. **Flush manifold**
12. **Flange screw (4 used)**

NOTE: The ports on the 4WD control manifold are marked for easy identification of components. Example: P1 is the pump supply port for the forward direction and S is the location for the solenoid valve (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

Removal (Fig. 64)

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold and fittings.

3. Disconnect wire harness connector from the solenoid valve.

4. Disconnect all hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly.

5. Support manifold to prevent it from falling.

6. Remove four (4) flange screws that secure 4WD control manifold to frame. Remove manifold from frame.

7. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

Installation (Fig. 64)

1. If fittings were removed from manifold:

   A. Lubricate new O-rings with clean hydraulic oil. Install lubricated O-rings on fittings.

   B. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings.

   C. Refer to Figure 65 for straight fitting installation torque. For information on tightening procedures for adjustable fittings, see Hydraulic Fitting Installation in the General Information section of this chapter.

2. Position 4WD control manifold to the frame and secure with four (4) flange screws.

3. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Connect wire harness connector to the solenoid valve.

5. Make sure hydraulic tank is full. Add correct oil if necessary.

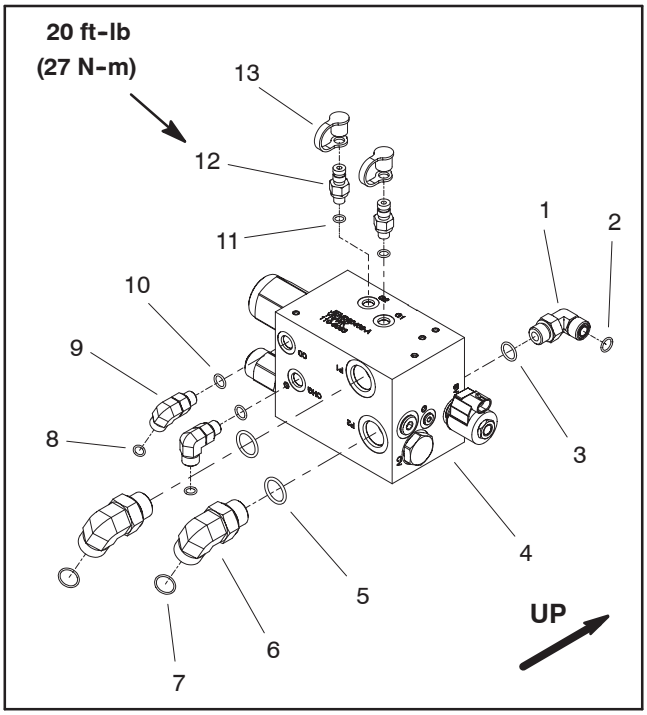


Figure 65

1. 90º fitting (P3)
2. O-ring
3. O-ring
4. 4WD manifold
5. O-ring
6. 90º fitting (P1 & P2)
7. O-ring
8. O-ring
9. 90º fitting (CHG & CD)
10. O-ring
11. O-ring
12. Quick fitting (G1 & G2)
13. Dust cap

4WD Control Manifold Service

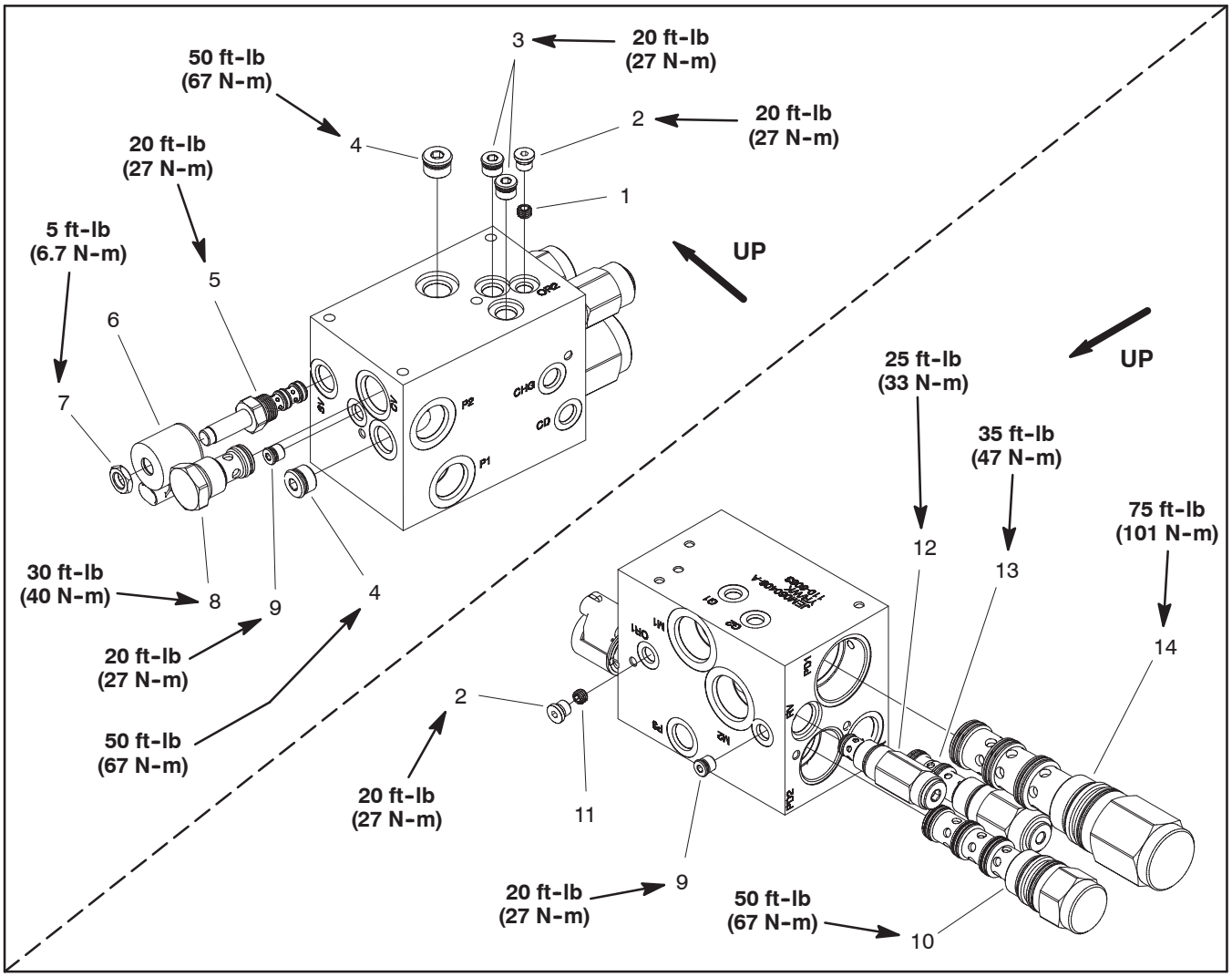


Figure 66

1. Orifice (0.040) (OR2)
2. Plug with O-ring
3. NWD #6 plug with O-ring
4. NWD #8 plug with O-ring
5. Solenoid valve (SV)
6. Solenoid coil
7. Nut
8. Check valve (CV)
9. NWD #4 plug with O-ring
10. Directional pilot valve (PD2)
11. Orifice (0.030) (OR1)
12. Relief valve (RV)
13. Pressure valve (PR)
14. Directional pilot valve (PD1)

NOTE: The ports on the 4WD control manifold are marked for easy identification of components. Example: P1 is the pump supply port for the forward direction and RV is the location for the relief valve (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

Valve Cartridge Service (Fig. 66)

For solenoid and control valve service procedures, see Hydraulic Traction Control Manifold Service in this section. Refer to Figure 66 for 4WD control manifold cartridge valve and plug installation torque.

NOTE: The 4WD control manifold includes several zero leak NWD plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O–ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing plugs, refer to Figure 66 for plug installation torque.

IMPORTANT: An orifice is placed beneath the plugs in the control manifold OR1 and OR2 ports. If one of these plugs is removed, make sure to remove orifice and label its position for assembly purposes.

This page is intentionally blank.

Traction Flush Manifold

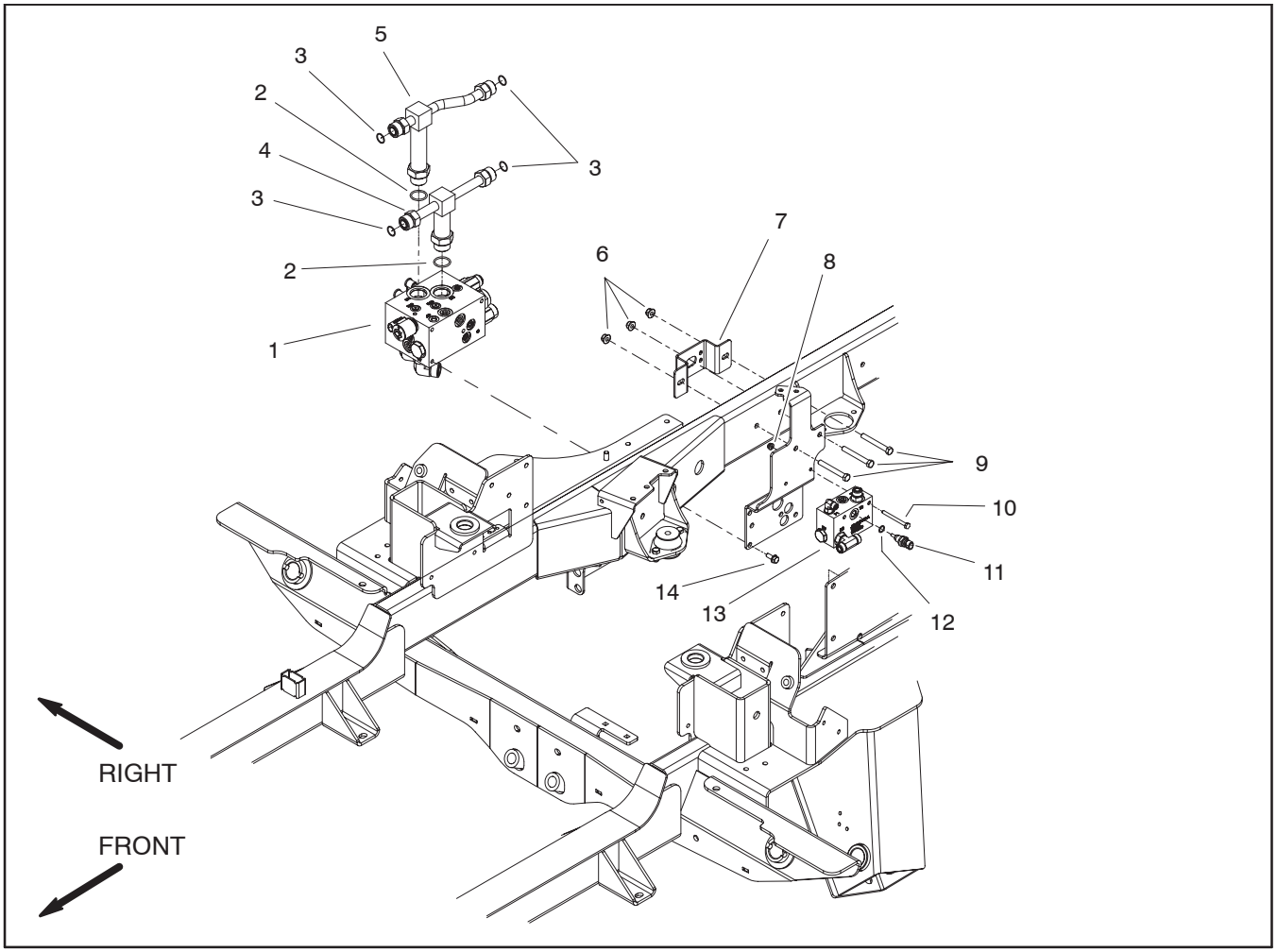


Figure 67

1. **4WD control manifold**
2. **O-ring**
3. **O-ring**
4. **Hydraulic tee fitting**
5. **Hydraulic tee fitting**
6. **Flange nut**
7. **Bulkhead mount plate**
8. **Flange nut (2 used)**
9. **Cap screw**
10. **Cap screw (2 used)**
11. **Hydraulic oil temp sender**
12. **O-ring**
13. **Flush manifold assembly**
14. **Flange screw (4 used)**

NOTE: The ports on the traction flush manifold are marked for easy identification of components. Example: CV is the check valve port and TS is the temperature sender port (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

NOTE: The traction flush manifold includes a zero leak NWD plug. This plug has a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plug also has an O-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug. When installing plug, refer to Figure 68 for plug installation torque.

Removal (Fig. 67)

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold and fittings.

3. Disconnect hydraulic lines from flush manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly.

4. Support flush manifold to prevent it from falling. Remove two (2) cap screws and flange nuts that secure manifold to frame (Fig. 67). Remove flush manifold from the machine.

5. If hydraulic fittings are to be removed from flush manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

Installation (Fig. 67)

1. If fittings were removed from manifold:

   A. Lubricate new o-rings with clean hydraulic oil. Install lubricated o-rings on fittings.

   B. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings.

   C. Refer to Figure 68 for straight fitting installation torque. For information on tightening procedures for adjustable fittings, see Hydraulic Fitting Installation in the General Information section of this chapter.

2. Refer to Figure 68 for check valve, shuttle valve and plug installation torque.

3. Position flush manifold to the frame and secure with two (2) cap screws and flange nuts.

4. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Make sure hydraulic tank is full. Add correct oil if necessary.

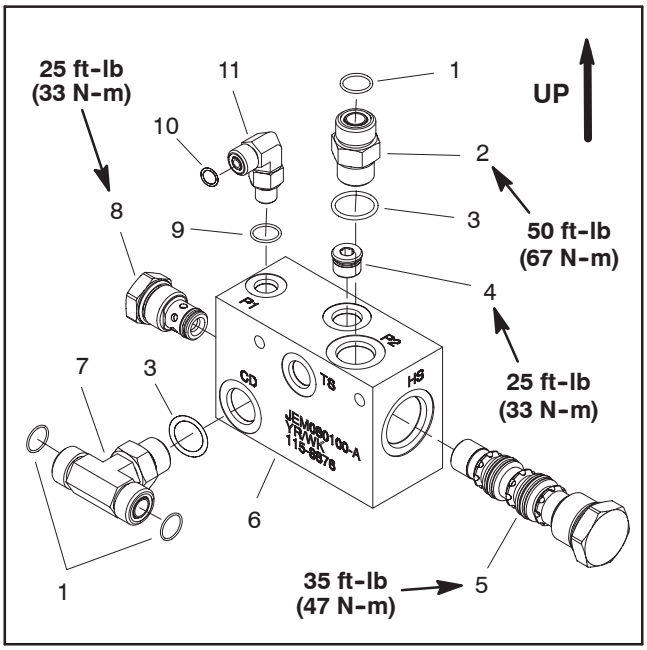


Figure 68

1. O-ring
2. Straight fitting (P2)
3. O-ring
4. #6 NWD plug/O-ring
5. Shuttle valve (HS)
6. Flush manifold
7. Tee fitting (CD)
8. Check valve (CV)
9. O-ring
10. O-ring
11. 90° fitting (P1)

PTO Circuit

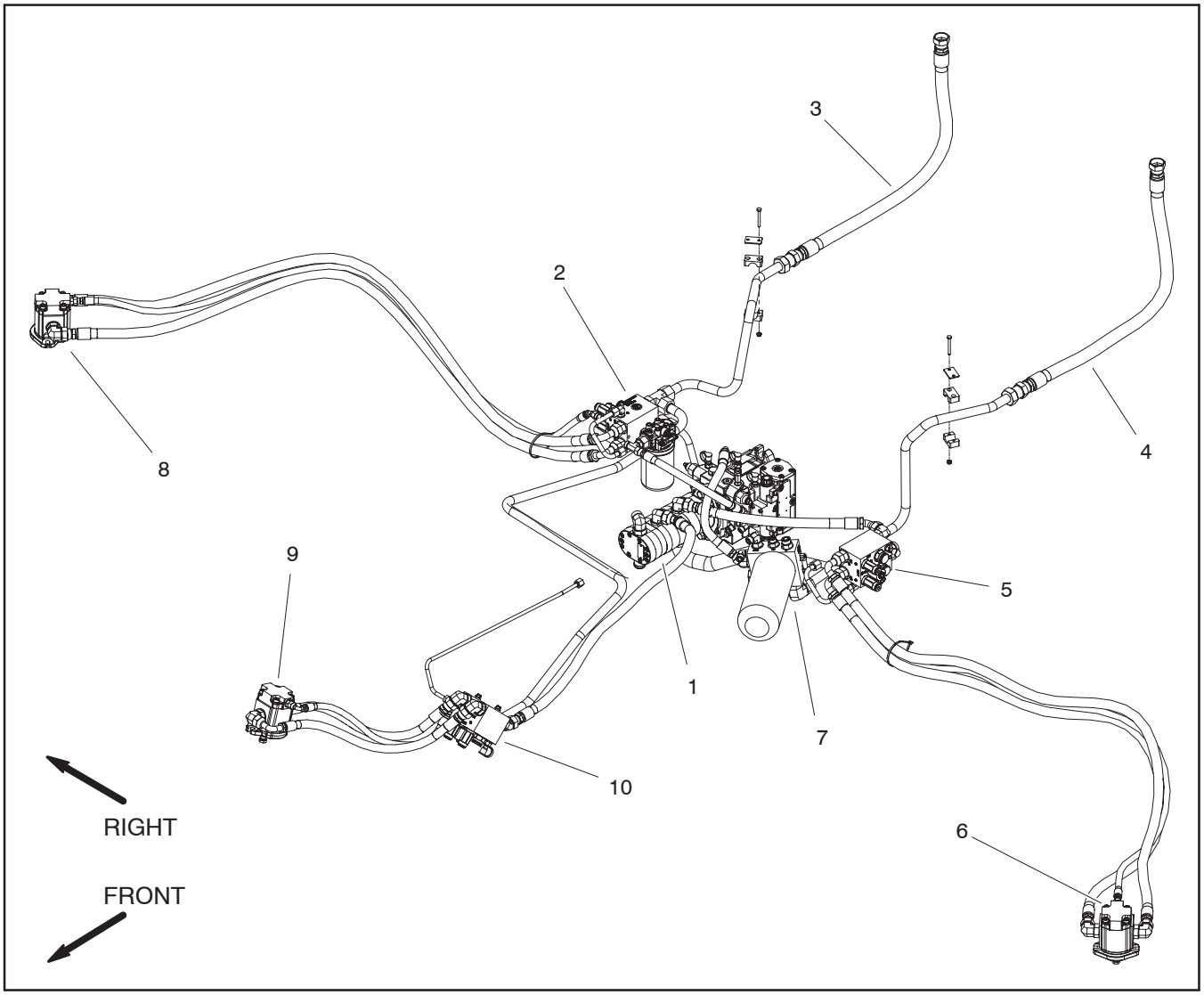


Figure 69

1. **Gear pump**
2. **RH PTO control manifold**
3. **Hydraulic hose to oil cooler**
4. **Hydraulic hose from oil cooler**
5. **LH PTO control manifold**
6. **LH cutting deck motor**
7. **Filter manifold**
8. **RH cutting deck motor**
9. **Front cutting deck motor**
10. **Front PTO control manifold**

Figure 69 illustrates the components that are used in the Groundsmaster PTO circuit. Procedures for removal, installation and disassembly/assembly of these components are provided on the following pages of this section.

This page is intentionally blank.

Cutting Deck Motor

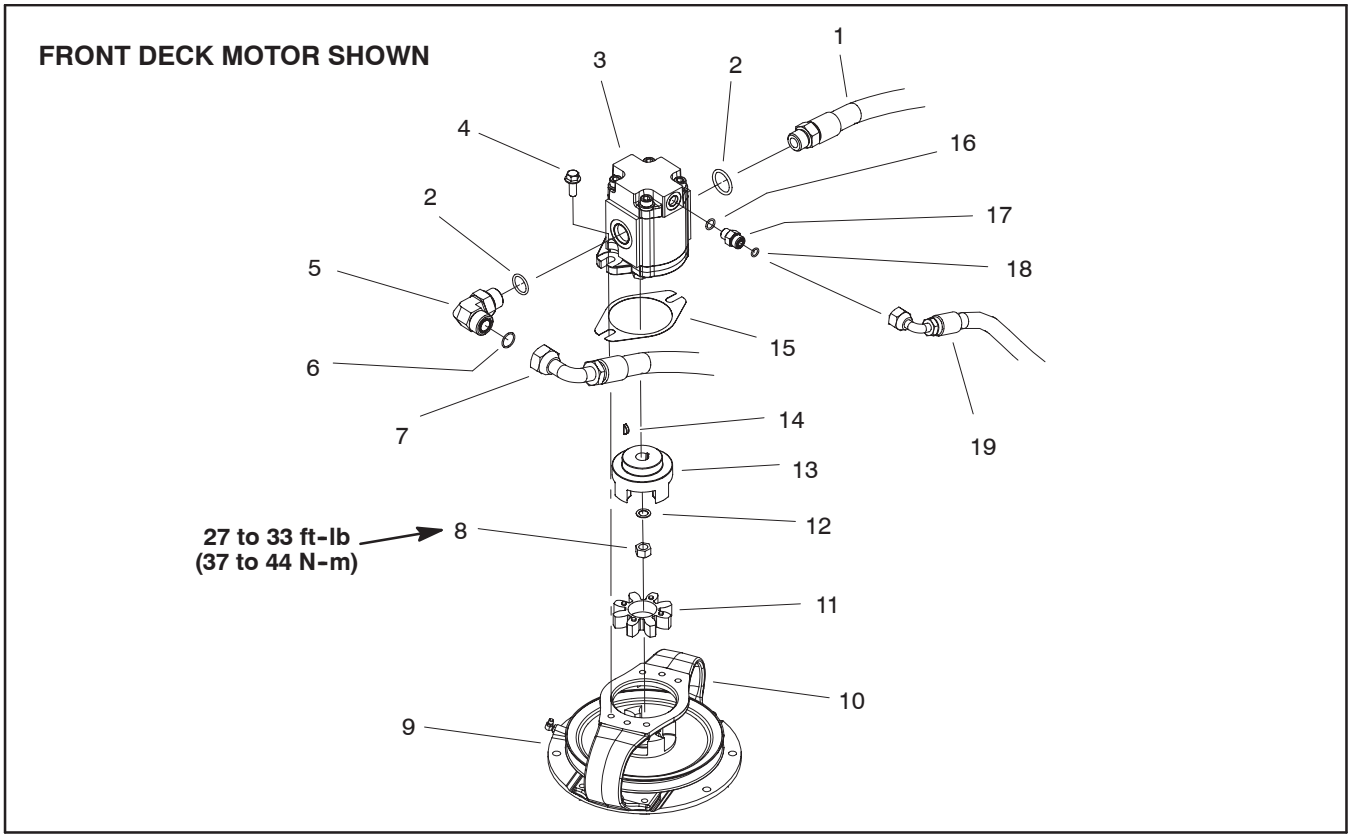


Figure 70

1. **Hydraulic hose**
2. **O-ring**
3. **Cutting deck motor**
4. **Flange head screw (2 used)**
5. **90º hydraulic fitting**
6. **O-ring**
7. **Hydraulic hose**
8. **Hex nut**
9. **Spindle assembly**
10. **Motor mount**
11. **Spider**
12. **Washer**
13. **Spider hub**
14. **Woodruff key**
15. **Mounting shim (if equipped)**
16. **O-ring**
17. **Hydraulic fitting**
18. **O-ring**
19. **Hydraulic hose**

Removal (Fig. 70)

1. Park machine on a level surface, lower cutting decks, stop engine, apply parking brake and remove key from the ignition switch.

2. Remove cutting deck cover to gain access to cutting deck motor.

3. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

4. Label hydraulic lines for proper assembly. Disconnect hydraulic hoses from deck motor. Put caps or plugs on fittings and hoses to prevent contamination.

5. Remove two (2) flange head screws that secure hydraulic motor to motor mount.

6. Carefully remove hydraulic motor from cutting deck taking care not to damage spider hub attached to motor. Locate and remove spider and mounting shim(s) (if present) from the deck.

7. If hydraulic fittings are to be removed from deck motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

8. If required, remove hex nut and washer that secure spider to motor shaft. Use suitable puller to remove hub from shaft. Remove woodruff key.

Installation (Fig. 70)

1. If fittings were removed from deck motor, lubricate and place new O-rings onto fittings. Install fittings into motor ports using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. If removed, install woodruff key and spider hub to motor shaft. Secure with washer and hex nut. Torque nut from **27 to 33 ft-lb (37 to 44 N-m)**.

3. Check for proper clearance between spider hub and spindle pulley. Install motor to cutting deck without placing the spider in the spindle pulley. The clearance between hub and pulley valleys should be from 0.830" to 0.930" (21.1 to 23.6 mm). If required, use mounting shim(s) between motor and motor mount to adjust clearance.

4. Position spider in spindle pulley. Place mounting shim(s) (if required) on deck. Carefully install hydraulic motor to the cutting deck taking care to not damage spider hub attached to motor.

5. Secure motor to cutting deck with two (2) flange head screws.

IMPORTANT: For proper hydraulic hose routing, make sure cutting decks are fully lowered before installing hoses to deck motor.

6. Remove caps or plugs from fittings and hoses. Connect hydraulic hoses to deck motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by moving components through full range of deck movement.

8. Install cutting deck cover.

9. Fill reservoir with new hydraulic fluid as required.

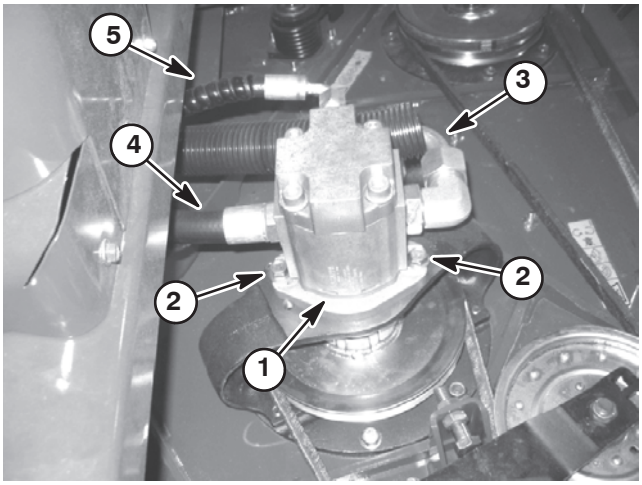


Figure 71

1. **Deck motor (front)**
2. **Flange head screw**
3. **Inlet hose**
4. **Return hose**
5. **Case drain hose**

Cutting Deck Motor Service

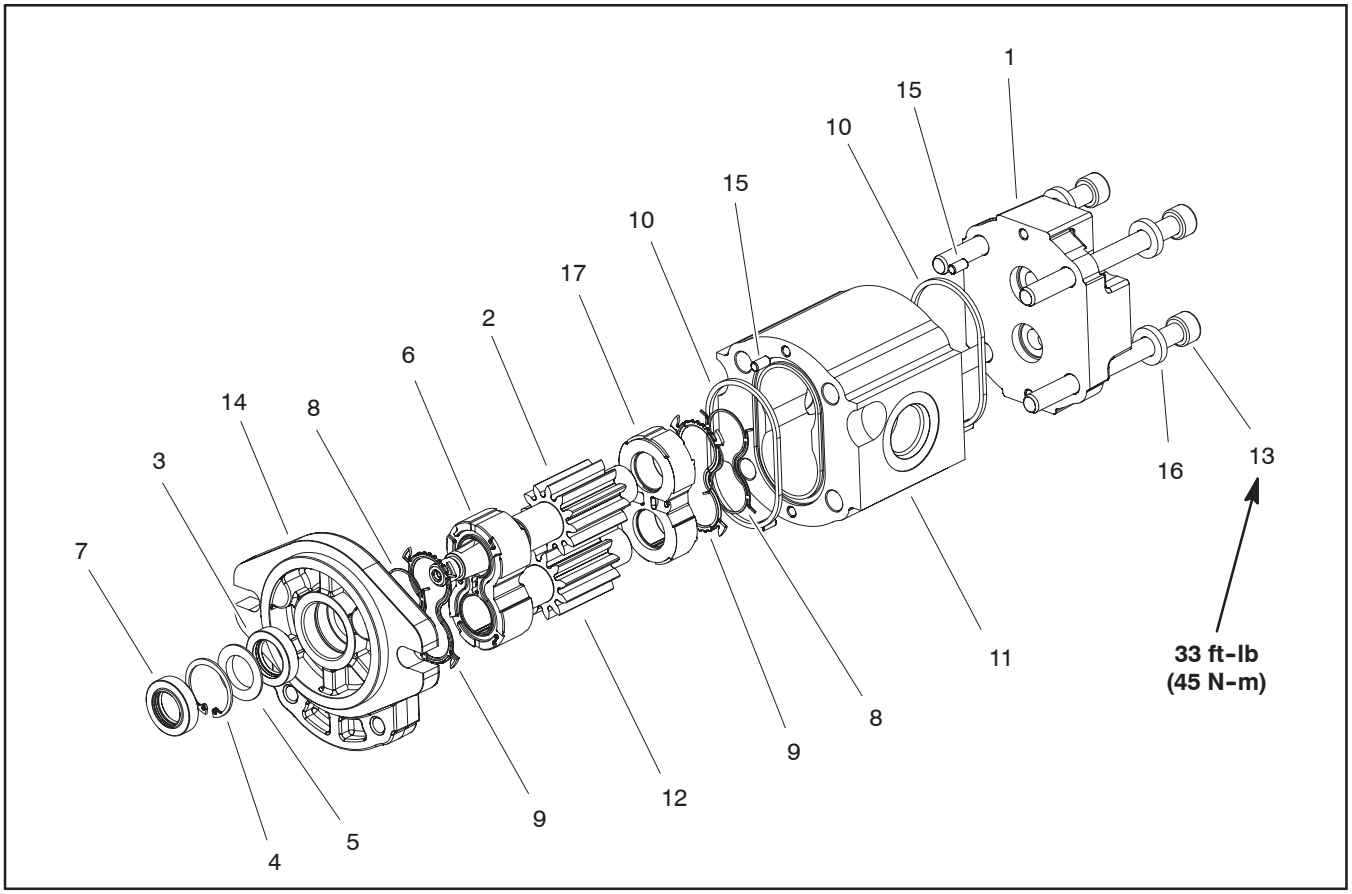


Figure 72

1. **Rear cover**
2. **Drive gear**
3. **Shaft seal**
4. **Retaining ring**
5. **Flange washer**
6. **Front wear plate**
7. **Dust seal**
8. **Pressure seal**
9. **Back-up gasket**
10. **O-ring**
11. **Body**
12. **Idler gear**
13. **Cap screw (4 used)**
14. **Front flange**
15. **Dowel pin (4 used)**
16. **Washer (4 used)**
17. **Rear wear plate**

Disassembly (Fig. 72)

1. Plug motor ports and clean the outside of the motor thoroughly. After cleaning, remove plugs and drain any oil out of the motor.

2. Remove nut and washer that secure spider hub to motor shaft (Fig. 73). Use suitable puller to remove hub from shaft. Remove woodruff key.

3. Use a marker to make a **diagonal** line across the front flange, body and rear cover for assembly purposes (Fig. 74).

IMPORTANT: To prevent distorting the motor housing during disassembly, do not clamp housing in a vise.

4. Clamp front flange of motor in a vise with soft jaws with the shaft end down.

5. Loosen cap screws from the rear cover.

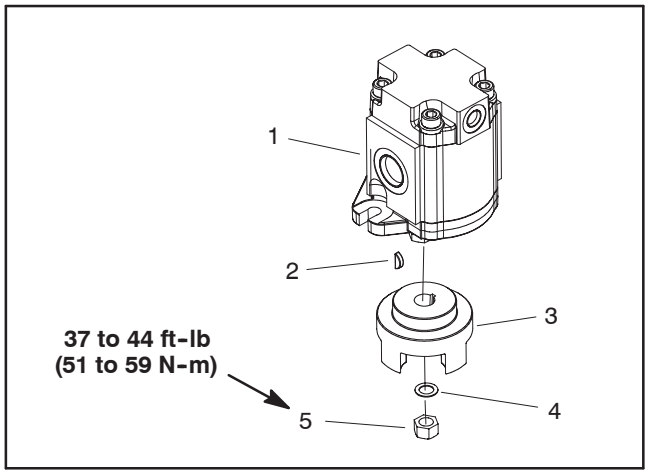


Figure 73

1. **Deck motor**
2. **Woodruff key**
3. **Spider hub**
4. **Washer**
5. **Nut**

6. Remove motor from the vise and remove cap screws.

7. Remove rear cover from the body.

8. Carefully remove body. Lift body straight up to remove. Make sure the rear wear plate remains on the drive and idler gear shafts. Remove and discard O–rings from the body. Locate and retrieve dowel pins.

IMPORTANT: Note position of the open and closed side of the wear plates before removing. Also, identify wear plates (front and rear) with a marker for proper assembly.

9. Carefully remove rear wear plate, idler gear, drive gear and front wear plate from the front flange.

10. Remove and discard back–up gaskets and pressure seals from wear plates.

11. Turn front flange over, with seal side up.

IMPORTANT: Make sure not to damage the front flange counter bore when removing the seals from the front flange.

12. Carefully remove dust seal, retaining ring, flange washer and shaft seal from the front flange (Fig. 76). Discard seals.

Inspection

1. Remove any nicks and burrs from all parts with emery cloth.

CAUTION

Use eye protection such as goggles when using compressed air.

2. Clean all parts with solvent. Dry all parts with compressed air.

3. Inspect drive gears and idler gears for the following (Fig. 75):

A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.

B. Gear teeth should be free of excessive scoring and wear. Any broken or nicked gear teeth must be replaced.

C. Inspect gear face edge for sharpness. Sharp edges of gears will mill into wear plates and, thus, must be replaced.

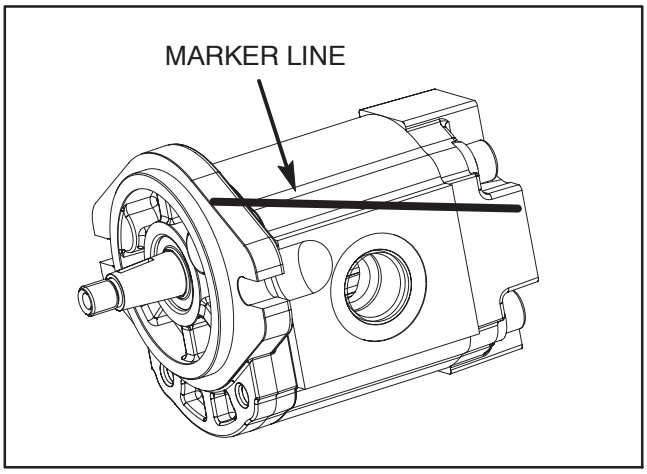


Figure 74

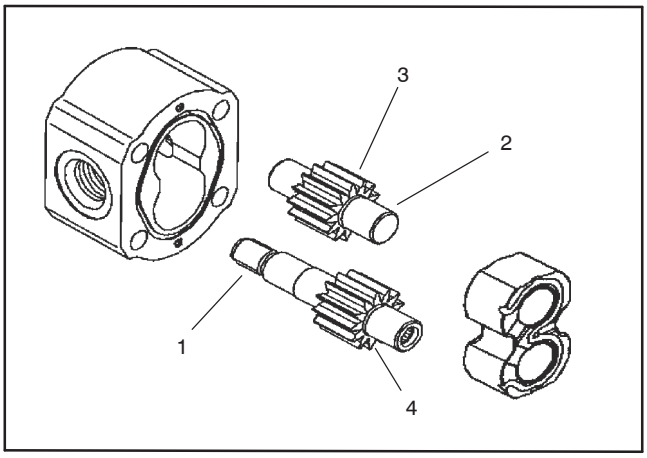


Figure 75

1. **Gear shaft spline**
2. **Gear shaft**
3. **Gear teeth**
4. **Gear face edge**

4. Inspect wear plates for the following:

A. Bearing areas should not have excessive wear or scoring.

B. Face of wear plates that are in contact with gears should be free of wear, roughness or scoring.

C. Thickness of wear plates should be equal.

5. Inspect front flange and rear cover for damage or wear.

Assembly (Fig. 72)

NOTE: When assembling the motor, check the marker line on each part to make sure the parts are properly aligned during assembly.

1. Lubricate O–rings, pressure seals, back–up gaskets and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

2. Install new seals into front flange (Fig. 76):

   A. Press shaft seal into front flange until it reaches the bottom of the bore.

   B. Install flange washer into front flange and then install retaining ring into the groove of the front flange.

   C. Install new dust seal into front flange.

3. Place front flange, seal side down, on a flat surface.

4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the backup gaskets, flat side outward, between the pressure seals and the grooves in the wear plate.

5. Apply a light coating of petroleum jelly to the exposed side of the front flange.

6. Lubricate the drive gear shaft with clean hydraulic oil. Insert the drive end of the drive shaft through the wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor. Carefully install shaft into front flange.

7. Lubricate the idler gear shaft with clean hydraulic oil. Install idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic oil to gear faces.

8. Install rear wear plate with pressure seal side up and open side of the pressure seal pointing to the inlet side of the motor.

9. Apply a light coating of petroleum jelly to new O-rings and O-ring grooves in the body. Install new O-rings to the body.

10. Install locating dowels in body. Align marker line on the body and front flange.

IMPORTANT: Do not dislodge seals during installation.

11. Gently slide the body onto the assembly. Firm hand pressure should be sufficient to engage the dowels.

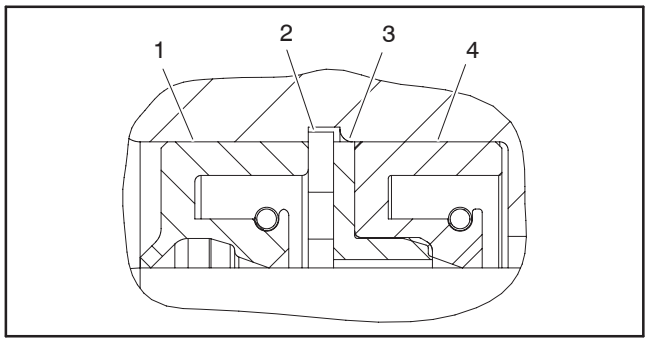


Figure 76

1. **Dust seal**
2. **Retaining ring**
3. **Flange washer**
4. **Shaft seal**

12. Check to make sure that the surface of the rear wear plate is slightly below the face of the body. If the wear plate is not below the body, check assembly for a shifted pressure seal, backup gasket or O-ring. Correct before proceeding.

13. Apply a light coating of petroleum jelly to the exposed side of the rear cover.

14. Place rear cover on assembly using marker line for proper location. Firm hand pressure should be sufficient to engage the dowels.

15. Install the four (4) cap screws with washers and hand tighten.

IMPORTANT: Avoid using excessive clamping pressure on the motor housing to prevent distorting the housing.

16. Place front flange of the motor into a vise with soft jaws and alternately torque the cap screws **33 ft-lb (45 N-m)**.

17. Remove motor from vise.

18. Place a small amount of clean hydraulic oil in the inlet of the motor and rotate the drive shaft away from the inlet one revolution. If any binding is noted, disassemble the motor and check for assembly problems.

This page is intentionally blank.

PTO Control Manifolds

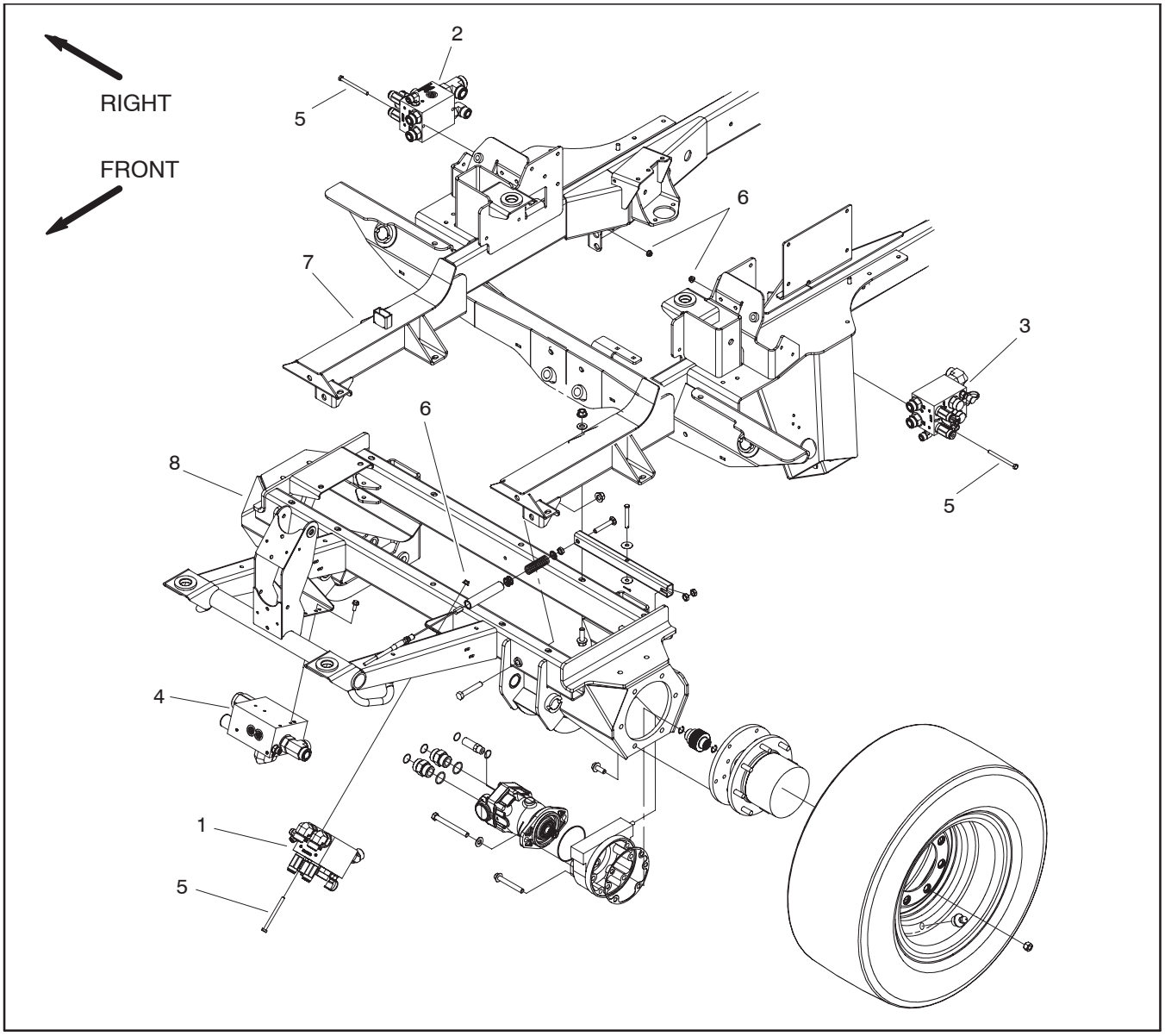


Figure 77

1. **Front PTO control manifold**
2. **RH PTO control manifold**
3. **LH PTO control manifold**
4. **Traction control manifold**
5. **Cap screw (2 used per manifold)**
6. **Flange nut (2 used per manifold)**
7. **Main frame**
8. **Front axle frame**

The control manifolds for the three cutting deck sections are very similar. **Note:** When servicing the PTO control manifolds, **DO NOT** interchange parts from one control manifold to another.

NOTE: The ports on the PTO control manifolds are marked for easy identification of components. Example: S is the solenoid valve and M2 is the return from the deck motor (see Hydraulic Schematic in Chapter 10 – Foldout Drawings to identify the function of the hydraulic lines and cartridge valves at each port).

Removal (Fig. 77)

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

2. To prevent contamination of hydraulic system during manifold removal, thoroughly clean exterior of manifold and fittings.

3. Disconnect wire harness connector from the manifold solenoid valve.

4. Disconnect hydraulic lines from manifold and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper assembly.

5. Support PTO control manifold to prevent it from falling.

6. Remove two (2) cap screws and flange nuts that secure manifold to frame. Remove PTO control manifold from the frame.

7. If hydraulic fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O–rings.

Installation (Fig. 77)

1. If fittings were removed from manifold:

   A. Lubricate new O–rings with clean hydraulic oil. Install lubricated O–rings on fittings.

   B. Install fittings into manifold openings using marks made during the removal process to properly orientate fittings.

   C. Refer to Figures 78, 79 and 80 for straight fitting installation torque. For information on tightening procedures for adjustable fittings, see Hydraulic Fitting Installation in the General Information section of this chapter.

2. Position PTO control manifold to the frame and secure with two (2) cap screws and flange nuts.

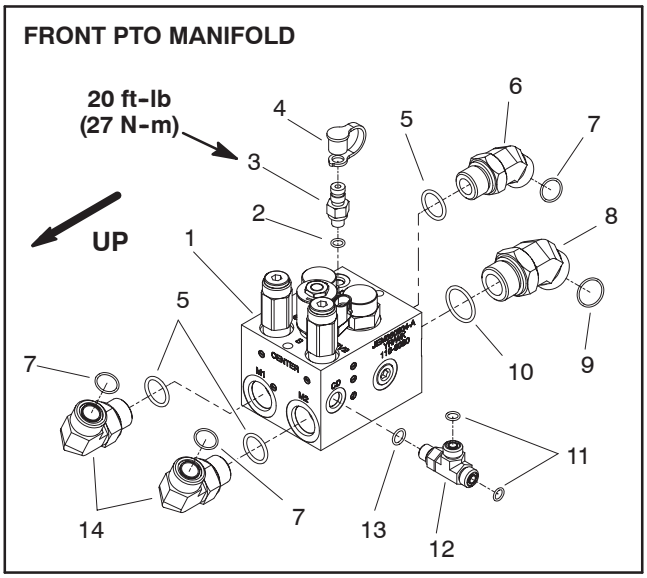


Figure 78

1. **Front PTO manifold**
2. **O-ring**
3. **Quick fitting**
4. **Dust cap**
5. **O-ring**
6. **Hydraulic 45º fitting**
7. **O-ring**
8. **Hydraulic 45º fitting**
9. **O-ring**
10. **O-ring**
11. **O-ring**
12. **Hydraulic tee fitting**
13. **O-ring**
14. **Hydraulic 90º fitting**

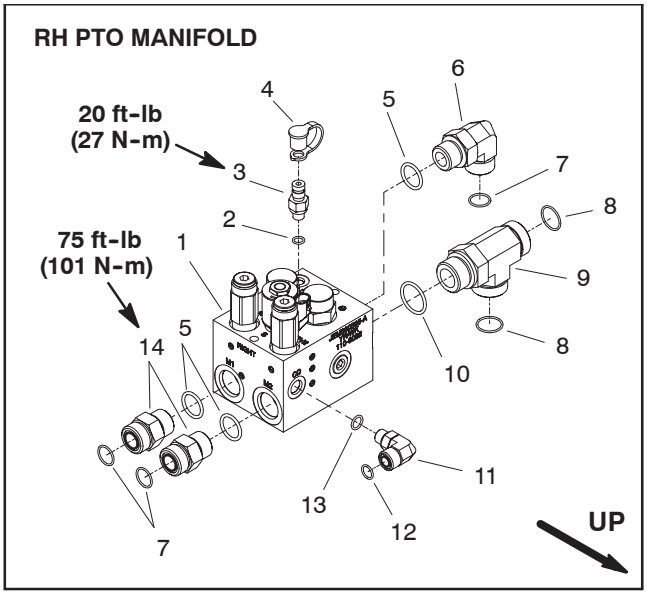


Figure 79

1. **RH PTO manifold**
2. **O-ring**
3. **Quick fitting**
4. **Dust cap**
5. **O-ring**
6. **Hydraulic 90º fitting**
7. **O-ring**
8. **O-ring**
9. **Hydraulic tee fitting**
10. **O-ring**
11. **Hydraulic 90º fitting**
12. **O-ring**
13. **O-ring**
14. **Straight fitting**

3. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Connect wire harness connector to the solenoid valve.

5. Make sure hydraulic tank is full. Add correct oil if necessary.

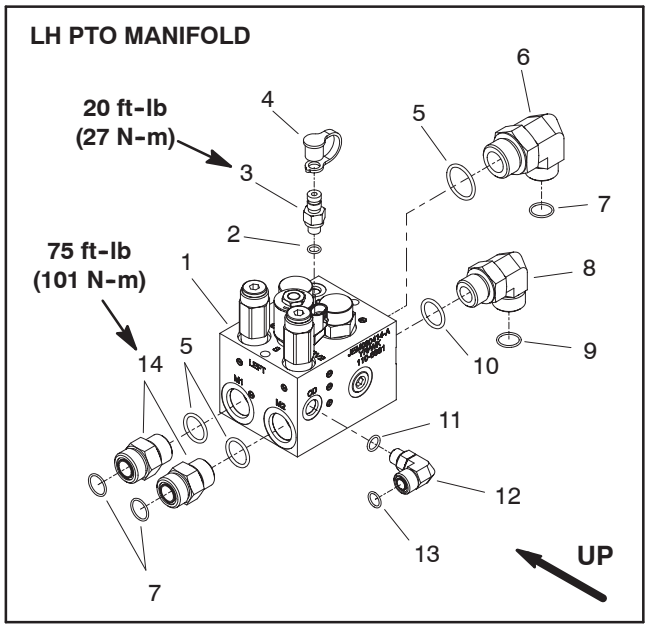


Figure 80

1. LH PTO manifold
2. O-ring
3. Quick fitting
4. Dust cap
5. O-ring
6. Hydraulic 90º fitting
7. O-ring
8. Hydraulic 90º fitting
9. O-ring
10. O-ring
11. O-ring
12. Hydraulic 90º fitting
13. O-ring
14. Straight fitting