

**X200-4**

**ALLISON TRANSMISSION  
NEW PRODUCT TRAINING**

**STUDENT  
STUDY GUIDE**

**DEPOT SUPPORT  
MAINTENANCE**

**DETROIT DIESEL ALLISON**

DIVISION OF GENERAL MOTORS  
PRODUCT COURSE DEVELOPMENT  
SALES & SERVICE TRAINING  
WORLD HEADQUARTERS  
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X200-4  
NEW EQUIPMENT TRAINING COURSE  
DEPOT SUPPORT MAINTENANCE  
STUDENT STUDY GUIDE  
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## INTRODUCTION

1. STUDENT INFORMATION AND ORIENTATION
2. COURSE OBJECTIVE
3. GENERAL DESCRIPTION

### REFERENCE MATERIAL

STUDENT STUDY GUIDE, DEPOT SUPPORT MAINTENANCE

STUDENT WORK BOOK, DEPOT SUPPORT MAINTENANCE

CLASS  
MATERIAL

GUIDE

COURSE OBJECTIVE  
GENERAL DESCRIPTION  
CROSS SECTION



## INFORMATION & ORIENTATION

1. CLASS DURATION - 10 DAYS
2. COMBINATION OF LECTURE, PRACTICAL EXERCISE
3. QUESTIONS PERTINENT TO THE SUBJECT ARE ENCOURAGED DURING INSTRUCTION
4. EXAMINATIONS ORAL OR WRITTEN
5. STUDENT MATERIAL

A. DISTRIBUTE THE FOLLOWING TO EACH STUDENT -

STUDENT STUDY GUIDE, DEPOT SUPPORT MAINTENANCE  
STUDENT WORK BOOK, DEPOT SUPPORT MAINTENANCE  
BINDER, STANDARD 3 RING  
WRITING TABLET  
PENCILS

B. USE OF STUDENT MATERIAL

THIS MATERIAL IS FOR THE STUDENT TO CARRY AND KEEP.

THE STUDENT STUDY GUIDE SHOULD BE READ AS SOON AS POSSIBLE OUTSIDE THE CLASS.

THE STUDENT WORK BOOK WILL BE USED IN CLASS IN CONJUNCTION WITH INSTRUCTION.

COURSE OBJECTIVE

NEW EQUIPMENT TRAINING COURSE  
DEPOT SUPPORT MAINTENANCE  
FOR THE X200-4

- I. THE STUDENT STUDY GUIDE IS A DESCRIPTIVE NARRATIVE PROVIDING:
  - A. STUDENTS WITH THE BASIS TO ACQUIRE THE SKILLS TO PERFORM MAINTENANCE TASK.
  - B. SUGGESTED SEQUENCES FOR DISASSEMBLY & REASSEMBLY OF SYSTEM COMPONENTS.
- II. FUNCTIONAL SYSTEM INFORMATION
  - A. DETAILED DESCRIPTION OF INDIVIDUAL COMPONENTS WHICH INCLUDES:
    - 1. HYDRAULIC SCHEMATIC
    - 2. DIAGRAMS
    - 3. POWER FLOWS



## X200 TRANSMISSION

## SECTION 1 - GENERAL DESCRIPTION

THE X200 IS A CROSS-DRIVE TRANSMISSION FEATURING A HYDRAULIC TORQUE CONVERTER IN COMBINATION WITH A RANGE PLANETARY PACKAGE FOR PROPULSION; A HYDROSTATIC PUMP AND MOTOR UNIT WITH COMBINING PLANETARIES FOR DIFFERENTIAL STEERING CONTROL; AND INTEGRAL HYDRAULIC BRAKES. ALL THESE FEATURES ARE ARRANGED IN A SINGLE SIMPLIFIED PACKAGE.

## 1-1 GENERAL DESCRIPTION

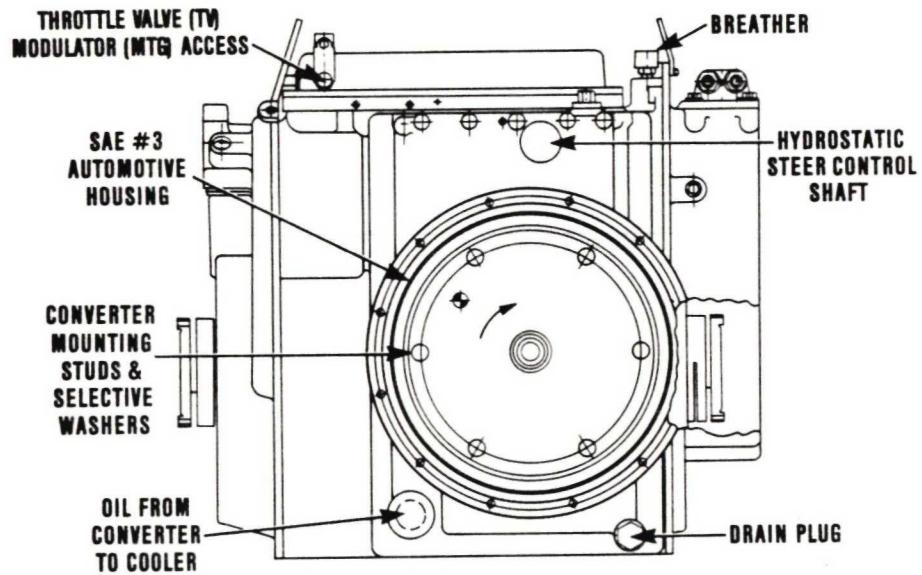
## A. X200 TRANSMISSION DESIGNED FOR TRACKLAYING VEHICLES.

1. CLASS - 9 TO 18 TON GVW, 18,000 TO 36,000 LB.
2. SPEEDS - 37 TO 50 MPH
3. APPLICATION - M730A1E1
4. ENGINE - 6V53T DETROIT DIESEL PRODUCING 265 B.H.P.  
@ 2800 RPM (ENGINE OUTPUT SHAFT)

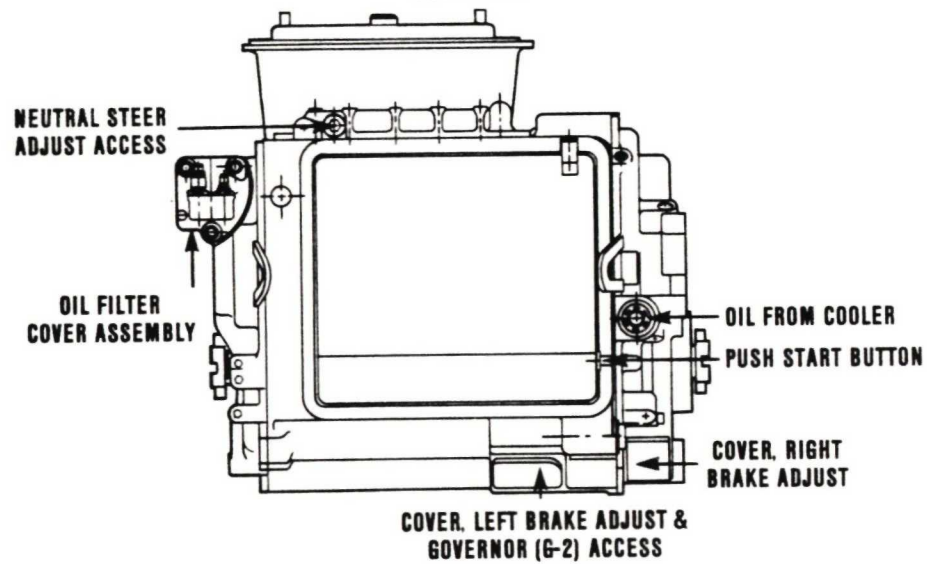
## B. X200 TRANSMISSION FEATURES

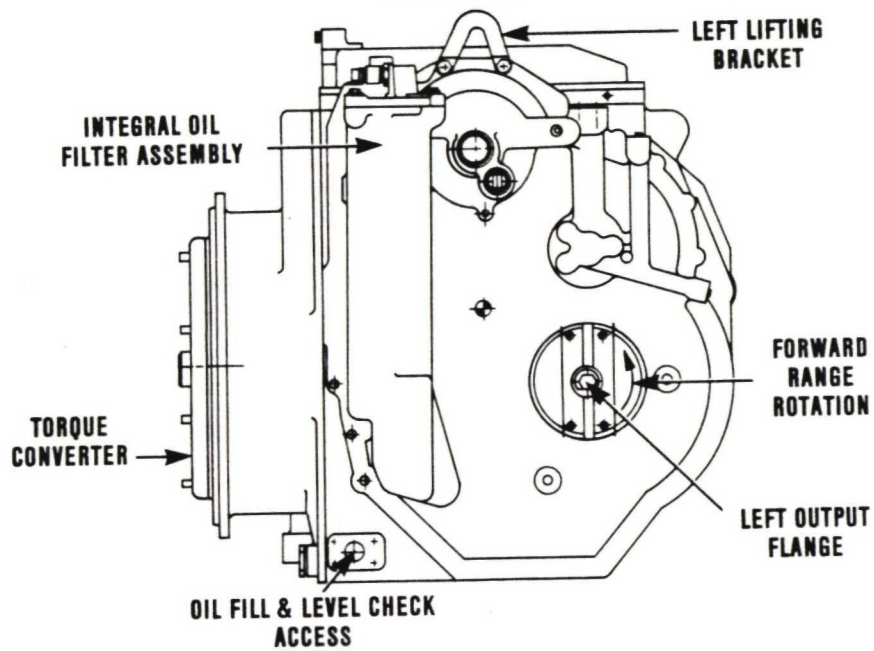
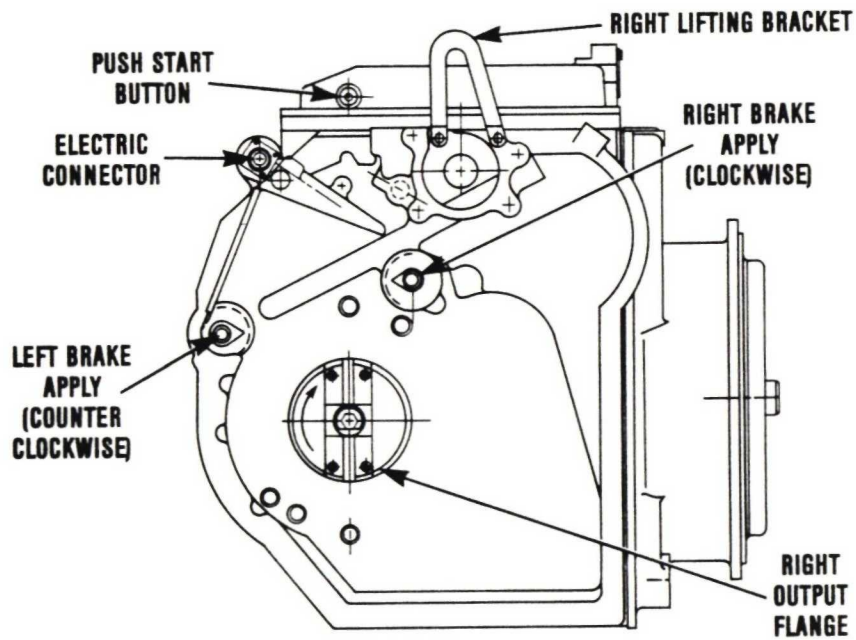
1. HYDRAULIC TORQUE CONVERTER
2. FOUR SPEED RANGE PACKAGE
3. ONE SPEED REVERSE
4. FULLY AUTOMATIC SHIFTING
5. LOCKUP EFFECTIVE IN 2ND THROUGH 4TH RANGES
6. HYDROSTATIC STEERING SYSTEM WITH PIVOT STEER
7. INTEGRAL HYDRAULIC BRAKES

# GENERAL CONSTRUCTION EXTERNAL FEATURES FRONT VIEW

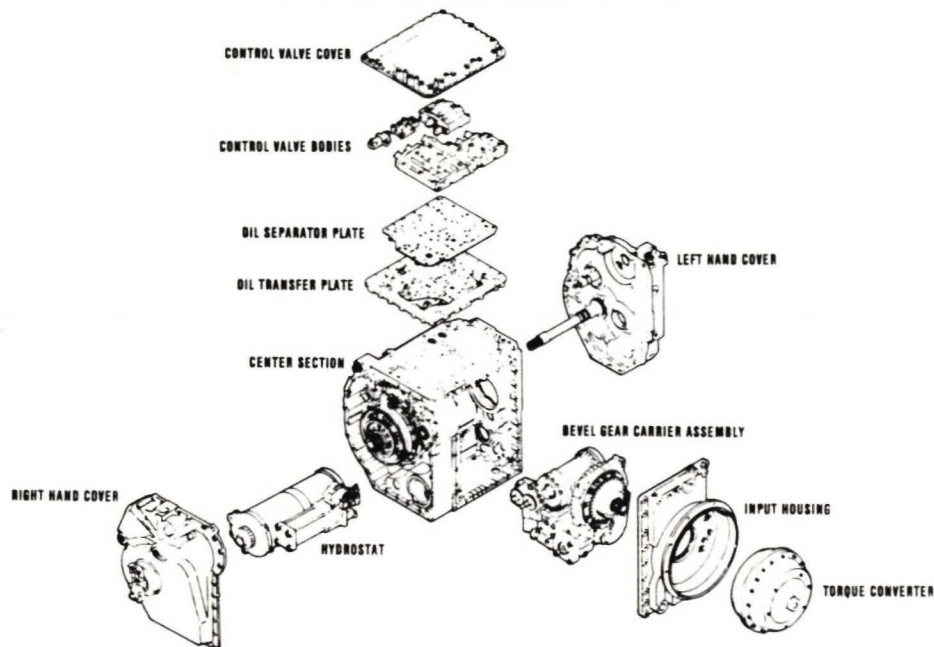


## EXTERNAL FEATURES TOP VIEW



**EXTERNAL FEATURES****LEFT VIEW****EXTERNAL FEATURES****RIGHT VIEW**

## TRANSMISSION MODULES



- B. TRANSMISSION MODULES THE TRANSMISSION IS DESIGNED TO PROVIDE APPLICATION FLEXIBILITY AND SPECIALIZATION WHILE MAINTAINING MAXIMUM PARTS COMMONALITY WITH OTHER APPLICATIONS.

THE TRANSMISSION COMPRISES AN INPUT MODULE AND CENTER MODULE (WHICH INCLUDES THE LEFT AND RIGHT END COVERS AND CENTER SECTION).

THE INPUT MODULE HOUSES THE TORQUE CONVERTER, LOCKUP CLUTCH, ENGINE DRIVEN INPUT GEAR. A TURBINE DRIVEN GEAR TRAIN TRANSFERS THE POWER FROM THE TORQUE CONVERTER TO THE INPUT BEVEL GEARS OF THE CENTER SECTION.

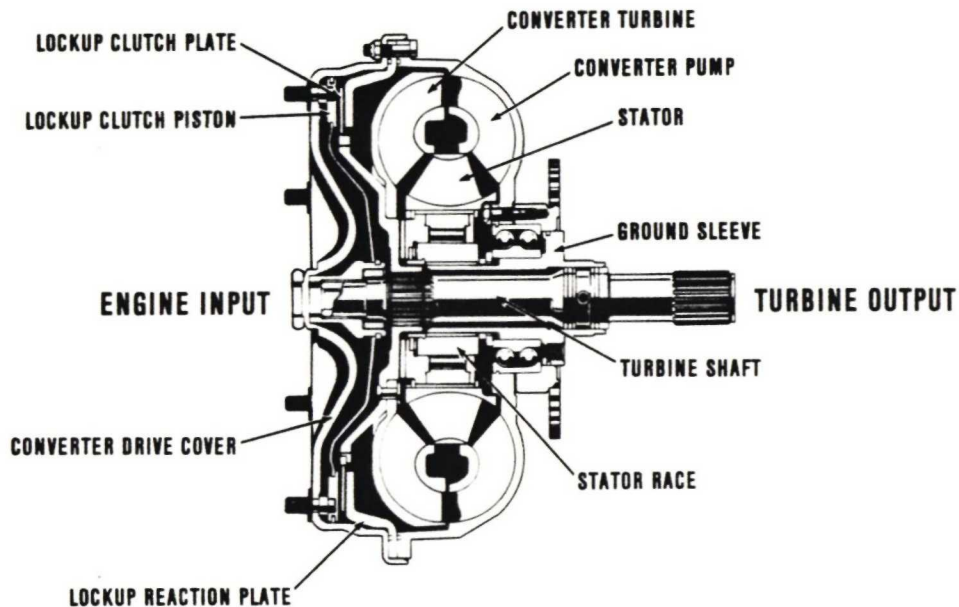
THE CENTER SECTION HOUSES THE INPUT BEVEL GEAR ASSEMBLY, THE RANGE INPUT DRIVEN GEARS, THE PLANETARY RANGE PACK, RANGE PACK OUTPUT GEARS, HYDROSTATIC PUMP AND MOTOR ASSEMBLY, AND THE HYDROSTATIC STEER DRIVE SYSTEM, THE LEFT COMBINING PLANETARY AND LEFT BRAKE CLUTCH PACK ASSEMBLY.

THE RIGHT END COVER HOUSES THE RIGHT COMBINING PLANETARY AND RIGHT BRAKE CLUTCH PACK ASSEMBLY.

THE LEFT END COVER HOUSES THE OIL TRANSFER TUBE ASSEMBLY.

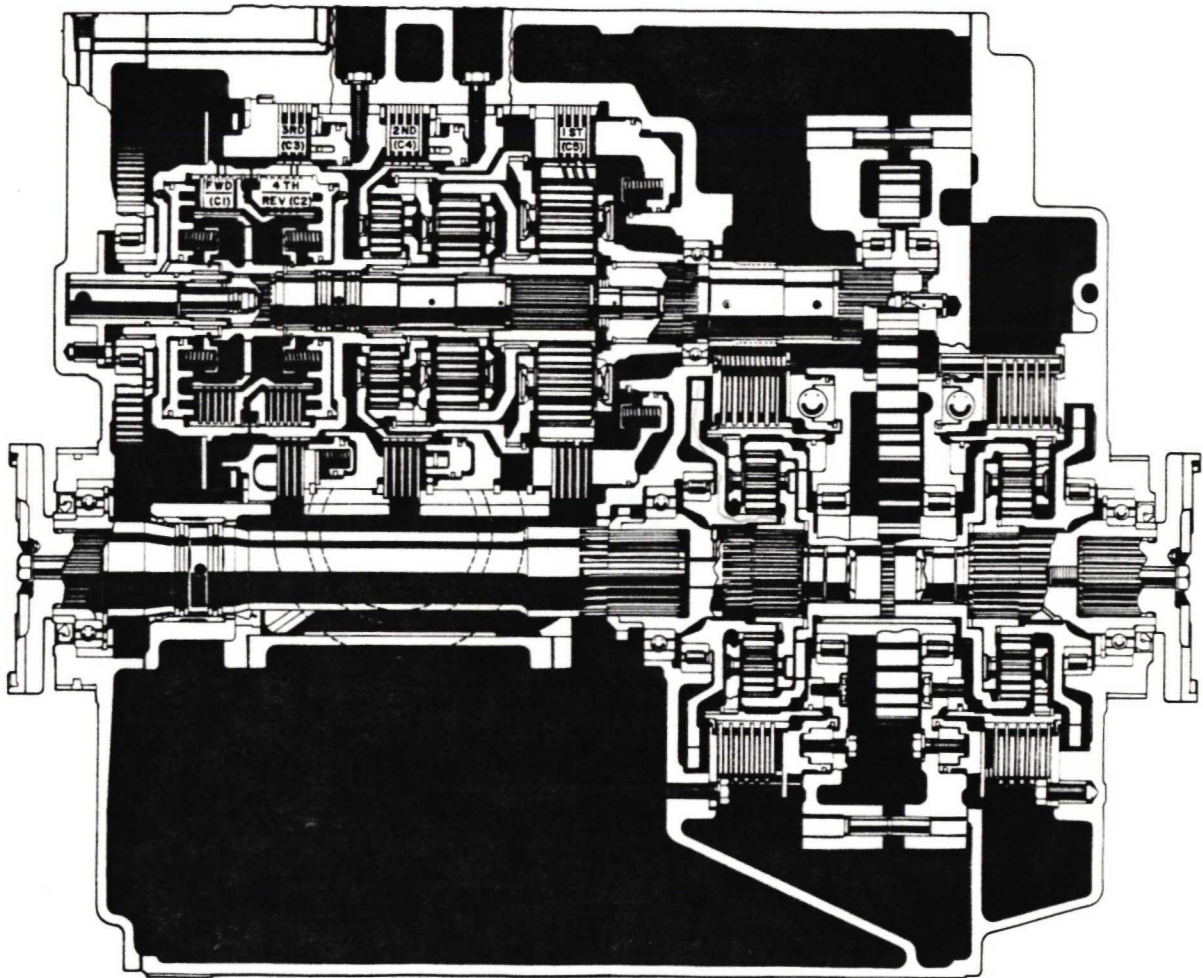


## X200-4 TORQUE CONVERTER CROSS SECTION



- C. THE TORQUE CONVERTER OF THE TC-300 FAMILY IS DIRECT MOUNTED TO THE ENGINE. IT IS A SIMPLE THREE ELEMENT, POLYPHASE, TYPE WHICH TRANSMITS POWER FROM THE ENGINE TO THE TRANSMISSION GEARING. THE TORQUE CONVERTER SERVES AS BOTH A TORQUE MULTIPLIER AND A FLUID COUPLING. TO IMPROVE SPEED COVERAGE AND TRANSMISSION PERFORMANCE A HYDRAULICALLY ACTUATED, AUTOMATIC LOCKUP CLUTCH IS USED.
1. THE LOCKUP CLUTCH AUTOMATICALLY LOCKS THE TURBINE ELEMENT OF THE TORQUE CONVERTER TO THE ENGINE DRIVEN PUMP ELEMENT. HYDRAULIC PRESSURE AUTOMATICALLY APPLIES THE LOCKUP CLUTCH AS THE TURBINE ATTAINS SUFFICIENT SPEED. WHEN THE LOCKUP CLUTCH IS APPLIED, THE ENGINE OUTPUT IS MECHANICALLY DIRECTED TO THE TRANSMISSION GEARING. A DECREASE IN TURBINE SPEED AUTOMATICALLY RELEASES THE LOCKUP CLUTCH. HOWEVER, DURING PART THROTTLE OPERATION, LOCKUP IS MODULATED BY THROTTLE VALVE PRESSURE DERIVED FROM THROTTLE POSITION.
- D. THE INPUT GEAR TRAIN IN THE INPUT MODULE TRANSFERS THE POWER FROM THE TORQUE CONVERTER TO THE BEVEL GEAR INPUT IN THE CENTER SECTION. THE BEVEL GEARS IN THE CENTER SECTION TRANSLATE THE DRIVE OF THE CONVERTER TURBINE TO THE TRANSVERSE PLANE OF THE TRANSMISSION.

## X200-4 TRANSMISSION CROSS SECTION



CENTER MODULE



- E. THE PLANETARY RANGE PACK CONSISTS OF HYDRAULICALLY APPLIED CLUTCHES AND PLANETARY GEARING WHICH PROVIDE THE FOUR SPEEDS FORWARD AND ONE SPEED REVERSE.

NOTE: THE GEARING ARRANGEMENT IS BASICALLY THE SAME AS THAT USED IN OTHER X-SERIES MILITARY TRANSMISSIONS AND ALLISON COMMERCIAL TRANSMISSIONS.

THE RANGE PACK CONSISTS OF FIVE CLUTCHES AND THREE PLANETARY GEAR SETS. ALL FORWARD AND REVERSE RANGES ARE ENGAGED BY APPLYING TWO CLUTCHES AT A TIME IN VARIOUS COMBINATIONS. RANGE SHIFTS ARE ACCOMPLISHED BY CHANGING THE APPLICATION OF A SINGLE CLUTCH. IN NEUTRAL ALL CLUTCHES ARE DISENGAGED.

- F. THE HYDROSTATIC STEER UNIT CONSISTS OF A HYDROSTATIC PUMP AND MOTOR WHICH CONTROLS THE TRANSMISSION DIFFERENTIAL STEER SYSTEM. THIS SYSTEM PROVIDES A POSITIVE SPEED RATIO CONTROL OF THE VEHICLE TRACKS UNDER ALL CONDITIONS.

NOTE: THIS FEATURE, NOT AVAILABLE WITH FORCE CONTROLLED SYSTEMS, IS PARTICULARLY VALUABLE AT HIGH SPEEDS AND ON SLIPPERY TERRAIN. THE HYDROSTATIC PUMP IS DRIVEN BY THE TURBINE DRIVEN INPUT GEARS THE SAME AS THE RANGE PACK INPUT. THE OUTPUT OF THE HYDROSTATIC STEER UNIT DRIVES THROUGH A REDUCTION GEARTRAIN AND IS CONNECTED TO THE COMBINING PLANETARY SUN GEARS. THE GEAR ARRANGEMENT CAUSES THE HYDROSTATIC OUTPUT TO DRIVE THE SUN GEARS AT EQUAL SPEEDS BUT IN OPPOSITE DIRECTIONS.

- G. COMBINING PLANETARIES THE OUTPUT FROM THE RANGE PLANETARY PACK AND THE HYDROSTATIC STEER UNIT ARE JOINED AT THE COMBINING PLANETARIES TO PROVIDE THE TRANSMISSION OUTPUT TO THE VEHICLE. THE RANGE PACK CONNECTS THE COMBINING PLANETARY RING GEARS, THE HYDROSTATIC STEER UNIT CONNECTS TO THE COMBINING PLANETARY SUN GEARS AND THE COMBINING PLANETARY CARRIERS BECOME THE OUTPUTS.

- H. SHIFT CONTROLS BEGIN AT THE DRIVERS CONTROL WHERE SELECTION OF AUTOMATIC RANGES SENDS AN ELECTRICAL SIGNAL TO THE TRANSMISSION WHICH ENERGIZES SOLENOIDS TO PLACE THE TRANSMISSION IN THE DESIRED OPERATING MODE. THE AUTOMATIC CONVERTER-TO-LOCKUP SHIFTS ARE CONTROLLED BY CONVERTER TURBINE SPEED. WHEN THE DRIVER'S TRANSMISSION CONTROL IS

IN THE DRIVE POSITION, ALL RANGE SHIFTS ARE ACTUATED BY THE TRANSMISSION OUTPUT SPEED. ENGINE THROTTLE POSITION IS TRANSLATED INTO THROTTLE VALVE PRESSURE (TV) AND IS USED TO MODULATE THE SHIFT POINTS TO PROVIDE DESIRED PERFORMANCE FOR ALL LOAD CONDITIONS. THE X200 CONTROL SYSTEM IS CAPABLE OF SUPPLYING COMPLETE LOGIC FOR THE FOLLOWING MODES OF OPERATION:

1. REVERSE 1 PROVIDES CLOSE-QUARTER MANEUVERING AND/OR HIGH TRACTIVE EFFORT.
2. PARK/NEUTRAL: STARTING ENGINE AND IDLING.
3. PIVOT STEER: TRANSMISSION REMAINS IN NEUTRAL. VEHICLE CAPABLE OF TURNING WITHIN ITS OWN RADIUS.
4. DRIVE (1-4) NORMAL FORWARD POSITION STARTS IN FIRST WITH AUTOMATIC SHIFTING FROM FIRST, TO SECOND, TO THIRD, AND FOURTH RANGES.
5. SHIFTS FROM FORWARD-TO-REVERSE OR REVERSE-TO-FORWARD ARE INHIBITED ABOVE APPROXIMATELY 3 MPH.
6. IN THE EVENT OF A TRANSMISSION CONTROL ELECTRICAL POWER FAILURE, THE TRANSMISSION WILL CONTINUE TO OPERATE IN THE PREVIOUSLY SELECTED DIRECTION OF VEHICLE MOVEMENT UNTIL THE ENGINE IS STOPPED. AT THAT TIME THE CONTROLS REVERT TO NEUTRAL. A MANUAL SHIFT CONTROL IS AVAILABLE TO PROVIDE FORWARD OPERATION IN THE EVENT OF LOSS OF ELECTRICAL POWER TO THE TRANSMISSION.

#### I. TOWING

1. TOW THE VEHICLE AT FORWARD SPEEDS NOT EXCEEDING 15 MPH. IN AN EMERGENCY, THE VEHICLE CAN BE TOWED REARWARD AT DISTANCES NOT EXCEEDING 1/4 MILE.
2. IF THE TRANSMISSION IS DAMAGED OR THE VEHICLE IS TO BE TOWED FASTER THAN 15 MPH, DISCONNECT FINAL DRIVES.

WARNING: TOW BAR MUST BE USED WHEN FINAL DRIVES ARE DISCONNECTED. STEERING AND BRAKING ARE NOT AVAILABLE FROM TOWED VEHICLE.

#### J. SPECIFICATIONS AND DATA

THE SPECIFICATIONS AND DATA IN THE FOLLOWING CHART PROVIDE A QUICK REFERENCE TO THE MAJOR FEATURES OF THE X200 TRANSMISSION.

##### RATING:

TURBINE STALL TORQUE.....	1725 LB-FT
GOVERNED INPUT SPEED.....	2800 RPM
INPUT POWER MAX.....	275 GHP



## DRIVE:

DIRECT MOUNT . . . . . SAE 3 FLYWHEEL HOUSING WITH FLEX  
PLATE DRIVE

## ROTATION INPUT

(VIEWED FROM INPUT) . . . . . CLOCKWISE

DRY WEIGHT: . . . . . 900 LBS.

BRAKES: . . . . . MULTIPLE WET PLATE, SERVICE AND  
PARKING

## OIL TEMPERATURE:

1. MAX. SUMP. . . . . 265°F

2. MAX. CONVERTER OUT . . . . . 315°F

CLUTCHES: . . . . . OIL COOLED, HYDRAULICALLY ACTUATED,  
SPRING RELEASED, SELF-COMPENSATING  
FOR WEAR.

RANGE GEARING: . . . . . PLANETARY, STRAIGHT-CUT SPUR,  
CONSTANT MESH.

OIL FILTER: . . . . . INTEGRAL, TWO ELEMENT WITH DIFFER-  
ENTIAL PRESSURE WARNING SWITCH AND  
AUTOMATIC BYPASS.

SUMP: . . . . . INTEGRAL

## PRESSURE PUMPS:

1. MAIN PRESSURE PUMP - ENGINE DRIVEN

A. MAIN PUMP

B. SCAVENGE PUMP

2. OUTPUT PUMP-OUTPUT DRIVEN

OIL: . . . . . MIL-L-2104C (OE/HDO-10) ABOVE -10°F  
MIL-L-46167 (OEA) BELOW 0°F

CAPACITY: . . . . . 12 GALLONS (U.S.) 45 LITRES

TORQUE CONVERTER: . . . . . TC-360 SINGLE STAGE, POLYPHASE,  
THREE ELEMENT, WITH AUTOMATIC LOCK-  
UP CLUTCH, 3.32:1 MAX. TORQUE  
MULTIPLICATION AT CONVERTER STALL.

*stall speed -*  
LOCKUP CLUTCH: . . . . . AUTOMATIC 2ND THROUGH 4TH RANGES.

## DRIVE RANGE AND

SHIFT CONTROL: . . . . . SOLENOID OPERATED

*Input Torque -*

RANGE SEQUENCE: . . . . . R - REVERSE  
 N - NEUTRAL  
 D - 1-4  
 3 - 1-3  
 2 - 1-2  
 1 - 1

SHIFTING MECHANISM: . . . . . HYDRAULIC GOVERNOR, OUTPUT SHAFT  
 SPEED CONTROLLED.

### SHIFT MODULATION

(UPSHIFT AND DOWNSHIFT): . . . THROTTLE VALVE PRESSURE

### NEUTRAL START AND REVERSE

SIGNAL SWITCHES: . . . . . SUPPLIED BY CUSTOMER

STEERING: . . . . . HYDROSTATICALLY - CONTROLLED  
 DIFFERENTIAL, PIVOT STEER IN  
NEUTRAL.



<u>RANGE</u>	<u>CLUTCHES ENGAGED</u>	<u>RATIO</u>
FWD:		
FIRST. . . . .	FORWARD & FIRST . . . . .	4.162:1
SECOND . . . . .	FORWARD & SECOND. . . . .	2.345:1
THIRD. . . . .	FORWARD & THIRD . . . . .	1.464:1
FOURTH . . . . .	FORWARD & FOURTH. . . . .	1.042:1
NEUTRAL. . . . .	NONE	

### REVERSE:

1. . . . . FOURTH & FIRST. . . . . 6.621:1

2. . . . . *FOURTH FIRST*  
*Second*

### OIL PUMP ASSEMBLIES:

MAIN INPUT PUMP. . . . . 50 GPM . . . . @ RPM (ENG.) 2400  
 OUTPUT PUMP. . . . . 29 GPM . . . . @ RPM (OUTPUT SHAFT)  
 MAIN SCAVENGE PUMP . . . . . 45 GPM . . . . @ RPM (ENG.) 2400

### PRESSURE SCHEDULES:

MAIN, NEUTRAL & REVERSE. . . . . 280-325 PSI @ 600 RPM  
 FORWARD (CONVERTER PHASE). . . . . 190-210 PSI @ 2500 RPM  
 FORWARD (LOCKUP) . . . . . 140-160 PSI @ 2500 RPM  
 BRAKE APPLY. . . . . 0-320 PSI @ 2500 RPM

## IMPORTANT SAFETY NOTICE

IT IS YOUR RESPONSIBILITY TO BE COMPLETELY FAMILIAR WITH THE WARNINGS AND CAUTIONS DESCRIBED IN THIS STUDY GUIDE. THESE WARNINGS AND CAUTIONS ADVISE AGAINST THE USE OF SPECIFIC SERVICE METHODS THAT CAN RESULT IN PERSONAL INJURY, DAMAGE TO THE EQUIPMENT, OR CAUSE THE EQUIPMENT TO BE UNSAFE. IT IS, HOWEVER, IMPORTANT TO UNDERSTAND THAT THESE WARNINGS AND CAUTIONS ARE NOT EXHAUSTIVE. DETROIT DIESEL ALLISON COULD NOT POSSIBLY KNOW, EVALUATE AND ADVISE THE SERVICE TRADE OF ALL CONCEIVABLE WAYS IN WHICH SERVICE MIGHT BE DONE OR OF THE POSSIBLE HAZARDOUS CONSEQUENCES OF EACH WAY. CONSEQUENTLY, DETROIT DIESEL ALLISON HAS NOT UNDERTAKEN ANY SUCH BROAD EVALUATION. ACCORDINGLY, ANYONE WHO USES A SERVICE PROCEDURE OR TOOL WHICH IS NOT RECOMMENDED BY DETROIT DIESEL ALLISON MUST FIRST BE THOROUGHLY SATISFIED THAT NEITHER PERSONAL SAFETY NOR EQUIPMENT SAFETY WILL BE JEOPARDIZED BY THE SERVICE METHODS SELECTED.

PROPER SERVICE AND REPAIR IS IMPORTANT TO THE SAFE, RELIABLE OPERATION OF THE EQUIPMENT. THE SERVICE PROCEDURES RECOMMENDED BY DETROIT DIESEL ALLISON AND DESCRIBED HEREIN ARE EFFECTIVE METHODS FOR PERFORMING SERVICE OPERATIONS. SOME OF THESE SERVICE OPERATIONS REQUIRE THE USE OF TOOLS SPECIALLY DESIGNED FOR THE PURPOSE. THE SPECIAL TOOLS SHOULD BE USED WHEN AND AS RECOMMENDED.



## TRANSMISSION DISASSEMBLY

### SUGGESTED SEQUENCE

NOTE: CONTROL VALVE BODIES MAY BE REMOVED BEFORE TRANSMISSION IS PUT ON STAND FOR EASIER ACCESSIBILITY. (SEE PAGE 2-13, PARA I. CONTROL VALVE BODIES)

WARNING: ADAPTER PLATE WEIGHS 127 POUNDS. LIFT PLATE WITH HOIST TO AVOID INJURY.

#### I. POSITIONING THE ADAPTER ON STAND

- A. INSTALL EYE BOLT IN END OF ADAPTER PLATE
- B. INSTALL (2) "5/8 - 11 X 3" BOLTS AND WASHERS THROUGH OPPOSITE SIDES OF MAINTENANCE STAND HEAD AND INTO ADAPTER PLATE TO HOLD ALIGNMENT
- C. INSTALL THE (4) REMAINING BOLTS AND WASHERS THAT HOLD THE ADAPTER TO THE MAINTENANCE STAND
- D. TORQUE ALL (6) BOLTS 160-175 LB. FT.
- E. INSTALL LIFTING BRACKETS INTO TRANSMISSION USING (2) "3/8 - 16 X 1 1/2" BOLTS AND WASHERS (RIGHT HAND BRACKET LONG - LEFT HAND SHORT)
- F. USING HOIST AND TWO LEGGED SLING, ATTACH SLING HOOKS INTO LEFT LIFTING AND RIGHT LIFTING BRACKETS

#### II. INSTALLING THREE LEGGED SLING

- A. FACING INPUT HOUSING, REMOVE THIRD BOLT FROM LEFT AT BOTTOM OF INPUT HOUSING
- B. FACING LEFT END COVER REMOVE THE BOLT THAT IS LOCATED FOURTH FROM THE TOP OF THE END COVER, ON THE LEFT EDGE
- C. FACING THE RIGHT END COVER REMOVE THE BOLT WHICH IS LOCATED AT THE TOP OF THE RIGHT EDGE OF THE END COVER
- D. ATTACH THE THREE LEGGED SLING TO THESE PLACES WHERE THE THREE BOLTS WERE REMOVED
- E. RAISE THE TRANSMISSION WITH THE TWO LEGGED SLING APPROXIMATELY ONE FOOT ABOVE THE FLOOR



CAUTION: WHEN ROTATING TRANSMISSION VERTICAL TO HORIZONTAL POSITION, WEIGHT OF TRANSMISSION IS TRANSFERRED FROM ONE SLING TO THE OTHER. WHEN THE CENTER OF GRAVITY SHIFTS, TRANSMISSION MAY SUDDENLY TILT, THRUSTING HEAVY MOMENTARY STRESS ON SLING AND HOIST. IF ALL EQUIPMENT IS NOT PROPERLY SECURED, TRANSMISSION COULD BE DAMAGED BY DROPPING TO FLOOR.

### III. POSITIONING TRANSMISSION ON STAND

- A. POSITION THE TRANSMISSION ON 4 X 4 WOOD BLOCKS SO WHEN TRANSMISSION IS LOWERED THE INPUT TILTS BACK
- B. NOW HOOK HOIST ONTO THE THREE LEGGED SLING. LIFT TRANSMISSION GRADUALLY WHILE KEEPING TENSION ON THE SLING

WARNING: WHEN LIFTING TRANSMISSION AT INPUT HOUSING, INPUT WILL SWING UPWARD.

- C. LIFT TRANSMISSION LEVEL WITH STAND. ALIGN TRANSMISSION AND INSTALL (3) 1/2 - 32 X 2" BOLTS AND WASHERS. TORQUE BOLTS 80-95 LB. FT.
- D. REMOVE THE (3) 3/8 - 16 X 1 3/4" BOLTS THAT RETAINS THE THREE LEGGED SLING. REMOVE SLING.

NOTE: IF VALVE BODIES WERE REMOVED FIRST, CONTINUE TO PAGE 2-15, PARA II., RIGHT SIDE COVER

## DISASSEMBLY

## I. CONTROL VALVE BODIES

- A. REMOVE (4) 3/8 - 16 X 1 1/2" THAT RETAIN THE LEFT HAND AND RIGHT HAND LIFTING BRACKET

NOTE: RIGHT HAND LIFTING BRACKET IS LONG. LEFT HAND LIFTING BRACKET IS SHORT.

- B. REMOVE (26) P/N 9441598 5/16 - 18 X 2" AND FLAT WASHERS THAT RETAIN THE CONTROL VALVE BODY COVER. TILT COVER WHEN REMOVING SO THAT THE MODULATOR PIN CLEARS.

- C. DISCONNECT ALL ELECTRICAL CONNECTIONS.

- D. REMOVE AS MANY OIL JUMPER TUBES THAT ARE ACCESSIBLE. BOLTS MAY VARY, 5/16" OR 1/4"; O RINGS ON CERTAIN TUBES WILL ALSO VARY.

NOTE: SOME WASHERS WITH THE BOLTS ARE USED AS SPACERS FOR THE OIL JUMPER TUBES. NOTE THE LOCATION FOR PROPER REINSTALLATION.

- E. REMOVE (6) BOLTS THAT RETAIN THE LOCKUP VALVE BODY ASSEMBLY P/N 23017931

(4) BOLTS P/N 9431456 5/16 - 18 X 2 3/4"

(4) WASHERS 5/16" FLAT P/N 9422846

(2) BOLTS P/N 9409621 5/16 - 18 X 2 1/4"

(2) WASHERS 5/16" FLAT 9422846

NOTE: JUMPER TUBES MAY STILL HOLD ASSEMBLY ON TRANSMISSION.

- F. REMOVE (4) BOLTS THAT RETAINS THE G2 BACKUP VALVE BODY ASSEMBLY P/N 23018615.

(2) 1/4 - 20 X 2 1/4" P/N 9441486

(2) 1/4 - 20 X 1 3/4" P/N 9434712

(4) WASHERS 1/4" FLAT P/N 2436161

NOTE: JUMPER TUBE MAY STILL RETAIN G2 BACKUP VALVE BODY ASSEMBLY.

- G. REMOVE (3) BOLTS THAT RETAIN THE PRIORITY VALVE BODY ASSEMBLY P/N 23018623.

(1) 1/4 - 20 X 1 3/4" P/N 9434712

(2) 1/4 - 20 X 2 1/8" P/N 9430161

(3) WASHER FLAT 1/4" P/N 2436161

- H. REMOVE (1) 1/4 - 20 X 1" BOLT FROM THE MAIN CONTROL VALVE BODY ASSEMBLY THAT RETAINS THE JUMPER TUBE COMING FROM THE G2 BACKUP VALVE BODY ASSEMBLY P/N 23018615

NOTE: THE G2 BACKUP VALVE BODY ASSEMBLY WILL COME OFF AT THIS TIME.

I. REMOVE (17) BOLTS THAT RETAINS THE MAIN CONTROL VALVE BODY TO THE TRANSMISSION. P/N 23017904

- (5) BOLT P/N 9419287 5/16 - 18 X 3 1/4"
- (5) WASHER P/N 9422846 WASHER FLAT 5/16"
- (4) BOLT P/N 9409015 5/16 - 18 X 3"
- (4) WASHER P/N 9422846 WASHER FLAT 5/16"
- (8) BOLT P/N 9431456 5/16 - 18 X 2 3/4"
- (8) WASHER P/N 9422846 WASHER FLAT 5/16"

NOTE: OIL JUMPER TUBES THAT RUN FROM MAIN CONTROL VALVE BODY ASSEMBLY TO LOCKUP VALVE BODY ASSEMBLY WILL COME OFF AT THIS TIME.

J. REMOVE (8) BOLTS THAT RETAINS THE OIL TRANSFER PLATE ASSEMBLY P/N 23018617.

- (2) P/N 9409253 1/4 - 20 X 1/4"
- (3) P/N 9409062 1/4 - 20 X 1"
- (3) P/N 9409076 5/16 - 18 X 1 1/4"

NOTE: WHEN REMOVING OIL TRANSFER PLATE ASSEMBLY P/N 23018617, CAREFULLY ROUTE ELECTRICAL HARNESS ASSEMBLY P/N 23017899 THROUGH ACCESS HOLE OF PLATE ASSEMBLY.

K. REMOVE OIL TRANSFER GASKET P/N 23018717.

NOTE: WHEN REMOVING OIL TRANSFER GASKET P/N 23018717, CAREFULLY ROUTE ELECTRICAL HARNESS ASSEMBLY P/N 23917899 THROUGH ACCESS HOLE OF GASKET ASSEMBLY.

L. REMOVE (4) SCREWS P/N 159184 - SCREW No. 4-40 X 7/16", THAT RETAINS THE ELECTRICAL HARNESS ASSEMBLY P/N 23017899 WITH GASKET 6832550.

M. REMOVE GOVERNOR FILTER ASSEMBLY SCREEN P/N 23045247 FROM HOLE WITH SEAT. STANDING AT REAR OF TRANSMISSION AND LOOKING AT 1ST PRESSURE PLUG FROM RIGHT, ACCESS HOLE IS AT 1:00 'O' CLOCK POSITION. USE SNAP-RING PLIERS FOR REMOVAL.

N. REMOVE (2) JUMPER TUBES (PITOT SIGNAL) 23018172, BY EITHER USING (2) 5/16 - 18 X 4" BOLTS OR SNAPRING PLIERS.

O. REMOVE (2) 3/8 - 18 X 1 1/4" BOLTS FROM MAIN CASE



## DISASSEMBLY (CONTINUED)

## II. RIGHT SIDE COVER

CAUTION: INSERT ONE 1/2 - 20 X 1" BOLT INTO EACH OUTPUT FLANGE - MOUNTING HOLE FINGER TIGHT. THIS PREVENTS SEAL RINGS FROM BECOMING DAMAGED DURING REMOVAL

## A. POSITION TRANSMISSION WITH RIGHT HAND COVER UPWARDS

1. REMOVE (27) BOLTS,  
(26) 3/8 - 16 X 1 1/4" P/N 9409082  
(1) 3/8 - 16 X 3 1/2" P/N 9434184  
THAT RETAINS THE RIGHT HAND COVER TO THE MAIN CASE.
2. USE ALL THREADS OR 3/8" BOLTS AT PULLER AREAS ON RIGHT HAND COVER - USE THE TWO LIFTER EYES ON THE THREE LEGGED SLING TO REMOVE R.H. COVER.

CAUTION: STEER GEAR MAY FALL OUT WHILE REMOVING THE R.H. COVER.

WARNING: WHEN REMOVING THE R.H COVER, THE RANGE DRIVEN GEAR MAY STAY WITH COVER.

- B. REMOVE RANGE DRIVE AND DRIVEN GEARS
- C. REMOVE STEER DRIVE GEAR 23018116
- D. REMOVE L.H. & R.H. DRIVE SHAFTS 2301811
- E. REMOVE (4) 3/8 - 16 X 1 1/4" BOLTS P/N 9440903 THAT RETAINS THE L.H. BRAKE ACCESS AND GOVERNOR COVER.
  1. REMOVE GOVERNOR ASSEMBLY 23017861 FROM GOVERNOR BODY P/N 23017859
- F. REMOVE SUMP COMMUNICATION TUBE
- G. REMOVE LUBE TUBE ASSEMBLY.
- H. REMOVE (2) 3/8 - 16 X 1 1/4" FROM EQUALIZER VALVE HOUSING. REMOVE HOUSING, VALVE, SPRING, AND PIN.
- I. REMOVE SCAVENGE TUBE AND SCREEN ASSEMBLY
- J. LOOSEN CASUAL LUBE TUBE
- K. REMOVE (15) 7/16 - 14 X 1 1/2" BOLTS THAT RETAIN THE L.H. BRAKE SUPPORT
- L. USING TWO PRY BARS, REMOVE BRAKE SUPPORT - 180° APART FROM PINS THAT LOCATE BRAKE SUPPORT.
- M. REMOVE 3/8 - 16 X 1 3/4" BOLTS THAT RETAIN THE GOVERNOR HOUSING
- N. REMOVE GOVERNOR HOUSING
- O. REMOVE FOUR BRAKE SUPPORT PINS



P. REMOVE SIX PIN KEEPERS.

Q. REMOVE BRAKE END REACTION PLATE AND (6) INTERNAL SPLINE FRICTION AND (5) EXTERNAL STEEL REACTION

R. REMOVE LEFT HAND COMBINING PLANETARY RING GEAR

NOTE: CAREFUL NOT TO LOSE THRUST WASHERS

S. REMOVE LEFT HAND PLANETARY CARRIER

NOTE: CAREFUL NOT TO LOSE THRUST WASHERS.

INSTRUCTOR NOTE: STEEL TOWARD FACE OF CARRIER AND BRONZE ON TOP OF STEEL

T. REMOVE METAL SEAL

INSTRUCTOR NOTE: IF LEFT OUT, YOU LOSE BRAKE COOLING

U. REMOVE (5)  $\frac{3}{8}$  - 16 X 1" BOLTS THAT RETAIN THE L.H. BRAKE BACKING PLATE.

V. REMOVE THE LEFT HAND BRAKE BACKING PLATE

NOTE: (6) BACKING PLATE SPRING GUIDE PINS WILL COME WITH THE BACKING PLATE.

W. REMOVE THE LEFT HAND OUTPUT SUN AND STEER GEAR.

X. FROM THE RIGHT HAND SIDE TAP AT THE LEFT HAND OUTPUT SHAFT TO REMOVE THE OUTPUT OIL PUMP DRIVE GEAR, BEARING ASSEMBLY AND LEFT HAND OUTPUT SHAFT.

NOTE: OUTPUT OIL PUMP DRIVE MAY FALL OFF THE L.H. OUTPUT SHAFT.

## DISASSEMBLY (CONTINUED)

## III. LEFT SIDE COVER

- A. ROTATE TRANSMISSION, LEFT SIDE FACING UPWARD.
- B. REMOVE (3) 5/16 - 18 X 1 BOLTS THAT RETAIN THE FILTER ASSEMBLY COVER.
  - 1. REMOVE FILTER ELEMENT
- C. REMOVE (29) 3/8 - 16 X 1 1/4" BOLTS THAT RETAIN THE LEFT HAND COVER TO THE TRANSMISSION.
- D. USE 3/8" BOLTS OR ALL THREADS AT PULLER AREAS ON LEFT HAND SIDE OF COVER; USE TWO LIFTING LEGS OF THREE LEGGED SLING TO REMOVE LEFT HAND COVER.

CAUTION: GEAR MAY STAY IN COVER WHEN LIFTING IT OFF.

## IV. CENTER SECTION

- A. REMOVE TWO FILTER STEEL TUBES.
  - SHORT TUBE - FILTER OUT.
  - LONG TUBE - FILTER IN.
- B. REMOVE THE RANGE AND HYDROSTATIC DRIVER GEAR
- C. REMOVE THE RANGE INPUT DRIVER
- D. REMOVE BEVEL GEAR DRIVEN SHAFT.
- E. REMOVE (6) 3/8 - 16 X 1" BOLTS FROM THE HYDROSTATIC IDLER RETAINER.
- F. REMOVE THE HYDROSTATIC IDLER
- G. REMOVE (2) 1/4 - 20 X 1/2" BOLTS FROM THE PITOT ASSEMBLY,
  - TILT THE PITOT ASSEMBLY WHILE REMOVING.
- H. REMOVE THE FORWARD CLUTCH (C1) HOUSING AND OIL COLLECTOR CAN
- I. REMOVE FOURTH (C2) CLUTCH HOUSING.

NOTE: DO NOT LOSE THRUST WASHERS THAT ARE LOCATED BETWEEN (C1) & (C2) HOUSINGS.

- J. REMOVE THE SNAPRING THAT RETAINS THE THIRD CLUTCH BACKING PLATE.
- K. REMOVE THE THIRD CLUTCH BACKING PLATE.
- L. REMOVE (4) EXTERNAL AND (3) INTERNAL FRICTION PLATES.
- M. REMOVE THE SNAP RING, FROM THE THIRD CLUTCH (C3) PISTON HOUSING.
- N. REMOVE THE THIRD (C3) CLUTCH PISTON HOUSING.

INSTRUCTOR NOTE: (1) 3/8 - 18 X 1 1/2" BOLT SHOULD HAVE BEEN REMOVED AT TOP OF TRANSMISSION DURING REMOVAL OF VALVE BODIES.

O. REMOVE THE SNAPRING THAT RETAINS THE SECOND CLUTCH (C4) PISTON HOUSING.

P. REMOVE THE (P1) FRONT PLANETARY CARRIER

CAUTION: DO NOT LOSE WASHERS THAT RIDE BETWEEN THE FRONT PLANETARY SUN GEAR AND CENTER PLANETARY CARRIER.

INSTRUCTOR NOTE: DO NOT ATTEMPT TO REMOVE THE PLANETARY RANGE PACK ASSEMBLY AS A COMPLETE UNIT. THE SECOND (C4) CLUTCH PISTON HOUSING INTERFERES WITH THE PLANETARY CONNECTING DRUM.

Q. REMOVE THE (5) EXTERNAL AND (4) INTERNAL FRICTION PLATES THAT MAKE UP SECOND (C4) CLUTCH.

R. REMOVE THE SELECTIVE SNAPRING THAT RETAINS THE SECOND (C4) CLUTCH PISTON HOUSING.

S. REMOVE THE PLANETARY RANGE ASSEMBLY ALONG WITH THE SECOND (C4) CLUTCH PISTON HOUSING USING LIFTING BRACKET J-24473 AND A S HOOK.

INSTRUCTOR NOTE: THE GOVERNOR DRIVE GEAR MAY SLIP OFF THE OUTPUT SHAFT WHEN REMOVING THE PLANETARY GEAR PACK.

T. REMOVE THE NON-SELECTIVE SNAPRING OF SECOND (C4) CLUTCH PISTON HOUSING.

U. REMOVE THE FIRST CLUTCH (C5) RETAINING SNAPRING

V. REMOVE THE FIRST CLUTCH (C5) RING GEAR ALONG WITH (5) EXTERNAL RE-ACTION PLATES AND (4) INTERNAL FRICTION PLATES.

W. INSTALL FIRST CLUTCH (C5) PISTON COMPRESSION TOOLS J-24452 AND J-24204-2 COMPRESS THE FIRST CLUTCH (C5) PISTON RETAINING RING UNTIL THE SNAPRING IS ACCESSIBLE FOR REMOVAL; REMOVE SNAPRING.

1. REMOVE RETAINING RING,

2. REMOVE (26) CLUTCH PISTON RETURN SPRINGS

3. USING (2) PAIR OF SNAPRING PLIERS, REMOVE FIRST CLUTCH (C5) PISTON FROM HOUSING.

CAUTION: WHEN COMPRESSING SPRING RETAINER ON INSTALLATION AND REMOVAL, RETAINER MAY GET CAUGHT IN SNAPRING GROOVE.



## DISASSEMBLY (CONTINUED)

## V. INPUT HOUSING

- A. ROTATE TRANSMISSION WITH INPUT HOUSING FACING UP.
- B. REMOVE (24) 1/4" - 24 NUTS FROM CONVERTER COVER
- C. REMOVE COVER FROM PUMP
- D. REMOVE THE LOCKUP FRICTION CLUTCH PLATE
- E. REMOVE THE LOCKUP BACKING PLATE.

NOTE: BALANCE WEIGHTS MUST BE ALIGNED ON INSTALLATION.

- F. REMOVE THE SNAPRING THAT RETAINS THE TURBINE TO THE TURBINE SHAFT.
  - 1. REMOVE THE TURBINE SHAFT
- G. WHILE ROTATING THE STATOR AND HOLDING IT IN THE LOCKED POSITION, REMOVE IT.

NOTE: IF STATOR IS NOT HELD IN THE LOCKED POSITION; THE RACE MAY STAY WITH THE STATOR SHAFT AND THE ROLLERS AND SPRINGS WILL FALL OUT OF STATOR HUB.

- H. BEND (4) LOCKSTRIPS FLUSH WITH BEARING RETAINER ON PUMP.
  - 1. REMOVE (8) 5/16 - 24 X 1 1/4" THAT RETAINS THE PUMP BEARING RETAINER.
  - 2. REMOVE THE PUMP BEARING RETAINER
- I. REMOVE THE PUMP ASSEMBLY BY GENTLY ROCKING THE PUMP WHILE APPLYING PULLING FORCE.
- J. REMOVE TWO 3/8 - 16 X 1 1/4" AT THE 3 'O' CLOCK POSTION FROM THE TOP OF THE TRANSMISSION.
  - 1. REMOVE THE REMAINING (22) 3/8 - 16 X 1 1/4" BOLTS FROM THE INPUT COVER,
  - 2. AND (5) 3/8 - 16 X 2 3/4" BOLTS.
  - 3. REMOVE THE REMAINING (9) 3/8 - 16 X 1 1/4" BOLTS IN THE CONVERTER SECTION OF THE INPUT HOUSING
- K. REMOVE THE INPUT COVER ASSEMBLY.



- L. USING (2) LEGS OF THE (3) LEGGED SLING; STAND ON THE LEFT SIDE OF THE TRANSMISSION; LOOKING DOWN AT THE INPUT; ATTACH ONE LEG OF YOUR SLING AT THE ACCESS TO THE RIGHT SIDE OF THE DOWEL USING A  $\frac{3}{8}$  - 16 X  $1\frac{3}{4}$ " BOLT. ATTACH THE (2ND) LEG OF THE SLING  $180^0$  DEGREES FROM THE POINT OF THE FIRST LEG, THEN LIFT AND REMOVE THE INPUT AND BEVEL GEAR AND PUMP ASSEMBLY.

## VI. HYDROSTATIC STEER

- A. MOVE THE HYDROSTATIC CONTROL PISTON TO EXPOSE THE (2) ALLEN SCREWS ON THE HOUSING OF THE HYDROSTAT. USING A  $\frac{3}{8}$ " ALLEN WRENCH REMOVE THE (2) SCREWS.
- B. REMOVE (2)  $\frac{5}{16}$  - 18 X  $1\frac{1}{2}$ " BOLTS, (2)  $\frac{5}{16}$  - 18 X  $2\frac{1}{4}$ " BOLTS.
- C. TURN THE TRANSMISSION SO THE RIGHT SIDE IS FACING UP.
- D. REMOVE (6)  $\frac{3}{8}$  - 16 X  $1\frac{1}{2}$ " BOLTS THAT RETAINS THE HYDROSTATIC UNIT TO THE MAIN CASE.
- E. ATTACH A  $\frac{7}{8}$  - 9 X 1" LIFTING EYE BOLT TO THE ACCESS AT THE TOP OF THE HYDROSTAT.
- F. LIFT THE HYDROSTAT OUT CAREFULLY.

NOTE: WHILE LIFTING THE HYDROSTAT STEER UNIT, MAKE SURE THAT THE TWO KNOBS PROTRUDING FROM IT DO NOT CATCH ON THE MAIN CASE. YOU MAY HAVE TO ROTATE THE HYDROSTAT WHILE REMOVING IT.

## SECTION 3

### INPUT MODULE

#### DESCRIPTION & OPERATION

##### SCOPE OF SECTION 3

THIS SECTION DESCRIBES THE TRANSMISSION COMPONENTS AND EXPLAINS THEIR FUNCTIONS. TORQUE PATHS WITHIN THE TRANSMISSION ARE ALSO EXPLAINED IN SECTION 3.

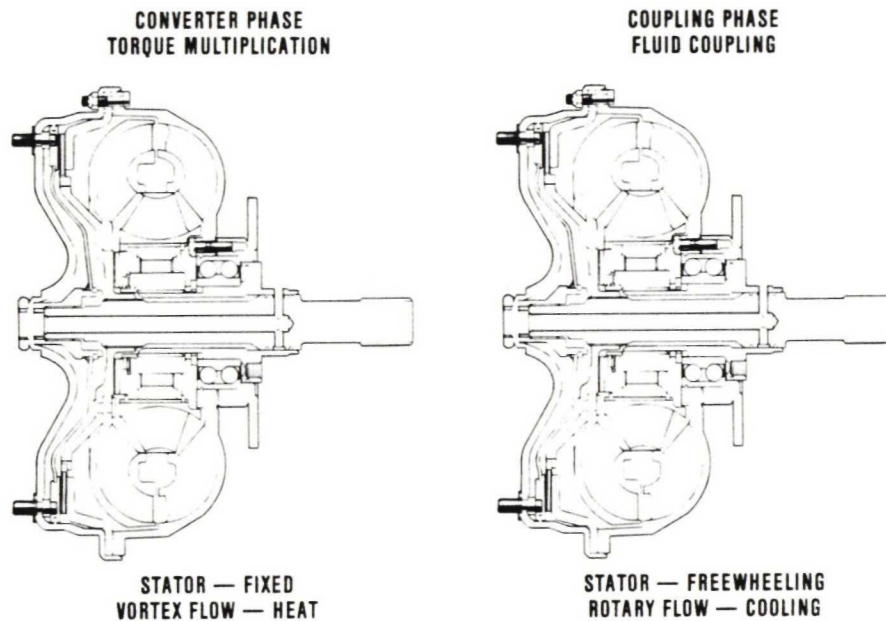
##### 3-1 MOUNTING

DIRECT MOUNTED TO THE ENGINE BY FLEX PLATE AND SUPPORTED BY TRUNION MOUNTS TO THE VEHICLE.

##### 3-2 INPUT DRIVE

THE DIRECT MOUNTED TRANSMISSION IS DRIVEN BY THE ENGINE THROUGH A FLEX PLATE TO THE CONVERTER INPUT DRIVE COVER ASSEMBLY. THE COVER ASSEMBLY IS BOLTED TO THE TORQUE CONVERTER PUMP.

## X200-4 TORQUE CONVERTER OPERATION



### 3-3 TORQUE CONVERTER

#### A. DESCRIPTION

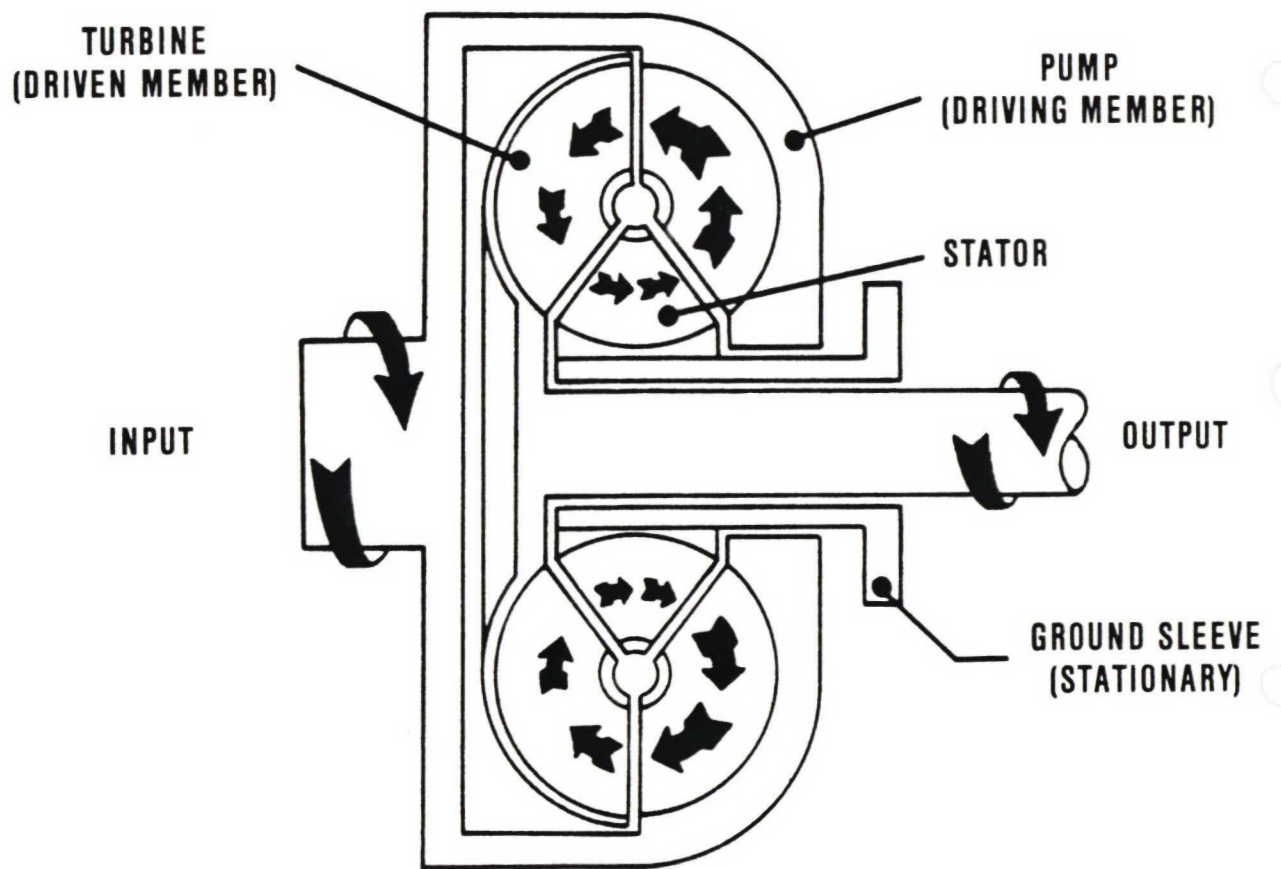
1. THE TORQUE CONVERTER IS MADE UP OF THREE ELEMENTS; PUMP ASSEMBLY, STATOR, AND TURBINE.
2. THE PUMP ASSEMBLY IS THE INPUT ELEMENT AND IS DRIVEN BY THE ENGINE. THE CONVERTER TURBINE IS THE OUTPUT ELEMENT AND IS SPLINED TO THE TURBINE SHAFT. THE STATOR IS THE REACTION (TORQUE MULTIPLYING) ELEMENT.
3. THE STATOR IS SUPPORTED ON A FREEWHEEL ROLLER RACE WHICH IS SPLINED TO THE STATIONARY GROUND SLEEVE ASSEMBLY. THIS STATOR ARRANGEMENT PROVIDES AN OVER-RUNNING CLUTCH WHICH PERMITS THE STATOR TO ROTATE FREELY IN THE DIRECTION OF ENGINE ROTATION ONLY. THE TORQUE CONVERTER THEN BECOMES A FLUID COUPLING IN OPERATION, NO TORQUE MULTIPLICATION.



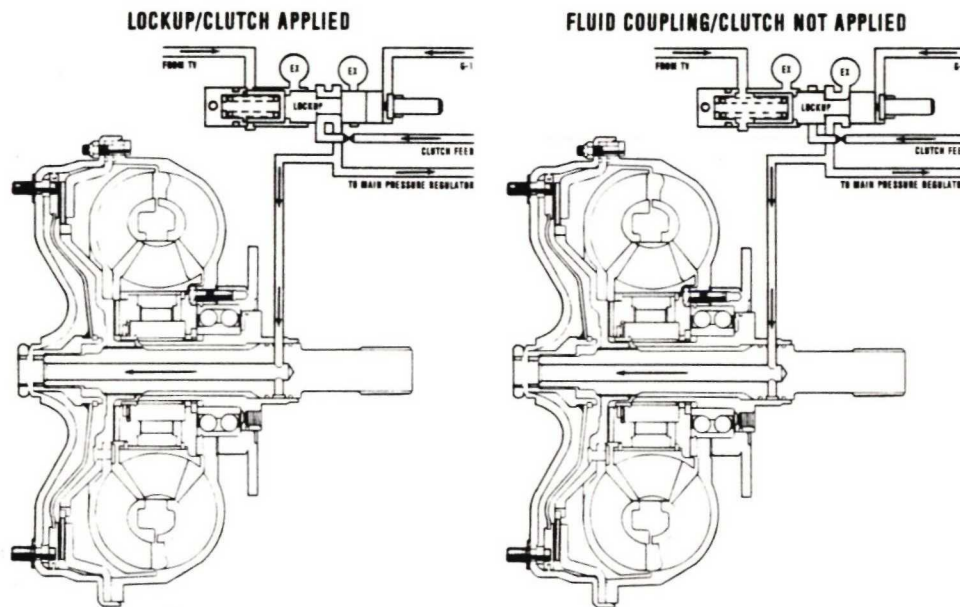
## B. OPERATION

1. THE TORQUE CONVERTER ASSEMBLY IS CONTINUOUSLY FILLED WITH OIL, WHICH FLOWS THROUGH THE CONVERTER TO COOL AND LUBRICATE IT. WHEN THE CONVERTER IS DRIVEN BY THE ENGINE, THE PUMP VANES THROW OIL AGAINST THE TURBINE VANES. THE IMPACT OF THE OIL AGAINST THE TURBINE VANES TENDS TO ROTATE THE TURBINE.
2. THE TURBINE, SPLINED TO THE TURBINE SHAFT, TRANSMITS TORQUE TO THE TRANSMISSION INPUT GEARING. AT ENGINE IDLE SPEED, THE IMPACT OF OIL AGAINST THE TURBINE VANES IS LIGHT. AT HIGH ENGINE SPEED, THE IMPACT IS MUCH GREATER THAN AT IDLE, AND HIGH TORQUE IS PRODUCED BY THE TURBINE.
3. OIL THROWN INTO THE TURBINE FLOWS TO THE STATOR VANES. THE STATOR VANES CHANGE THE DIRECTION OF OIL FLOW (WHEN THE STATOR IS FIXED AGAINST ROTATION), AND DIRECTS THE OIL TO THE PUMP IN A DIRECTION THAT ASSISTS THE ROTATION OF THE PUMP. IT IS THIS REDIRECTION OF THE OIL THAT ENABLES THE TORQUE CONVERTER TO MULTIPLY INPUT TORQUE.
4. GREATEST TORQUE MULTIPLICATION OCCURS WHEN THE CONVERTER TURBINE IS STALLED (STATIONARY) AND THE PUMP IS ROTATING AT ITS HIGHEST SPEED. TORQUE MULTIPLICATION DECREASES AS THE TURBINE ROTATES AND GAINS SPEED.
5. WHEN TURBINE SPEED APPROACHES PUMP SPEED, OIL FLOWING TO THE STATOR BEGINS STRIKING THE BACKS OF THE STATOR VANES. THIS ROTATES THE STATOR IN THE SAME DIRECTION AS THE TURBINE PUMP. AT THIS POINT, TORQUE MULTIPLICATION STOPS AND THE CONVERTER BECOMES, IN EFFECT, A FLUID COUPLING.
6. THUS, AS EXPLAINED IN 1 THRU 5 ABOVE, THE TORQUE CONVERTER HAS THREE MAIN FUNCTIONS. IT ACTS AS A DISCONNECT CLUTCH AT ENGINE IDLE SPEED. IT MULTIPLIES TORQUE AT LOW TURBINE/HIGH PUMP SPEED TO GIVE GREATER STARTING OR DRIVING EFFORT WHEN NEEDED. IT ACTS AS A FLUID COUPLING TO SMOOTHLY TRANSMIT ENGINE TORQUE TO THE TRANSMISSION GEARING.

## TORQUE CONVERTER SCHEMATIC DIAGRAM



## X200-4 CONVERTER LOCKUP CLUTCH OPERATION



### 3-4 LOCKUP CLUTCH

#### A. DESCRIPTION:

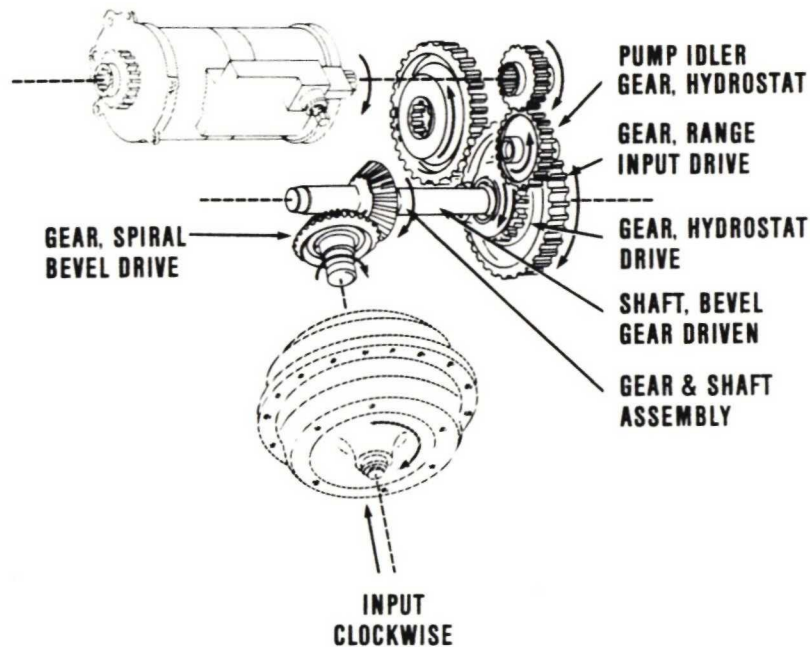
THE LOCKUP CLUTCH IS MADE UP OF THREE MAIN ELEMENTS: PISTON, CLUTCH PLATE, AND BACKING PLATE. THESE ELEMENTS ARE LOCATED BETWEEN THE CONVERTER DRIVE COVER AND THE CONVERTER TURBINE. THE PISTON AND BACKING PLATE ROTATE WITH THE CONVERTER PUMP. THE CLUTCH PLATE IS LOCATED BETWEEN THE PISTON AND BACKING PLATE AND IS SPLINED TO THE CONVERTER TURBINE HUB AND ROTATES WITH THE TURBINE.

#### B. OPERATION:

THE LOCKUP SHIFT VALVE DIRECTS CLUTCH APPLY PRESSURE TO THE LOCK-UP CLUTCH PISTON AT A PREDETERMINED TURBINE SPEED SENSED BY THE FORWARD CLUTCH HOUSING ROTATION BY A PITOT TUBE. THE CLUTCH APPLY PRESSURE COMPRESSES THE LOCKUP CLUTCH PLATE BETWEEN THE PISTON AND THE BACKING PLATE, LOCKING ALL THREE TOGETHER. THIS PROVIDES A DIRECT DRIVE FROM THE ENGINE TO THE TRANSMISSION GEARING. AS THE ROTATIONAL SPEED OF THE FORWARD CLUTCH AND SHAFT ASSEMBLY DECREASES, THE SAME VALVE AUTOMATICALLY RELEASES THE LOCKUP CLUTCH.



### INPUT GEARING CONVERTER DRIVEN



### 3-6 INPUT GEARS (CONVERTER DRIVEN)

#### A. DESCRIPTION

1. INPUT GEARS DRIVEN BY CONVERTER TURBINE
  - A. BEVEL GEAR SET
  - B. RANGE & HYDROSTAT DRIVER GEAR ASSEMBLY
  - C. RANGE INPUT DRIVE GEAR
  - D. HYDROSTAT IDLER GEAR
  - E. HYDROSTAT INPUT DRIVE GEAR
2. THE INPUT BEVEL DRIVE GEAR IS SPLINED TO THE TURBINE SHAFT AND MESHES WITH THE BEVEL DRIVEN GEAR AND SHAFT ASSEMBLY. THESE GEARS ARE SPIRAL CUT AND IN CONSTANT MESH LOCATED IN THE BEVEL GEAR CARRIER ASSEMBLY. THE BEVEL DRIVE GEAR IS ON THE AXIAL PLANE AND THE BEVEL DRIVEN GEAR IS ON THE TRANSVERSE PLANE OF THE TRANSMISSION. THE DRIVEN BEVEL GEAR AND SHAFT ASSEMBLY IS SPLINED INTO THE RANGE AND HYDROSTAT PUMP INPUT DRIVER GEARS ASSEMBLY. THE RANGE INPUT DRIVER GEAR MESHES WITH THE RANGE INPUT DRIVE GEAR WHICH DRIVES THE FORWARD CLUTCH HOUSING ASSEMBLY AT TURBINE SHAFT SPEED. THE HYDROSTAT DRIVER GEAR MESHES WITH AN IDLER GEAR WHICH MESHES WITH THE HYDROSTAT INPUT DRIVE GEAR WHICH DRIVES THE HYDROSTAT PUMP TURBINE SHAFT SPEED.

## B. OPERATION

THE INPUT GEARS TRANSMIT POWER FROM THE TORQUE CONVERTER IN THE INPUT MODULE TO THE BEVEL GEARS IN THE CENTER SECTION. THE BEVEL GEARS TRANSMIT POWER FROM THE AXIAL HORIZONTAL PLANE TO THE TRANSVERSE HORIZONTAL PLANE AND PROVIDES POWER INPUT TO BOTH THE HYDROSTATIC STEER UNIT AND THE PLANETARY RANGE PACK.

3-8

(BLANK)



BEVEL GEAR CARRIER & PUMP  
DISASSEMBLY  
(SUGGESTED SEQUENCE)

## I. DISASSEMBLY

- A. REMOVE MAIN INPUT PUMP DRIVE GEAR  
1/2 IN HEX NUT - CAREFULLY
- B. DO NOT LOSE WOODRUFF KEY
- C. REMOVE SIGNAL PRESSURE TUBE
- D. REMOVE (2) 5/16 - 18 X 2 1/2",  
(7) 5/16 - 18 X 2 3/4" FROM INPUT  
PUMP & SCAVENGE PUMP, (1) 5/16 -  
18 X 4 1/2"
- E. REMOVE (2) 5/16 - 18 X 1 1/2", (2)  
5/16 - 18 X 3" AND (2) 5/16 - 18 X  
2 3/4", SEPERATE SCAVENGE PUMP BODY  
FROM THE MAIN INPUT PUMP BODY
- F. REMOVE SNAPRINGS TO REMOVE GEARS

NOTE: ON MAIN PUMP DRIVE GEAR (LONG SHAFT) THERE IS A WOODRUFF KEY  
THAT ALIGNS THE GEAR ON THE SHAFT.

- G. PUT PUMP BODY IN VISE - WHILE  
GRADUALLY COMPRESSING MAIN PRESSURE  
REGULATOR VALVE

NOTE: FITTING ON VALVE WILL DAMAGE HOUSING IF COMPRESSED TOO MUCH.  
REMOVE SNAPRING - GRADUALLY LET OFF TENSION OF SPRING.

- H. USE VISE TO GRADUALLY COMPRESS THE  
FILTER DUMP VALVE SPRING; USING A  
SOCKET. USING A GUIDE PIN, TAP OUT  
ROLL PIN, GRADUALLY LET OFF  
PRESSURE
- I. REMOVE (2) 5/16 - 18 X 1 1/4" BOLTS  
AND WASHERS

CAUTION: REMOVE COVER CAREFULLY, SPRING LOADED. REMOVE CONVERTER RELIEF VALVE - AND (2) SPRINGS

- J. REMOVE (2)  $\frac{3}{8}$  - 16 X 1  $\frac{1}{2}$ " BOLTS & WASHERS, THAT RETAINS THE OUTPUT PUMP HOUSING
- K. REMOVE BYPASS VALVE, SPRING
- L. REMOVE (9)  $\frac{5}{16}$  - 18 X 2  $\frac{1}{4}$ " BOLTS THAT RETAINS THE BYPASS HOUSING. OUTPUT CHECK VALVE IS LOCATED IN HOUSING
- M. INPUT CHECK VALVE AND LUBE REGULATOR VALVE ANGLED APART - PRESSED FIT IN HOUSING
- N. REMOVE SNAPRING FROM TURBINE
- O. REMOVE (9)  $\frac{3}{8}$  - 16 X 1  $\frac{1}{2}$ " BOLTS FROM THE DIAPHRAGM ASSEMBLY. USE (2)  $\frac{3}{8}$  - 16 X 1  $\frac{1}{2}$ " BOLTS AT PULLER ACCESSSES TO PULL DIAPHRAGM ASSEMBLY OUT.
- P. REMOVE THE SNAPRING THAT RETAINS THE DRIVER GEAR AND INPUT PUMP BEARING
- Q. REMOVE (15)  $\frac{7}{16}$  - 14 X 1  $\frac{1}{2}$ " BOLTS THAT RETAINS THE DRIVE BEVEL GEAR HOUSING. USE  $\frac{3}{8}$  - 16 X 1  $\frac{1}{2}$ " PULLER BOLTS TO DRAW THE DRIVER BEVEL GEAR ASSEMBLY OUT.

## BEVEL GEAR ADJUSTMENT



## I. BEVEL GEAR ASSEMBLY "N"

A. THE BEVEL GEAR ASSEMBLY IS A MATCHED GEAR SET SUPPLIED AND SERVICED AS SUCH

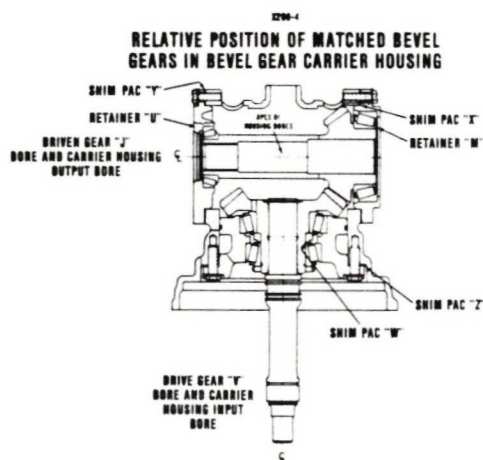
1. MEASUREMENTS OF DIMENSION, END PLAY, DRAG TORQUE, BACKLASH, AND GEAR PATTERN TO BE PERFORMED AT ROOM TEMPERATURE.

2. BEVEL GEAR SET INTENDED FOR RE-USE IN THE SAME HOUSING

A. NO ADJUSTMENT SHOULD BE NEEDED BUT TOOTH CONTACT AND BACK LASH SHOULD BE VERIFIED

3. BEVEL GEARS OR HOUSING REPLACED

A. MEASURED DIMENSIONS MUST BE USED AND SHIM PACKS CALCULATED TO MAKE PROPER INSTALLATION AND NECESSARY ADJUSTMENTS TO OBTAIN THE DESIRED TOOTH CONTACT PATTERN, BACKLASH, AND BEARING DRAG TORQUE



## I. RELATIVE POSITION OF THE MATCHED BEVEL GEAR ASSEMBLY "N" IN THE BEVEL GEAR HOUSING

A. DRIVER GEAR ASSEMBLY "V"

1. THE CENTERLINE OF ITS BORE COINCIDES WITH CENTERLINE OF BEVEL GEAR HOUSING INPUT.

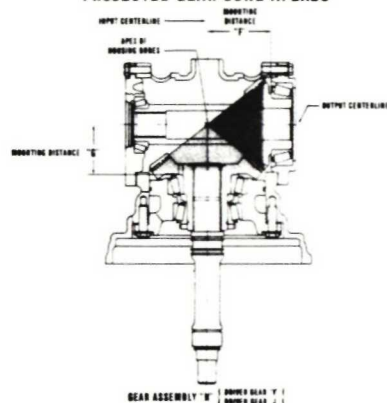
B. DRIVEN GEAR ASSEMBLY "J"

1. THE CENTERLINE OF ITS BORE COINCIDES WITH THE CENTERLINE OF BEVEL GEAR HOUSING OUTPUT

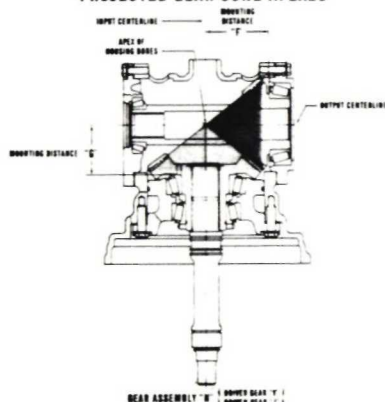
C. THESE CENTERLINES ARE IN THE SAME PLANE AND INTERSECT EACH OTHER.



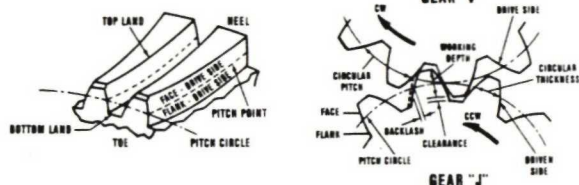
3290-4  
TERMINOLOGY AND LOGIC OF SHIMMING PROCEDURE  
PROJECTED GEAR CONE APEXES



3290-4  
TERMINOLOGY AND LOGIC OF SHIMMING PROCEDURE  
PROJECTED GEAR CONE APEXES



3290-4  
TERMINOLOGY OF GEAR TEETH



D. THE POINT OF INTERSECTION IS THE APEX OF BEVEL GEAR HOUSING BORES.

## I. TERMINOLOGY AND LOGIC OF THE SHIM PROCEDURE

- A. PROJECTED GEAR CONES. THE IMAGE FORMED BY PROJECTING LINES ON EACH GEAR TOOTH STARTING AT THE HEEL OF THE GEAR ON THE PITCH DIAMETER AND EXTENDING THROUGH THE TOE TO A POINT WHERE THE LINES CONVERGE INTO A TIP.
- B. APEX. THE POINT WHERE THE CONVERGING LINES FORM A TIP.

## II. SHIM SELECTION PROCEDURE

- A. PROPERLY INSTALL AND OPERATE BEVEL GEARS AT THE GEAR SETTING DIMENSION ETCHED ON EACH GEAR, I.E. (DIM. G) DRIVER GEAR AND (DIM. F) DRIVEN GEAR.
- B. THIS LEADS TO THE STATEMENT THAT BEVEL GEARS ARE PROPERLY INSTALLED WHEN THE APEXES OF THEIR PROJECTED CONES COINCIDE WITH THE APEX OF THE BEVEL GEAR HOUSING BORES.

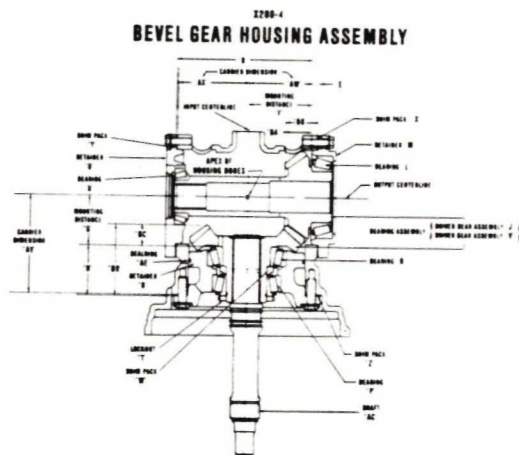
## III. TERMINOLOGY OF GEAR TEETH

- A. WORKING DEPTH IS THE DEPTH IN THE TOOTH SPACE, TO WHICH THE TOOTH OF THE MATING GEAR EXTENDS.
- B. FACE OF THE GEAR TOOTH IS THE PART OF THE GEAR TOOTH OUTLINE WHICH EXTENDS ABOVE THE PITCH CIRCLE.
- C. FLANK IS THAT PART OF THE GEAR TOOTH OUTLINE BELOW THE PITCH CIRCLE.

- D. BACKLASH IS THE AMOUNT BY WHICH A TOOTH SPACE EXCEEDS THE THICKNESS OF AN ENGAGING TOOTH (OR THE CLEARANCE BETWEEN TEETH).
- E. HEEL - THICK END OF THE GEAR TOOTH.
- F. TOE - THE END OPPOSITE THE HEEL OF A GEAR TOOTH.
- G. DRIVER SIDE - CONVEX SIDE OF DRIVE GEAR "V".
- H. DRIVEN SIDE - CONCAVE SIDE OF DRIVEN GEAR "J".
- I. COAST SIDE - THE OPPOSITE FACE AND FLANK OF BOTH DRIVE AND DRIVEN GEAR.

NOTE: TOOTH CONTACT PATTERN AND BACKLASH ARE VERIFIED ON THE DRIVE SIDE OF THE DRIVE GEAR I.E. AT THE PITCH POINT OF THE TOOTH PROFILE ON THE CONVEX, (DRIVE) SIDE OF THE DRIVE GEAR.

#### IV. REASSEMBLY BEVEL GEAR HOUSING (SHIMMING PROCEDURE LOGIC)



- A. SHIM PACK "Y" (DRIVEN GEAR ASSEMBLY "J")
  - 1. ASSEMBLE GEAR AND SHAFT ASSEMBLY "J" AND BEARING "K" AND "L".
  - 2. PRESS CUP "KA" OF BEARING "K" INTO RETAINER "U"
    - A. CHECK CUP FOR PROPER SEATING AGAINST SHOULDER
    - B. CUP "KA" IS .0040-.0065 PRESS FIT INTO THE RETAINER
    - C. TO FACILITATE ASSEMBLY HEAT RETAINER AND OR FREEZE CUP.
  - 3. PRESS CONE AND ROLLER ASSEMBLY "KB" OF BEARING "K" ONTO GEAR AND SHAFT ASSEMBLY "J".

- A. CHECK CONE FOR PROPER SEATING AGAINST SHOULDER, CONE "KB" IS .0010-.0026 PRESS FIT ON THE SHAFT.
- B. TO FACILITATE ASSEMBLY HEAT CONE AND/OR FREEZE SHAFT.
- 4. ASSEMBLE RETAINER "U" AND GEAR AND SHAFT ASSEMBLY "J".
  - A. MEASURE DISTANCE "B" FROM MOUNTING FACE OF THE GEAR TO THE MOUNTING FACE OF THE RETAINER.
  - B. THIS DIMENSION, MINUS MOUNTING DISTANCE "F", MINUS CARRIER DISTANCE "AX" IS THE NOMINAL SHIM PACK THICKNESS "Y".

$$Y = B - F - AX$$

Y = CALCULATED NOMINAL SHIM PACK  
(DRIVEN SIDE)

B = MEASURED DISTANCE

F = ETCHED ON DRIVEN GEAR

AX = ETCHED ON TOP OF BEVEL GEAR  
CARRIER

#### B. SHIM PACK "X"

(DRIVEN GEAR ASSEMBLY "J")

1. REMOVE RETAINER "U"

2. MEASURED DIMENSION "BA"

A. PRESS CUP "LA" OF BEARING  
"L" INTO RETAINER "M"

B. CHECK CUP FOR PROPER SEATING  
AGAINST SHOULDER

C. CUP "LA" IS .005"-.007" PRESS  
FIT IN THE RETAINER

- D. TO FACILITATE ASSEMBLY HEAT RETAINER AND OR FREEZE CUP
- 3. PRESS CONE AND ROLLER ASSEMBLY "LB" OF BEARING "L" ONTO GEAR AND SHAFT ASSEMBLY "J"
  - A. CHECK CONE FOR PROPER SEATING AGAINST SHOULDER
  - B. CONE "LB" ID .0010"-.0026" PRESS FIT ON GEAR
  - C. TO FACILITATE ASSEMBLY HEAT CONE AND OR FREEZE GEAR
  - D. CHECK CONE FOR PROPER SEATING AGAINST SHOULDER
- 4. ASSEMBLE RETAINER "M" WITH GEAR AND SHAFT ASSEMBLY "J" AND MEASURE DIMENSION "BB" FROM TOE END OF GEAR TEETH TO MOUNTING FACE OF RETAINER. DIMENSION  $E = BB - BA$
- 5. THE NOMINAL SHIM PACK THICKNESS "X" IS DETERMINED BY SUBTRACTING CARRIER DIMENSION "AW" FROM THE SUM OF DIMENSION "E" AND THE GEAR AND MOUNTING DISTANCE "F" AS MARKED ON THE GEAR.
 
$$S = (F + E) - AW$$
  - X - CALCULATED NOMINAL SHIM PACK
  - F - ETCHED ON DRIVEN GEAR
  - E - CALCULATED DIMENSION (BB-BA)
  - AW - ETCHED ON TOP OF BEVEL GEAR CARRIER
- 6. ASSEMBLE RETAINER "M" WITH GEAR AND SHAFT ASSEMBLY "J" USING SHIM PACK "X" AND TIGHTEN (12) 3/8 - 16 X 1 1/2" BOLTS. 36-43 LB. FT.



7. ASSEMBLE RETAINER "U" WITH CALCULATED SHIM PACK "Y"

A. WHILE TIGHTENING RETAINER BOLTS (12) 3/8 - 16 X 1 1/2" 36-43 LB. FT., ROTATE THE ASSEMBLED GEAR AND SHAFT ASSEMBLY TO FEEL FOR DRAG TORQUE.

B. ADD OR REMOVE SHIMS TO SHIM PACK "Y" TO OBTAIN 0-.0015 END PLAY

(1) DRAG TORQUE MUST NOT EXCEED 2 LB. IN.

C. SHIM PACK "W"

(DRIVER GEAR ASSEMBLY "Y")

1. ASSEMBLE DRIVER GEAR "Y", BEARINGS "P" AND "O", SPACER "S", RETAINER "R" AND NOMINAL SHIM PACK "W" AND LOCKNUT "T".

2. PRESS CUP "OA" OF BEARING "O" INTO RETAINER "R".

3. CHECK CUP FOR PROPER SEATING AGAINST SHOULDER

4. CUP "OA" IS .005"-.007" PRESS FIT IN THE RETAINER

5. TO FACILITATE ASSEMBLY, HEAT RETAINER AND/OR FREEZE CUP

6. MEASURED DIMENSION "BC"

A. PRESS CONE AND ROLLER ASSEMBLY "OB" OF BEARING "O" ONTO DRIVER GEAR "V"

B. CHECK CONE FOR PROPER SEATING AGAINST SHOULDER

C. CONE "OB" IS .0010"-.0026" PRESS FIT ON THE GEAR

D. TO FACILITATE ASSEMBLY HEAT CONE AND/OR FREEZE GEAR

7. INSTALL SPACER "S" ONTO DRIVER GEAR "V"
8. INSTALL SHIM PACK "W" OF .042" NOMINAL THICKNESS ONTO DRIVER GEAR "V"
9. PRESS CUP "PA" OF BEARING "P" INTO RETAINER "R"
  - A. CHECK CUP FOR PROPER SEATING AGAINST SHOULDER
  - B. CUP "PA" IS .005"-.007" PRESS FIT IN THE RETAINER
  - C. TO FACILITATE ASSEMBLY, HEAT RETAINER AND/OR FREEZE CUP
10. INSTALL DRIVER GEAR "V" INTO RETAINER "R"
  - A. PRESS CONE AND ROLLER ASSEMBLY "PB" OF BEARING "P" ONTO DRIVER GEAR "V"
  - B. CONE "PB" IS .0010"-.0030" PRESS FIT ON THE GEAR
  - C. TO FACILITATE ASSEMBLY HEAT CONE AND OR FREEZE GEAR
11. INSTALL LOCKNUT "T" AND TORQUE 150 LB. FT. WHILE ROTATING PARTS TO INSURE SEATING OF BEARINGS
12. ADD OR REMOVE SHIMS TO SHIM PACK "W" TO OBTAIN 0.0015" END PLAY. DRAG TORQUE MUST NOT EXCEED 2 LB. IN.
13. AFTER ADJUSTMENT OF SHIM PACK "W" FOR DESIRED END PLAY AND DRAG TORQUE, RETIGHTEN LOCKNUT "T" TO 150 LB. FT. AND STAKE 2 PLACES 180<sup>0</sup> APART.

## D. SHIM PACK "Z"

(DRIVER GEAR ASSEMBLY "V")

1. MEASURE DIMENSION "BD" FROM TOE END OF GEAR TEETH TO MOUNTING FACE OF THE BEARING RETAINER
2. DIMENSION  $H = BD - BC$
3. THE NOMINAL SHIM PACK THICKNESS "Z" IS DETERMINED BY SUBTRACTING THE CARRIER DIMENSION "AV" FROM THE SUM OF DIMENSION "H" AND THE GEAR
4.  $Z = (H + G) - AV$   
 $Z =$  CALCULATED NOMINAL DRIVER GEAR SHIM PACK  
 $H =$  CALCULATED DIMENSION  
 $G =$  ETCHED ON DRIVER GEAR  
 $AV =$  ETCHED ON TOP OF BEVEL GEAR CARRIER
5. INSERT SHAFT "AC" THRU DRIVE GEAR "V" AND INSTALL SNAPRING "AB"
6. INSTALL RETAINER ASSEMBLY "R" WITH SHIM PACK "Z" AS DETERMINED IN PREVIOUS STEP.
7. INSTALL AND TIGHTEN (15) 7/16 - 14 X 1 1/2" P/N 9415011 AND TORQUE TO 54-65 LB. FT.
8. CHECK OVERALL DRAG TORQUE, IT MUST NOT EXCEED 4 LB. IN.
9. CHECK BACKLASH FOR BEING WITHIN .002" OF BACKLASH ETCHED ON GEAR SET "N"
10. APPLY A THIN COAT OF MARKING COMPOUND TO BOTH SIDES OF GEAR TEETH ON GEAR AND SHAFT ASSEMBLY "J"

11. ROTATE GEARS UNDER SUFFICIENT LOAD TO ESTABLISH A CONTACT PATTERN. THE DRIVER GEAR "V" TURNS CLOCKWISE WHEN VIEWED FROM INPUT.
12. THE PATTERN MUST CONFORM WITH FIGURES IN YOUR STUDENT WORK BOOK

#### E. ADJUSTMENTS

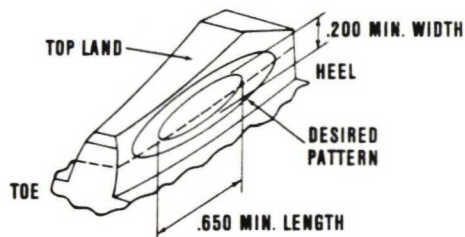
1. MAKE ADJUSTMENTS IN SHIM PACKS "X", "Y" AND "Z" AS REQUIRED TO OBTAIN ACCEPTABLE TOOTH CONTACT PATTERN AND BACKLASH.
2. TO MAINTAIN PROPER PRELOAD FOR BEARINGS "K" AND "L", ANY CHANGE IN SHIM PACK "X" MUST BE ACCOMPANIED BY AN EQUAL BUT OPPOSITE CHANGE IN SHIM PACK "Y", AND VICE VERSA.
3. WHEN TOOTH CONTACT PATTERN IS ACCEPTABLE, RECHECK FOR PROPER PRELOAD FOR BEARINGS "K" AND "L", BY CHECKING END PLAY 0-.0015" AND DRAG TORQUE NOT TO EXCEED 2 LB. IN.

#### F. SEAL RING INSTALLATION

1. UNSCREW BOLTS "AD" AND REMOVE ASSEMBLY OF RETAINER "R" WITH GEAR, BEARINGS, SPACER, SHIM PACK "W", AND LOCK NUT INTACT.
2. "DO NOT" LOOSEN LOCKNUT "T", THICKNESS AND QUALITY OF SHIM PACK "Z" MUST BE MAINTAINED
3. INSTALL SEALRING "AE" ONTO ASSEMBLY OF RETAINER "R" AND REINSTALL ASSEMBLY INTO CARRIER
4. REINSTALL WASHERS AND BOLTS "AD" (15) 7/16 - 14 X 1 1/2" TORQUE 54-65 LB. FT.



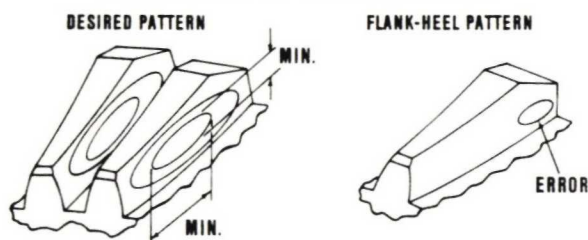
X200-4  
**DESIRED TOOTH CONTACT PATTERN**



V. DESIRED TOOTH CONTACT PATTERN  
 (DRIVE SIDE (CONVEX) OF DRIVE GEAR  
 "Y")

- A. LONG AXIS OF PATTERN (MINIMUM .650 INCH) CENTERED ON PITCH POINT OF TOOTH PROFILE
- B. SHORT AXIS OF PATTERN (MINIMUM .200 INCH) DIVIDED EQUALLY ON FACE AND FLANK OF TOOTH

X200-4  
**CORRECTION OF PATTERN ERROR**

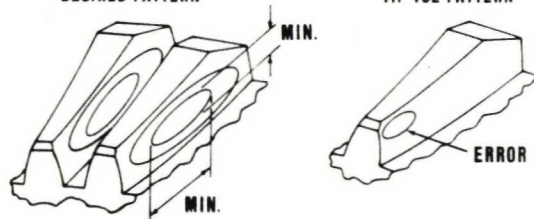


VI. ERROR FLANK-HEEL PATTERN - RIGHT IMAGE

A. CORRECT TO DESIRED PATTERN - LEFT IMAGE

1. MOVE DRIVEN GEAR "J" TOWARD HOUSING BORE APEX
  - A. DECREASE SHIM PACK "X"
  - B. INCREASE SHIM PACK "Y"
2. MOVE DRIVER GEAR "V" AWAY FROM HOUSING BORE APEX FOR CORRECT BACKLASH
  - A. INCREASE SHIM PACK "Z"

X200-4  
**CORRECTION OF PATTERN ERROR**



VII. ERROR TIP-TOE PATTERN - RIGHT IMAGE

A. CORRECT TO DESIRED PATTERN - LEFT IMAGE

1. MOVE DRIVER GEAR "V" AWAY FROM HOUSING BORE APEX
  - A. INCREASE SHIM PACK "Z"
2. MOVE DRIVEN GEAR "J" TOWARD HOUSING BORE APEX TO CORRECT BACKLASH
  - A. DECREASE SHIM PACK "X"
  - B. INCREASE SHIM PACK "Y"
3. CORRECT BACKLASH BETWEEN GEARS CONTROLLED BY SHIM PACK "Z"

REASSEMBLY

BEVEL GEAR CARRIER & PUMPS ASSEMBLY

(SUGGESTED SEQUENCE)

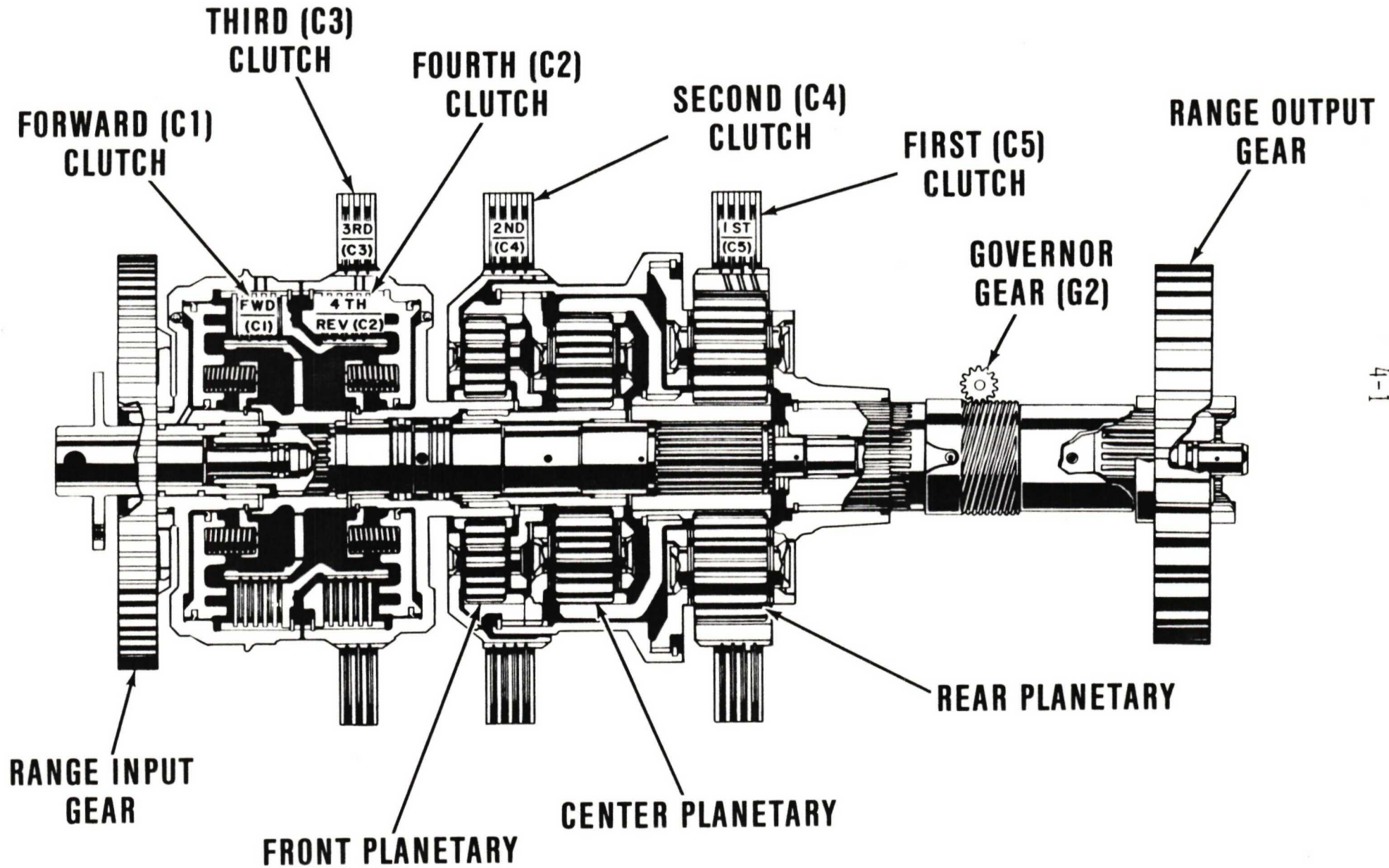
INSTRUCTOR NOTE: BEVEL GEAR SHIMMING LOGIC SHOULD HAVE BEEN FOLLOWED AND UNDERSTOOD BY STUDENTS. REASSEMBLY OF BEVEL GEARS WAS COMPLETED DURING THIS INSTRUCTIONAL PORTION. TO RE-ASSEMBLE THE BEVEL GEAR CARRIER & PUMPS ASSEMBLY, REVERSE THE PROCEDURE THAT WAS FOLLOWED IN PAGES 3-9 - 3-10.

3-22

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X20

# CLUTCH & PLANETARY GEAR SETS





## ESTABLISH CLUTCH & PLANETARY GEAR DESIGNATION

### I. DESIGNATION OF CLUTCHES AND PLANETARY GEAR SETS

A. IN THIS SECTION UNIFORM DESIGNATION FOR CLUTCHES ARE NECESSARY FOR CLARITY OF DESCRIPTION

1. CLUTCHES ARE DESIGNATED AS FIRST (C5), SECOND (C4), THIRD (C3), FOURTH (C2), FORWARD (C1)

### II. THE PLANETARY GEAR SETS ARE DESIGNATED AS TO THEIR POSITION IN THE PLANETARY RANGE PACK ASSEMBLY.

A. REAR PLANETARY GEAR SET COMPRISES,

1. REAR RING GEAR
2. REAR PLANETARY CARRIER ASSEMBLY
3. REAR SUN GEAR

B. CENTER PLANETARY GEAR SET COMPRISES,

1. CENTER RING GEAR
2. CENTER PLANETARY CARRIER ASSEMBLY
3. CENTER SUN GEAR

C. FRONT PLANETARY GEAR SET COMPRISES

1. FRONT RING GEAR
2. FRONT PLANETARY CARRIER ASSEMBLY
3. FRONT SUN GEAR

#### 4-7 FORWARD CLUTCH AND RANGE INPUT GEAR

THE FORWARD CLUTCH HAS MULTIPLE FUNCTIONS. WHEN ENGAGED WITH FIRST CLUTCH, SECOND CLUTCH, THIRD CLUTCH, OR FOURTH CLUTCH IT PRODUCES FIRST, SECOND, THIRD AND FOURTH RANGES IN THAT SEQUENCE.

##### A. DESCRIPTION

1. THE FORWARD CLUTCH ASSEMBLY CONTAINS A CLUTCH HOUSING, 5 EACH EXTERNAL-TANGED AND 5 EACH INTERNAL-SPLINED CLUTCH PLATES, PISTON, FORWARD CLUTCH HUB AND A FOURTH CLUTCH DRIVING HUB.
2. THE CLUTCH HOUSING HAS AN OIL COLLECTOR RING ATTACHED TO ITS OUTER DIAMETER THAT, WITH A PITOT TUBE, PRODUCES FRONT GOVERNOR PRESSURE (G1). THE CLUTCH HOUSING CONTAINS THE FORWARD CLUTCH PISTON RETAINED BY THE PISTON RETURN SPRINGS, A SPRING RETAINER AND A SNAPRING.

THE INTERNAL-SPLINED PLATES ARE SPLINED TO THE FORWARD CLUTCH HUB. THE EXTERNAL-TANGED PLATES ARE ANCHORED AGAINST ROTATION TO THE INTERNAL GROOVES OF THE FORWARD CLUTCH HOUSING.

##### B. OPERATION

1. THE FORWARD CLUTCH HOUSING ROTATES WHEN THE CONVERTER TURBINE ROTATES. FOURTH-CLUTCH DRIVE HUB ALSO ROTATES CAUSING THE INTERNAL-SPLINED PLATES OF THE FOURTH-CLUTCH PACK TO ROTATE.
2. WHEN HYDRAULIC PRESSURE IS DIRECTED TO THE BACK SIDE OF THE FORWARD CLUTCH PISTON, THE CLUTCH PLATES ARE COMPRESSED TOGETHER. THIS LOCKS THE FORWARD-CLUTCH HUB TO THE FORWARD CLUTCH HOUSING. SINCE THE HUB IS SPLINED TO THE TRANSMISSION MAIN SHAFT, THE SHAFT WILL ROTATE WITH THE HUB, AT INPUT SPEED.
3. THE SIMULTANEOUS APPLICATION OF TWO CLUTCHES IS NECESSARY TO PRODUCE ONE FORWARD OR REVERSE RANGE. THE FORWARD CLUTCH IS APPLIED ONLY IN FORWARD RANGES.
4. ROTATION OF THE OIL (PITOT) COLLECTOR RING DIRECTS OIL AGAINST THE PITOT TUBE ANYTIME THE CONVERTER TURBINE ROTATES. THUS, AN INCREASE IN TURBINE SPEED PRODUCES A PROPORTIONAL INCREASE IN FRONT GOVERNOR PRESSURE.

#### 4-8 FOURTH-CLUTCH

THE FOURTH CLUTCH IN THE X200-4 HAS A DUAL FUNCTION. WHEN ENGAGED WITH THE FORWARD CLUTCH, IT PRODUCES FOURTH RANGE. WHEN ENGAGED WITH THE FIRST CLUTCH, IT PRODUCES REVERSE RANGE.

##### A. DESCRIPTION

1. THE FOURTH CLUTCH ASSEMBLY CONTAINS A CLUTCH HOUSING, FIVE (5) INTERNAL-SPLINED AND FIVE (5) EXTERNAL-TANGED CLUTCH PLATES, A CLUTCH PISTON AND A BACKING PLATE. THE PISTON IS RETAINED BY PISTON RETURN SPRINGS, A SPRING RETAINER AND A SNAPRING.

##### B. OPERATION

1. THE INTERNAL-SPLINED CLUTCH PLATES, DRIVEN BY THE FOURTH-CLUTCH DRIVE HUB, ROTATE ANYTIME THE FORWARD-CLUTCH HOUSING ASSEMBLY ROTATES.
2. WHEN HYDRAULIC PRESSURE IS DIRECTED TO THE BACK SIDE OF THE FOURTH-CLUTCH PISTON, THE PISTON CLAMPS THE CLUTCH PLATES TOGETHER. THIS LOCKS THE INTERNAL-SPLINED PLATES TO EXTERNAL TANGED-PLATES, AND, IN TURN, TO THE FOURTH CLUTCH HOUSING.
3. THE SUN GEAR SHAFT ASSEMBLY IS SPLINED TO THE CLUTCH HOUSING, IT ALSO ROTATES AT INPUT SPEED.

#### 4-9 THIRD CLUTCH

THE THIRD CLUTCH PERFORMS ONLY ONE FUNCTION. WHEN FORWARD AND THIRD CLUTCHES ARE APPLIED, THE COMBINATION PRODUCES THIRD RANGE.

##### A. DESCRIPTION

1. THE THIRD CLUTCH CONTAINS A PISTON, INTERNAL-SPLINED AND EXTERNAL-TANGED CLUTCH PLATES, AND CENTER DIAPHRAGM.

THE INTERNAL-SPLINED PLATES ARE SPLINED TO THE OUTSIDE DIAMETER OF THE FOURTH CLUTCH HOUSING. THE EXTERNAL-TANGED PLATES ARE ANCHORED AGAINST ROTATION BY THE TRANSMISSION HOUSING.



THE PISTON IS RETAINED IN ITS BORE BY THE PISTON RETURN SPRINGS, A PISTON RETURN PLATE, AND BACKING PLATE. THE CENTER DIAPHRAGM ASSEMBLY IS HOUSED IN THE TRANSMISSION AND LOCATED BY ANCHOR KEYS. THIS INSURES ACCURATE OIL PASSAGE ALIGNMENT FROM THE VALVE BODY TO THE THIRD PISTON CAVITY.

#### B. OPERATION

1. WHEN HYDRAULIC PRESSURE IS DIRECTED THROUGH THE OIL PASSAGES IN THE CENTER DIAPHRAGM TO THE BACK SIDE OF THE CLUTCH PISTON THE CLUTCH PLATES ARE PRESSED TOGETHER. THIS LOCKS THE FOURTH CLUTCH HOUSING TO THE TRANSMISSION HOUSING, WHICH PREVENTS THE FOURTH CLUTCH HOUSING AND ATTACHED PARTS FROM ROTATING.
2. WITH THE APPLICATION OF THE FORWARD CLUTCH AND THE THIRD CLUTCH, A REACTION WITHIN THE PLANETARY GEARING WILL PRODUCE ROTATION OF THE RANGE OUTPUT GEAR.

### 4-10 SECOND CLUTCH

THE SECOND CLUTCH HAS A SINGLE FUNCTION. WHEN ENGAGED ALONG WITH THE FORWARD CLUTCH, IT PRODUCES SECOND RANGE.

#### A. DESCRIPTION

1. THE SECOND CLUTCH CONTAINS INTERNAL-SPLINED AND EXTERNAL-TANGED CLUTCH PLATES, AND A PISTON HOUSED IN THE FIRST AND SECOND CLUTCH PISTON HOUSING. THE EXTERNAL-TANGED PLATES ARE ANCHORED AGAINST ROTATION BY THE TRANSMISSION HOUSING, WHILE THE INTERNAL-SPLINED PLATES ARE SPLINED ONTO THE FRONT PLANETARY CARRIER.
2. THE PISTON IS RETAINED IN ITS BORE BY THE PISTON RETURN SPRINGS A PISTON RETURN PLATE, AND BACKING PLATE.

#### B. OPERATION

1. WHEN THE SECOND CLUTCH IS RELEASED, THE INTERNAL-SPLINED PLATES ARE FREE TO ROTATE. SINCE THE FRONT PLANETARY CARRIER IS SPLINED TO THE INTERNAL PLATES, IT WILL ALSO ROTATE FREELY.



2. WHEN HYDRAULIC PRESSURE IS DIRECTED TO THE BACK SIDE OF THE PISTON, IT PRESSES THE CLUTCH PLATES TOGETHER. THIS LOCKS THE ROTATING (INTERNAL-SPLINED) PLATES TO THE STATIONARY (EXTERNAL-TANGED) PLATES, STOPPING THE CARRIER FROM ROTATING.
3. WHEN FORWARD CLUTCH IS APPLIED TOGETHER WITH SECOND CLUTCH, A REACTION WITHIN THE PLANETARY GEARING WILL PRODUCE SECOND RANGE.

#### 4-11 FIRST CLUTCH

THE FIRST CLUTCH HAS A DUAL FUNCTION. WHEN ENGAGED TOGETHER WITH THE FORWARD CLUTCH IT PRODUCES FIRST RANGE. WHEN ENGAGED WITH FOURTH CLUTCH IT PRODUCES REVERSE 1 RANGE.

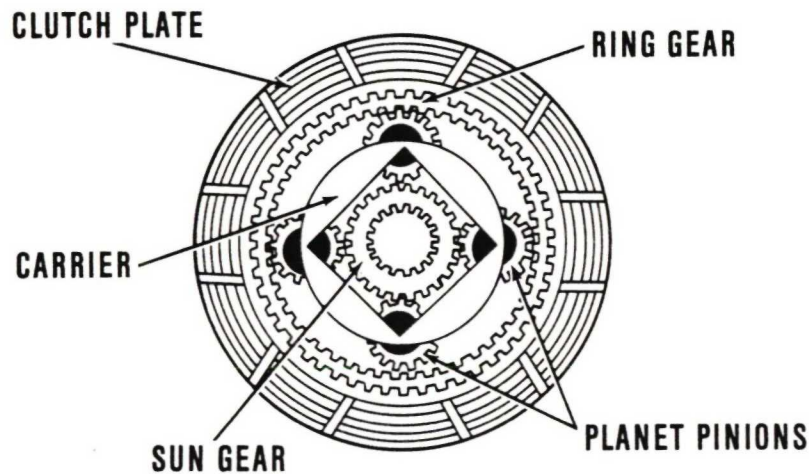
##### A. DESCRIPTION

1. THE FIRST CLUTCH CONTAINS INTERNAL-SPLINED AND EXTERNAL-TANGED CLUTCH PLATES, AND PISTON HOUSED IN THE FIRST AND SECOND PISTON HOUSING. THE EXTERNAL-TANGED PLATES ARE HELD BY THE TRANSMISSION HOUSING, WHILE THE INTERNAL-SPLINED PLATES ARE SPLINED ONTO THE REAR PLANETARY RING GEAR. THE PISTON IS RETAINED IN ITS BORE BY THE PISTON RETURN SPRINGS, PISTON RETURN PLATE, AND BACKING PLATE.

##### B. OPERATION

1. WHEN THE FIRST CLUTCH IS RELEASED, THE INTERNAL-SPLINED PLATES ARE FREE TO ROTATE. SINCE THE REAR PLANETARY RING GEAR IS SPLINED TO THE PLATES, IT WILL ALSO ROTATE FREELY.
2. WHEN HYDRAULIC PRESSURE IS DIRECTED TO THE BACK SIDE OF THE PISTON IT PRESSES THE CLUTCH PLATES TOGETHER. THIS LOCKS THE ROTATING INTERNAL-SPLINED PLATES TO THE STATIONARY EXTERNAL-TANGED PLATES, STOPPING THE RING GEAR FROM ROTATING.
3. WITH THE APPLICATION OF FORWARD CLUTCH TOGETHER WITH THE FIRST CLUTCH, A REACTION WITHIN THE PLANETARY GEARING WILL PRODUCE FIRST RANGE. WHEN THE FOURTH CLUTCH IS APPLIED TOGETHER WITH THE FIRST CLUTCH, THE REACTION PRODUCES REVERSE 1 RANGE.

## PLANETARY GEAR SET



### 4-12 PLANETARY GEAR SET

#### A. DESCRIPTION:

A SIMPLE PLANETARY GEAR SET COMPRISES A SUN GEAR, CARRIER ASSEMBLY, AND RING GEAR.

THE SUN GEAR IS LOCATED IN THE CENTER OF THE PLANETARY SET AND IS EITHER SPLINED OR MANUFACTURED ONTO A SHAFT. THE SUN GEAR HAS EXTERNAL TEETH WHICH MESH WITH THE PINION GEARS OF THE CARRIER.

THE CARRIER ASSEMBLY IS LOCATED BETWEEN THE SUN GEAR AND THE RING GEAR OF THE PLANETARY SET. THE CARRIER IS THE COMMON MEMBER CONNECTING THE PINION GEARS TOGETHER.

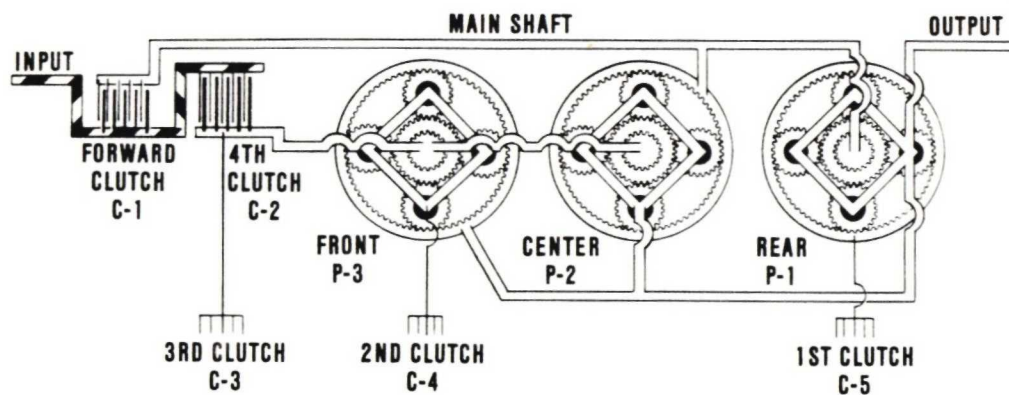
THE RING GEAR IS THE OUTSIDE MEMBER OF THE PLANETARY SET WHICH ENCOMPASSES THE PINION GEARS. THE INTERNAL TEETH OF THE RING GEAR MESH WITH THE EXTERNAL TEETH OF THE PINIONS.

#### B. OPERATION:

VARIATIONS IN SPEED AND DIRECTION THROUGH THE PLANETARY SET CAN BE ACCOMPLISHED BY UTILIZING ONE MEMBER AS AN INPUT OR DRIVE MEMBER, ANOTHER AS A HELD OR REACTIONARY MEMBER, AND ONE AS AN OUTPUT OR DRIVEN MEMBER. COMPOUNDING TWO OR MORE SIMPLE PLANETARY GEAR SETS WILL GIVE ADDITIONAL VARIATIONS OF SPEED AND DIRECTION.

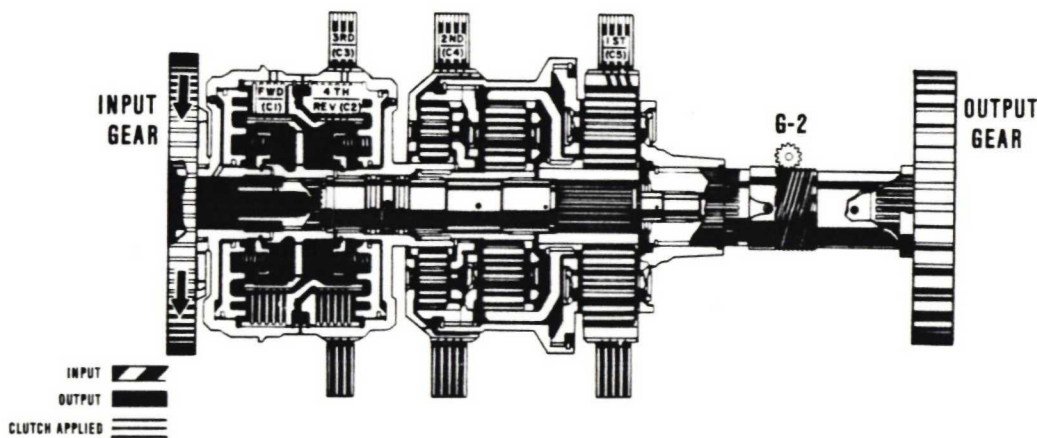
## 4-13 PLANETARY RANGE PACK TORQUE PATHS

BECAUSE INPUT GEAR TRAIN TORQUE PATHS ARE IDENTICAL IN ALL SITUATIONS, THE TORQUE PATHS DESCRIBED IN THE FOLLOWING PARAGRAPHS ALL START AT THE RANGE INPUT GEAR WHICH IS ALSO ATTACHED TO THE FORWARD CLUTCH (C-1) HOUSING. REFER TO INPUT GEARS (CONVERTER DRIVEN)



**4 SPEED AUTOMATIC  
WITH ONE REVERSE**

**NEUTRAL RANGE**

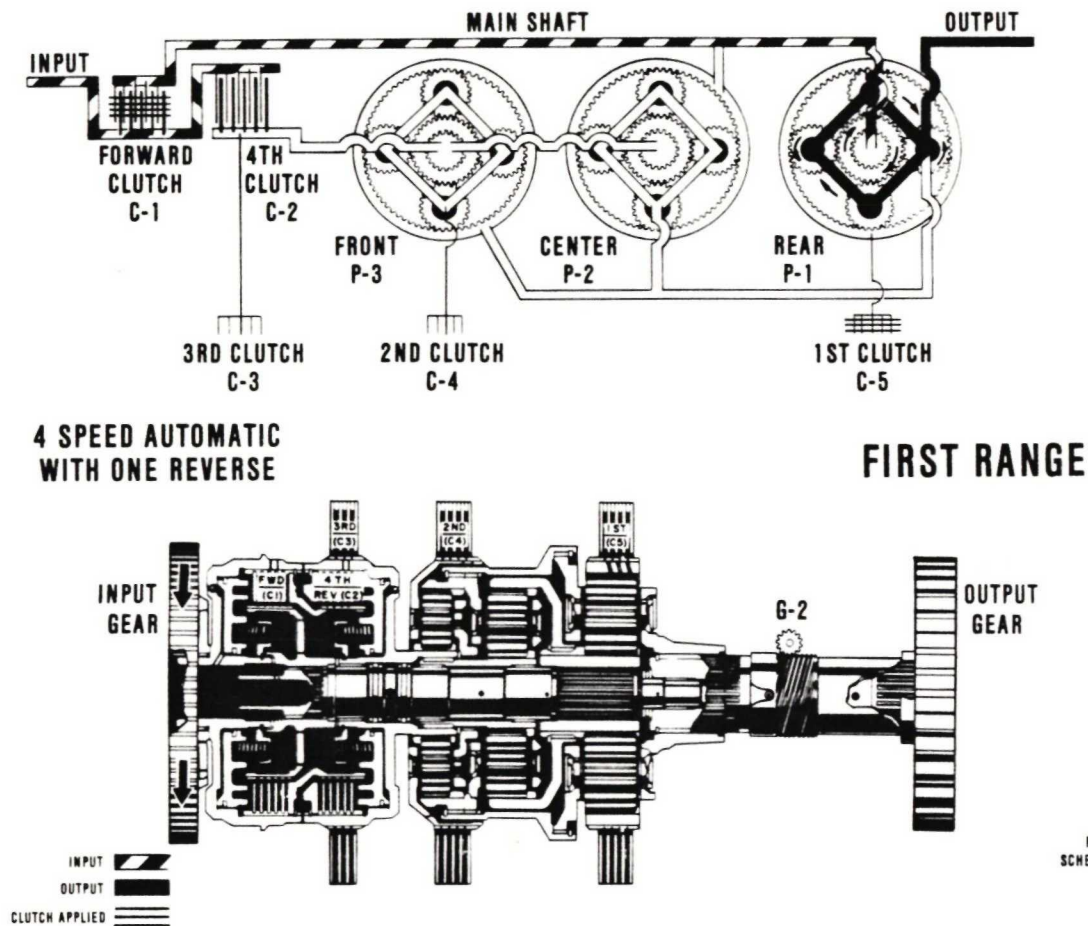


X200-4  
PLANETARY RANGE PACK  
SCHEMATIC AND CROSS SECTION  
POWER FLOWS

### I. NEUTRAL - TORQUE PATH

THERE ARE NO CLUTCHES APPLIED IN NEUTRAL, THEREFORE, TORQUE PRODUCED IN THE CONVERTER IS NOT TRANSMITTED BEYOND THE RANGE INPUT GEAR AND FORWARD CLUTCH (C1) HOUSING.

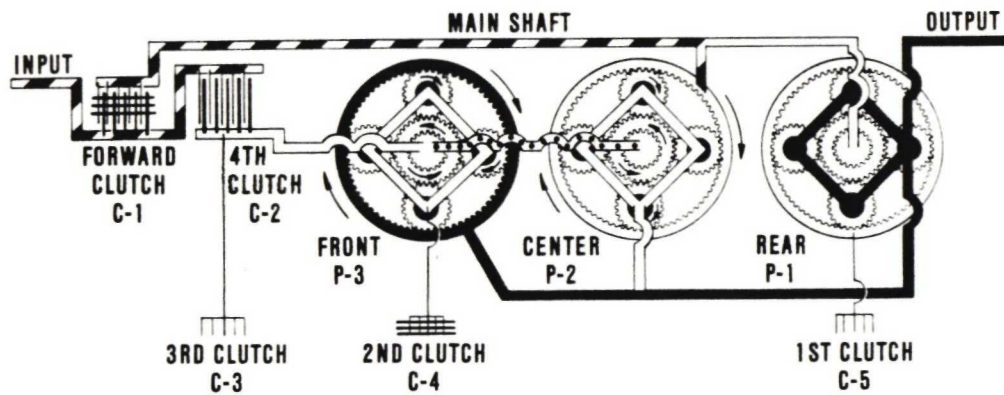




## II. FIRST RANGE - TORQUE PATH

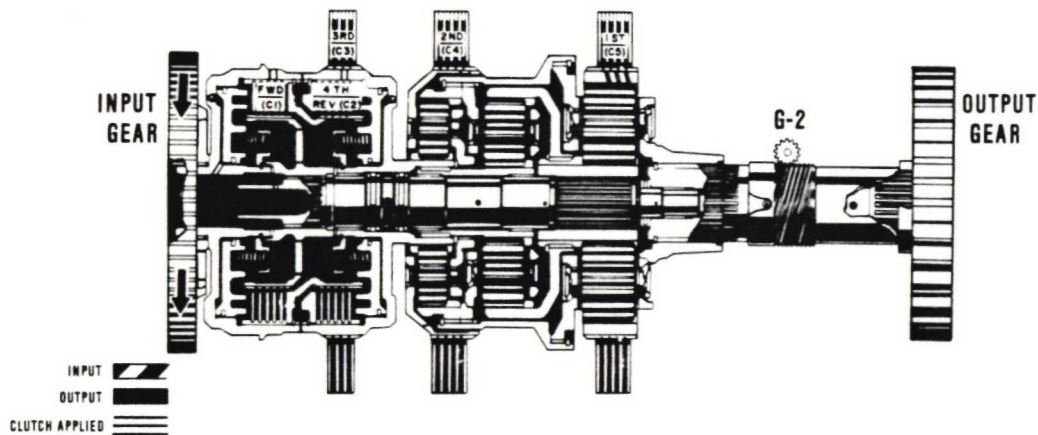
THE FORWARD (C1) AND FIRST (C5) CLUTCHES ARE APPLIED. THE FIRST CLUTCH (C5) APPLICATION ANCHORS THE REAR PLANETARY RING GEAR AGAINST ROTATION. THE FORWARD CLUTCH (C1) APPLICATION LOCKS THE RANGE INPUT GEAR AND MAIN SHAFT TOGETHER TO ROTATE AS A UNIT. THE REAR SUN GEAR IS SPLINED TO THE MAIN SHAFT AND ROTATES WITH IT AND, IN TURN, ROTATES THE REAR PLANETARY PINIONS. THE PINIONS ARE PART OF THE CARRIER ASSEMBLY WHICH IS SPLINED TO THE OUTPUT SHAFT AND RANGE OUTPUT GEAR. WITH THE REAR RING GEAR HELD STATIONARY BY THE APPLIED FIRST CLUTCH (C5) AND REAR SUN GEAR ROTATING THE PINIONS, THE REAR PLANETARY CARRIER MUST ROTATE WITHIN THE RING GEAR AND DRIVE THE RANGE OUTPUT GEAR CLOCKWISE.





4 SPEED AUTOMATIC  
WITH ONE REVERSE

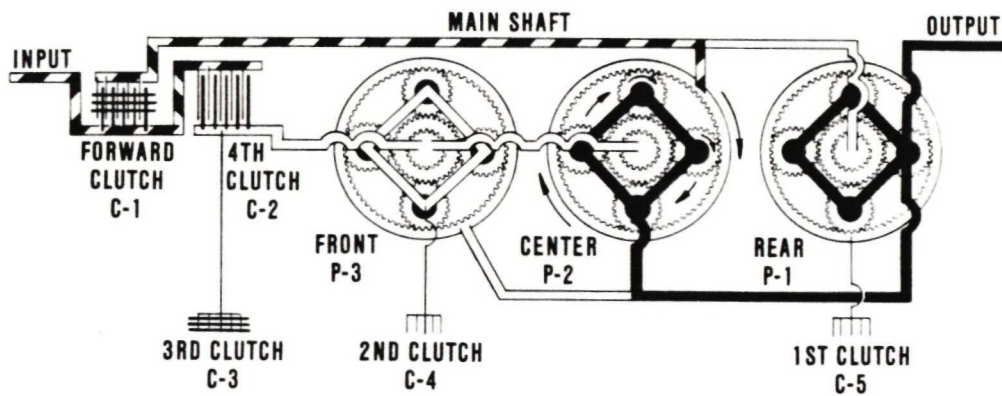
SECOND RANGE



X200-4  
PLANETARY RANGE PACK  
SCHEMATIC AND CROSS SECTION  
POWER FLOWS

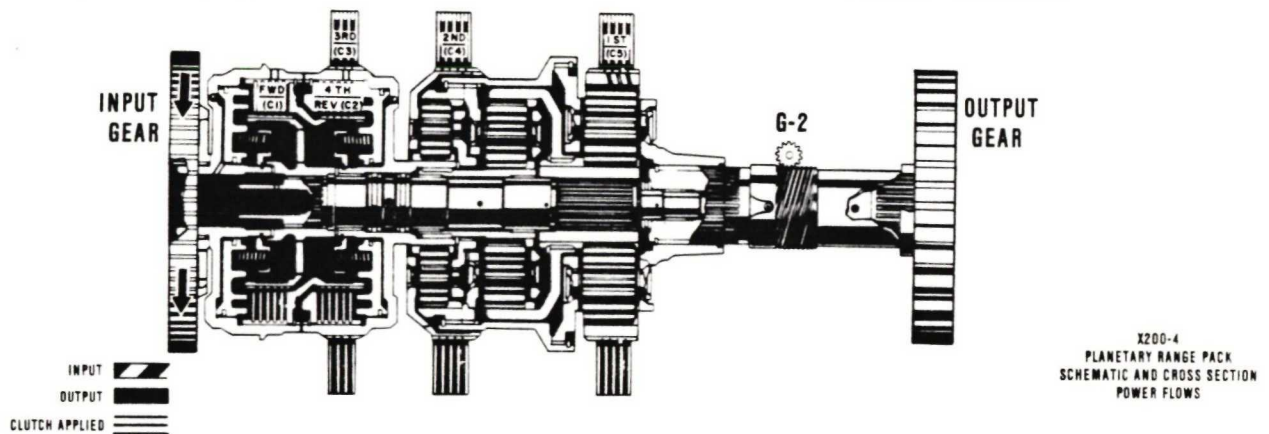
### III. SECOND RANGE - TORQUE PATH

THE FORWARD (C1) AND SECOND (C4) CLUTCHES ARE APPLIED. THE SECOND CLUTCH (C4) APPLICATION ANCHORS THE CARRIER OF THE FRONT PLANETARY ASSEMBLY AGAINST ROTATION. THE FORWARD CLUTCH (C1) APPLICATION LOCKS THE RANGE INPUT GEAR AND MAIN SHAFT TOGETHER TO ROTATE AS A UNIT. THE REAR SUN GEAR IS SPLINED TO BOTH THE ROTATING MAIN SHAFT AND THE CENTER RING GEAR AND ALL THREE PARTS ROTATE AT RANGE INPUT SPEED. WITH THE CARRIER OF THE FRONT PLANETARY ASSEMBLY ANCHORED AGAINST ROTATION (BY SECOND CLUTCH (C4) APPLICATION), THE ROTATING CENTER RING GEAR ROTATES THE CENTER SUN GEAR VIA THE PLANETARY PINIONS. THIS SUN GEAR IS SPLINED TO THE FRONT SUN GEAR, WHICH IS MANUFACTURED AS PART OF THE 4TH CLUTCH (C2) HOUSING. THE ROTATING FRONT SUN GEAR ROTATES THE FRONT CARRIER PINIONS WHOSE CARRIER IS ANCHORED AGAINST ROTATING BY THE APPLIED SECOND CLUTCH (C4). IN TURN, THE ROTATING FRONT CARRIER PINIONS DRIVE THE FRONT RING GEAR, WHICH, ALONG WITH THE CENTER CARRIER, IS SPLINED TO THE EXTENSION DRUM OF THE REAR CARRIER ASSEMBLY, TO THE RANGE OUTPUT GEAR.



**4 SPEED AUTOMATIC  
WITH ONE REVERSE**

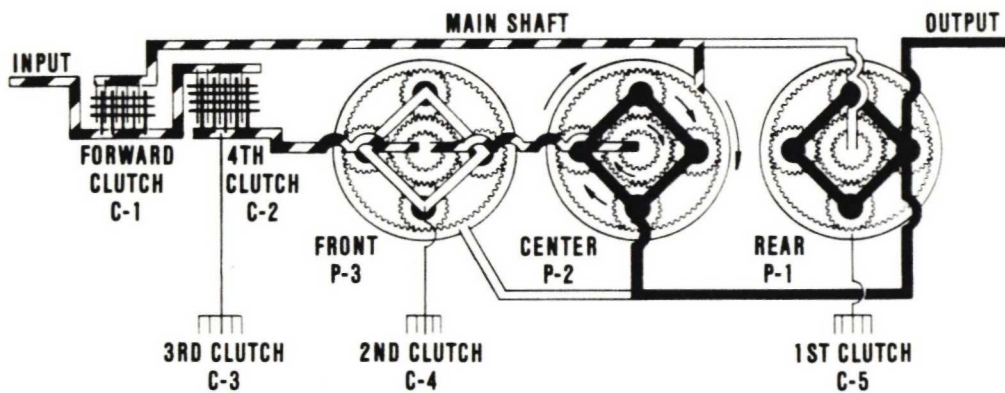
### THIRD RANGE



#### IV. THIRD RANGE - TORQUE PATH

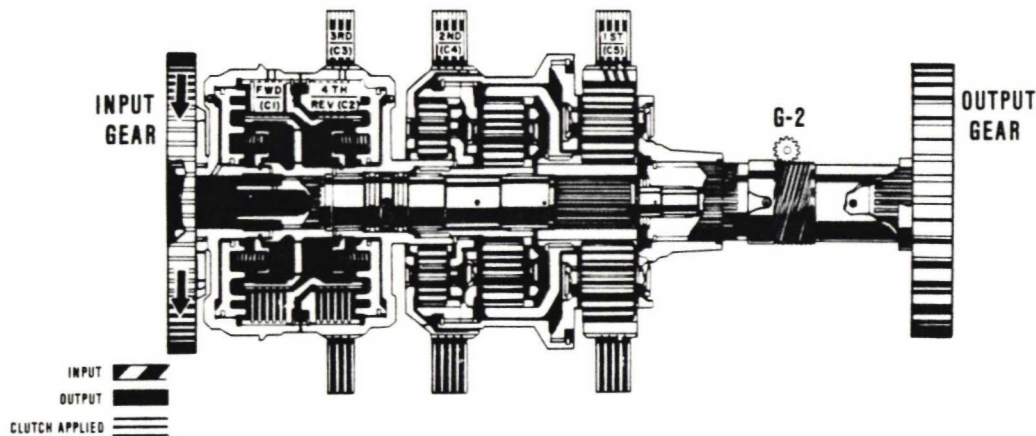
THE FORWARD (C1) AND THIRD (C3) CLUTCHES ARE APPLIED. THE THIRD CLUTCH (C3) APPLICATION ANCHORS THE FOURTH CLUTCH (C2) HOUSING AND FRONT SUN GEAR FROM ROTATING. THE FORWARD CLUTCH (C1) APPLICATION LOCKS THE RANGE INPUT GEAR AND MAIN SHAFT TOGETHER, TO ROTATE AS A UNIT. THE REAR SUN GEAR IS SPLINED TO BOTH THE MAIN SHAFT AND THE CENTER RING GEAR AND ROTATES AT RANGE INPUT SPEED. WITH THE CENTER SUN GEAR STATIONARY AND THE CENTER RING GEAR ROTATING, THE RING GEAR DRIVES THE CENTER PLANETARY CARRIER PINIONS. THIS ROTATES THE CENTER PLANETARY CARRIER AT A SPEED REDUCTION. THIS CARRIER (AND THE REAR PLANETARY CARRIER) IS SPLINED TO THE FRONT RING GEAR VIA THE EXTENSION DRUM OF THE REAR CARRIER ASSEMBLY AND ROTATES WITH IT AS A UNIT. THE REAR CARRIER AND OUTPUT SHAFT ASSEMBLY IS SPLINED TO THE RANGE OUTPUT GEAR WHICH ROTATES AT THE SAME SPEED AS THE CENTER PLANETARY CARRIER.





4 SPEED AUTOMATIC  
WITH ONE REVERSE

FOURTH RANGE

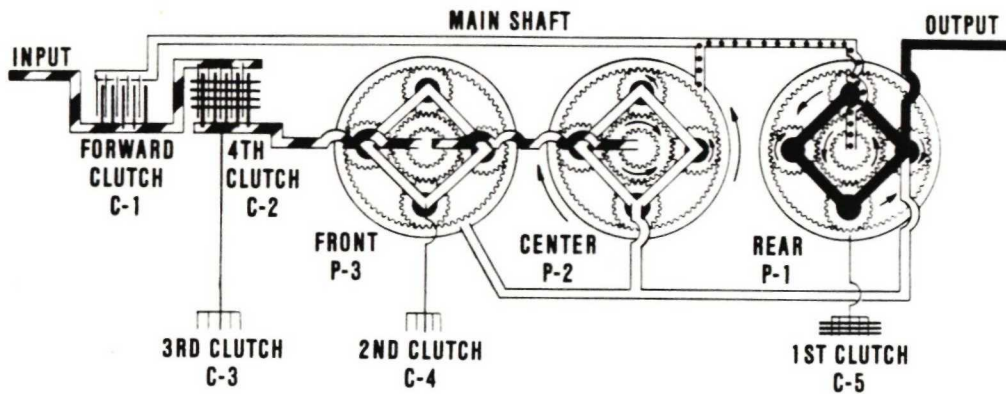


X200-4  
PLANETARY RANGE PACK  
SCHEMATIC AND CROSS SECTION  
POWER FLOWS

## V. FOURTH RANGE - TORQUE PATH

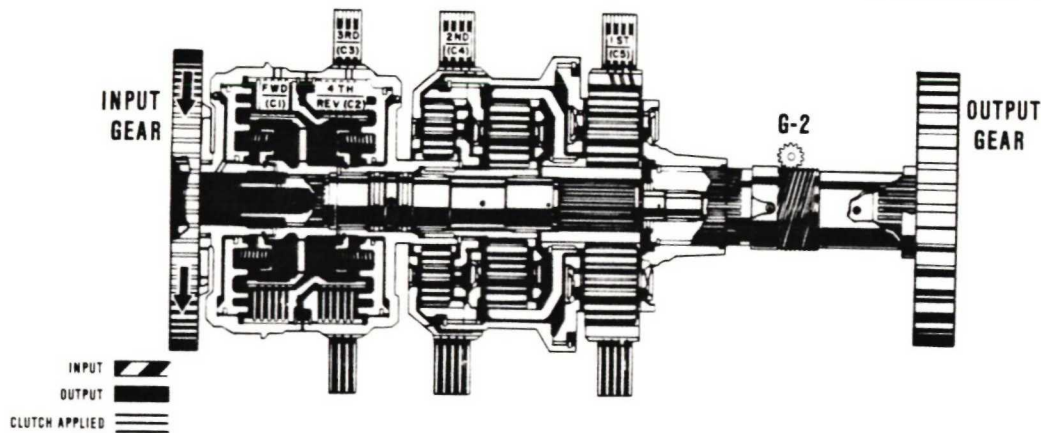
THE FORWARD (C1) AND FOURTH (C2) CLUTCHES ARE APPLIED. THE FORWARD CLUTCH (C1) APPLIED, DRIVES THE MAIN SHAFT AND CENTER RING GEAR TURBINE SPEED.

THE FOURTH CLUTCH (C2) APPLIED, DRIVES THE FOURTH CLUTCH (C2) HOUSING AND THE FRONT AND CENTER SUN GEARS TURBINE SPEED. THEREFORE TWO MEMBERS OF A SIMPLE PLANETARY GEAR SET HELD TO THE SAME SPEED (TURBINE) AND DIRECTION (CLOCKWISE) ROTATES ENMASS AND CREATES A RANGE OUTPUT RATIO OF 1:1.



4 SPEED AUTOMATIC  
WITH ONE REVERSE

## REVERSE RANGE



## VI. REVERSE RANGE - TORQUE PATH

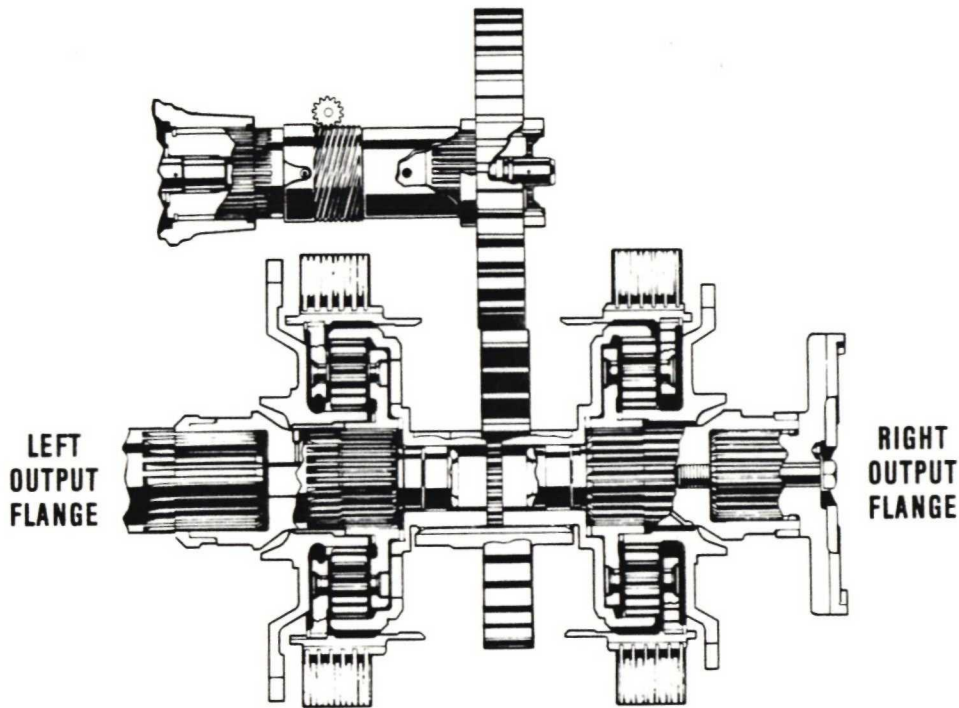
IN REVERSE RANGE - FOURTH CLUTCH (C2) IS APPLIED AND DRIVES FOURTH CLUTCH (C2) HOUSING, THE FRONT AND CENTER SUN GEARS TURBINE SPEED.

FIRST CLUTCH (C5) IS APPLIED AND HOLDS THE REAR RING GEAR STATIONARY. THE CENTER SUN GEAR ROTATES THE CENTER CARRIER PINIONS COUNTER CLOCKWISE WHICH ROTATES THE CENTER RING GEAR COUNTER-CLOCKWISE. THE REAR SUN GEAR IS SPLINED INTO THE HUB OF THE CENTER RING GEAR AND ROTATES IN THE SAME DIRECTION AS THE CENTER RING GEAR (COUNTER-CLOCKWISE).

THE FIRST CLUTCH (C5) HOLDS THE REAR RING GEAR STATIONARY, THEREFORE, THE REAR PLANET PINIONS ARE ROTATED CLOCKWISE AND DRIVES THE REAR CARRIER AND OUTPUT SHAFT ASSEMBLY IN A COUNTER-CLOCKWISE DIRECTION.



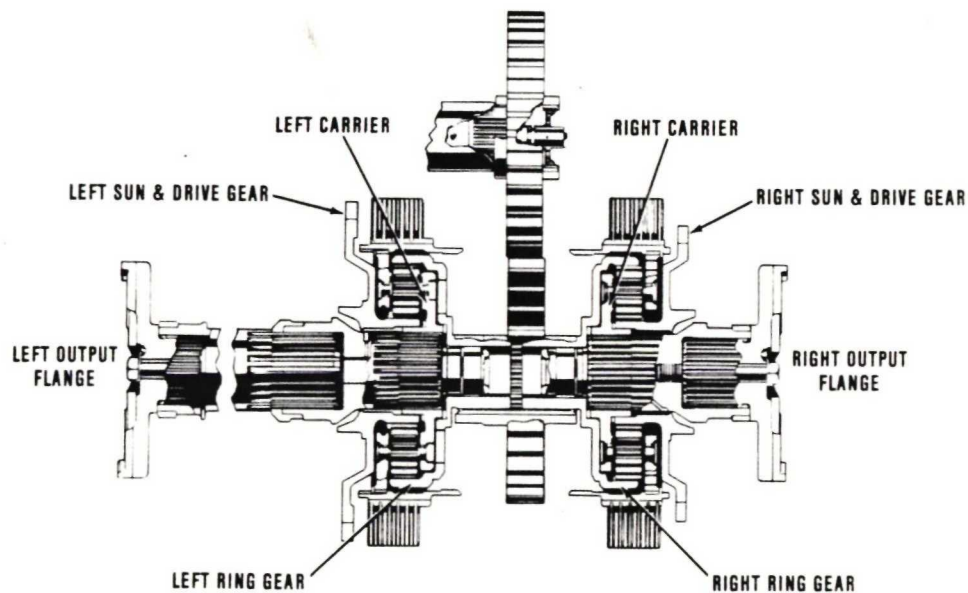
## X200-4 TORQUE PATH RANGE OUTPUT



### 4-14 RANGE OUTPUT TORQUE PATH

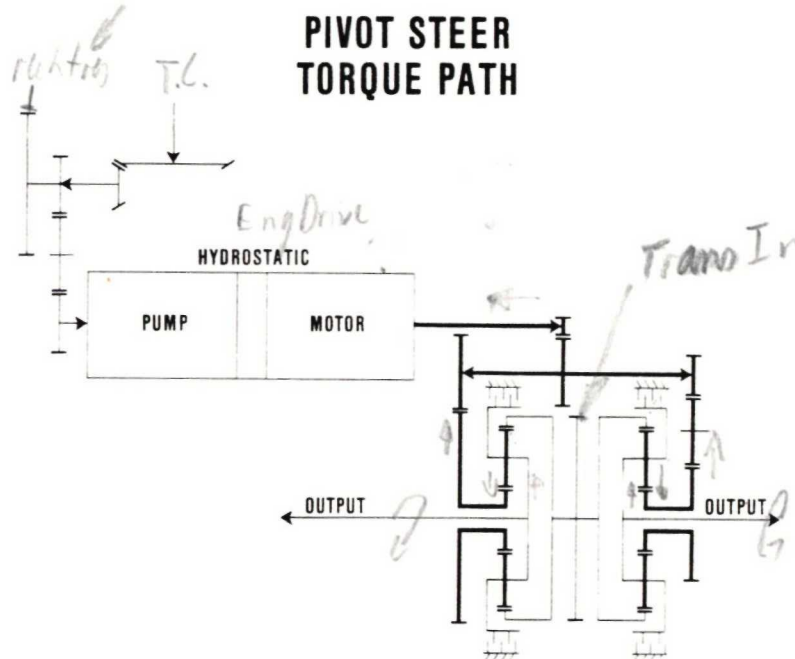
POWER IS TRANSMITTED FROM THE RANGE OUTPUT DRIVE GEAR TO A RANGE OUTPUT DRIVEN GEAR, SPLINED TO STEER RING GEAR ASSEMBLIES OF BOTH COMBINING PLANETARIES AND DRIVES BOTH RING GEARS IN EACH COMBINING PLANETARY THE SAME SPEED AND DIRECTION.

## OUTPUT COMBINING PLANETARY GEARS



### 4-15 COMBINING PLANETARIES

THE RING GEAR IS THE INPUT FROM THE RANGE PACK TO EACH COMBINING PLANETARY SET, THE SUN GEAR IS THE VARIABLE INPUT SPEED REACTION MEMBER MAKING THE CARRIER THE OUTPUT MEMBER TO THE OUTPUT FLANGES.



REASSEMBLY  
ASSEMBLY OF CENTER SECTION RANGE SECTION  
CLUTCHES AND PLANETARY GEARS  
(SUGGESTED SEQUENCE)

I. REASSEMBLY

A. CLUTCHES AND PLANETARY GEAR ASSEMBLIES

1. FIRST CLUTCH ASSEMBLY C-5

A. PISTON

(1) SEAL RING LIP EXTERNAL P/N 6883033

(2) SEAL RING LIP INTERNAL P/N 6883031

B. SPRING, PISTON RETURN(26 EA) P/N 6880251

C. RING RETAINER SPRING P/N 6834339

D. SNAP RING EXTERNAL P/N 6833993

E. PLATE, REACTION STEEL 5 EA. P/N 23018099

F. PLATE, CLUTCH FRICTION 4 EA. P/N 23018225

INSTRUCTOR NOTE: 1) ALIGN 1 EA. PLATE REACTION INTO RANGE HOUSING ENGAGING EXTERNAL TANGS OF PLATE WITH GROOVES OF HOUSING.  
2) PLACE 1 EA CLUTCH PLATE INTO RANGE HOUSING INSTALL,  
3) REAR PLANETARY RING GEAR P/N 23018135 (WITH SPLINE ADDENDUM DOWN) ENGAGING THE INTERNAL TANGS OF CLUTCH PLATE WITH EXTERNAL SPLINES OF REAR RING GEAR. THEN,  
4) ALTERNATE REACTION PLATE AND CLUTCH PLATE FOR TOTAL OF NINE PLATES.

G. PLATE, CLUTCH BACKING P/N 23018167

H. SNAP RING, INTERNAL P/N 6884275 (GREEN)

## SUB ASSEMBLY

## B. PLANETARY RANGE PACK

1. ASSEMBLE SHAFT AND BUSHING  
ASSEMBLY P/N 23018095 WITH
  - A. CARRIER ASSEMBLY REAR  
P.N 23018136, ATTACH WITH
  - B. SNAPRING P/N 23018274,  
INSTALL
  - C. BEARING P/N 907692 ON SHAFT  
ASSEMBLY P/N 23018096 INSTALL
  - D. PIN SPRING P/N 456641 3/16"  
SET TO DIM. 1.196"-1.192"
2. DRUM REAR CARRIER P/N 23018101

INSTRUCTOR NOTE: PLACE ON WORK TABLE, SMALL DIAMETER DOWN. INSERT REAR CARRIER ASSEMBLY P/N 23018136, WITH SHAFT AND BUSHING ATTACHED, INTO REAR CARRIER DRUM P/N 23018101

- A. RETAIN WITH SNAPRING P/N  
6834512
3. SHAFT RANGE INPUT P/N 23018095,  
INSTALL
  - A. SEAL RING (2 EA.) P/N  
6836264
  - B. BEARING ASSY. P/N 9415107
  - C. RACE (2 EA.) P/N 9431987
  - D. GEAR ASSEMBLY CENTER SUN P/N  
23018010 (SMALL END FIRST)
  - E. WASHER P/N 23018282
4. CENTER RING GEAR P/N 23018139,  
ONTO
  - A. REAR SUN GEAR P/N 23018102,  
AND RETAIN WITH
  - B. SNAPRING P/N 23018178,  
INSTALL ONTO
  - C. INPUT RANGE SHAFT P/N  
28018095, RETAIN WITH



- D. RING P/N 6836117
- 5. CENTER CARRIER ASSEMBLY P/N 6831676
- 6. FRONT RING GEAR P/N 6831675,  
RETAIN WITH  
A. SNAPRING P/N 6755007

INSTRUCTOR NOTE: INSTALL:

- 1) SNAPRING P/N 6884275 (GREEN), (.155-.157), INTO  
CENTER SECTION RANGE HOUSING
- 2) ATTACH SPECIAL TOOL #J-24473 TO THE RANGE INPUT SHAFT  
AT THE DEPRESSION BELOW THE SECOND SEAL RING P/N  
6836264 AND ABOVE THE SPLINES ON THE CENTER SUN GEAR  
ASSEMBLY THAT MOUNTS THE FRONT SUN GEAR.
- 3) INSTALL THE PARTIALLY ASSEMBLED

- 7. PLANETARY GEAR PACK INTO THE  
CENTER SECTION RANGE HOUSING.  
A. REMOVE SPECIAL TOOL #J-24473.  
CAREFULLY AVOID DAMAGE TO  
SEAL RING AND SEAL RING  
GROOVES.

CAUTION:

## SECOND CLUTCH ASSEMBLY (C-4)

8. SECOND CLUTCH HOUSING P/N  
23018100

INSTRUCTOR NOTE: ALIGN THE HOUSING SO AS TO INTERFACE WITH THE SECOND CLUTCH PISTON APPLY OIL SOURCE AND INSTALL

- A. BOLT 3/8 - 16 X 1 1/2"  
P/N 9409231
- B. WASHER FLAT (SPECIAL)  
3/8" P/N 6769636
- C. TORQUE BOLT (36-43 LB. FT.)  
RETAIN CLUTCH HOUSING WITH  
SELECTED
- D. SNAPRING THAT CAN BE INSTAL-  
LED INTO SNAPRING GROOVE P/N  
(AS REQUIRED) 6884273 THRU  
P/N 6884276
- 9. WASHER P/N 6831673
  - A. ASSEMBLED WITH PETROLATUM  
TO THE UNDERSIDE OF
- 10. FRONT CARRIER ASSEMBLY P/N  
23018169, INSTALL INTO
  - A. PLANETARY GEAR PACK, ASSEMBLE
- 11. WASHER P/N 23013453 (WITH  
PETROLATUM) TO THE TOP SIDE OF
  - A. FRONT CARRIER ASSEMBLY
- 12. SECOND CLUTCH PACK C-4
  - A. PLATE REACTION STEEL (EXT)  
5 EA. P/N 23018099
  - B. PLATE, CLUTCH FRICTION (INT)  
4 EA. P/N 23018225

INSTRUCTOR NOTE: 1) ALIGN 1 EA. PLATE REACTION INTO RANGE HOUSING ENGAG-  
ING EXTERNAL TANGS OF PLATE WITH GROOVES OF HOUSING.  
2) PLACE 1 EA. PLATE CLUTCH INTO RANGE HOUSING ENGAGING  
THE INTERNAL TANGS OF PLATE TO SPLINES OF THE FRONT  
CARRIER HUB.

INSTRUCTOR NOTE: (CONTINUED)

3) REPEAT ITEM 1) & 2) ABOVE FOR TOTAL OF FIVE REACTION PLATES AND FOUR CLUTCH PLATES AND RETAIN WITH

C. SNAPRING P/N 6884275 (GREEN)(.155-.157") INSTALLED INTO SNAPRING GROOVE OF THE RANGE HOUSING.  
THIRD CLUTCH ASSEMBLY - C-3

13. THIRD CLUTCH HOUSING ASSEMBLY  
P/N 23018100

INSTRUCTOR NOTE: ALIGN THE HOUSING SO AS TO INTERFACE WITH THE THIRD CLUTCH PISTON APPLY OIL SOURCE AND INSTALL

- A. BOLT 3/8 - 16 X 1 1/2" P/N 9409231
- B. WASHER FLAT (SPECIAL) 3/8" P/N 6769636
- C. TORQUE BOLT (36 - 53 LB.FT.) RETAIN CLUTCH HOUSING WITH SELECTED
- D. SNAPRING THAT CAN BE INSTALLED INTO SNAPRING GROOVE P/N (AS REQ'D.) 6884273 THRU P/N 6884276 INSTALL

FOURTH & REVERSE CLUTCH ASSEMBLY C-2  
14. CLUTCH ASSEMBLY 4TH & REV. (C-2)  
WITH FRONT PLANETARY SUN GEAR  
P/N 23045115

INSTRUCTOR NOTE: 1) CAUTION, DURING INSTALLATION, MUST BE USED OR SEAL RINGS P/N 6836264 WILL BE DAMAGED ON RANGE INPUT SHAFT  
2) SUN GEAR TEETH MUST BE ENGAGED WITH PINION GEAR TEETH IN FRONT CARRIER ASSEMBLY

## 15. THIRD CLUTCH PACK (C-3)

- A. PLATE, REACTION STEEL (EXT)  
(4 EA.) P/N 23018099
- B. PLATE, CLUTCH FRICTION (INT)  
(3 EA.) P/N 23018225

INSTRUCTOR NOTE: 1) ALIGN (1 EA.) PLATE REACTION INTO RANGE HOUSING ENGAGING EXTERNAL TANGS OF PLATE WITH GROOVES OF HOUSING

2) ALIGN (1 EA.) PLATE CLUTCH INTO RANGE HOUSING ENGAGING THE INTERNAL TANGS OF PLATE TO EXTERNAL SPLINES OF THE 4TH AND REVERSE CLUTCH HOUSING.

3) REPEAT ITEM 1) AND 2) ABOVE FOR A TOTAL OF FOUR REACTION PLATES AND THREE CLUTCH PLATES AND INSTALL

C. PLATE CLUTCH BACKING P/N  
23018098 WITH

D. PIN P/N 141190 RETAIN  
BACKING PLATE WITH

E. RING RETAINING P/N 6836108

## 16. WASHER THRUST P/N 23018282

- A. ASSEMBLED WITH PETROLATUM  
TO THE TOP SIDE OF THE 4TH  
AND REVERSE CLUTCH ASSEMBLY

17. FORWARD CLUTCH ASSEMBLY (C-1)  
P/N 23015116

INSTRUCTOR NOTE: USING THE BACKING PLATE AND 4TH CLUTCH DRIVE HUB, ALIGN THE INTERNAL TANGS OF THE 4TH CLUTCH PLATES BY INSERTING THE DRIVE HUB OF THE BACKING PLATE INTO THE INSTALLED 4TH CLUTCH ASSEMBLY. APPLY AIR TO 4TH CLUTCH FEED AND REMOVE BACKING PLATE AND HUB.

- A. INSTALL FORWARD CLUTCH  
ASSEMBLY P/N 23015116 INTO
- B. FOURTH CLUTCH ASSEMBLY  
ENGAGING ALL FIVE CLUTCH  
PLATES, THEN ALIGN & INSTALL



- C. PITOT P/N 23018044 AND  
RETAIN WITH
- D. SCREWS 2 EA P/N 455531 AND
- E. TORQUE TO 108 - 132 LB. IN.

NOTE: GOVERNOR DRIVE GEAR SPACER TO BE INSTALLED WHEN TRANSMISSION IS POSITIONED RIGHT SIDE UP.

CAUTION: INSTALL COMPRESSOR BAR, TOOL (NUMBER J-23630-02), WITH ONE BOLT 3/8 - 16 X 1 1/4" AND WASHER ON THE TRANSMISSION LEFT SPLIT LINE TO RETAIN THE FORWARD CLUTCH HOUSING ASSEMBLY WHEN THE TRANSMISSION IS INVERTED TO FACILITATE ASSEMBLY.

### C. HYDROSTATIC STEER UNIT

NOTE: ROTATE TRANSMISSION RIGHT SIDE UP.

1. ATTACH 7/8 - 9 X 1" EYE BOLT TO HYDROSTAT OUTPUT SHAFT THREADED ACCESS HOLE
2. ATTACH "S" HOOK & HOIST TO EYE BOLT
3. LIFT HYDROSTAT AND INSTALL INTO CENTER SECTION

CAUTION: TAKE CARE TO CLEAR OBSTRUCTIONS IN MAIN HOUSING.

4. INSTALL (6) EA. 3/8 - 16 X 1 1/2" BOLTS TO RETAIN UNIT TO MAIN CASE (SEE INSTRUCTOR NOTE).
5. MOUNT THE CONTROL SERVO VALVE ASSEMBLY AND ATTACH WITH BOLTS (2 EA) 5/16 - 18 X 1 1/2" AND (2) EA. 5/16 - 18 X 2 1/4" BOLTS WITH WASHERS. TORQUE.

INSTRUCTOR NOTE: INSTALL BOLTS IN 3 ABOVE, FINGER TIGHT TO ALLOW CENTERING OF STEER CONTROL SHAFT DURING INSTALLATION OF FRONT HOUSING ASSEMBLY.

ASSEMBLY OF CENTER SECTION  
INPUT GEAR TRAIN

## I. ASSEMBLY

## A. INSTALL ONTO HYDROSTAT INPUT

1. GEAR HYDROSTATIC P/N 23018074  
RETAIN WITH
2. SNAP RING (EXT) 1.517" I.D.  
P/N 6832579

INSTRUCTOR NOTE: MAKE SUB-ASSEMBLY OF FOLLOWING PARTS AND INSTALL INTO  
LEFT SIDE OF CENTER SECTION.

3. GEAR HYDROSTATIC PUMP IDLER  
P/N 23018160
4. RING RETAINING (INT) 1.195" O.D.  
2 EA. P/N 6836111
5. BEARING 2 EA. P/N 7455766 PRESS-  
ED ONTO BEARING JOURNALS OF GEAR  
P/N 23018160. INSTALL INTO CENTER  
SECTION ENGAGING TEETH OF IDLER  
GEAR WITH THOSE OF HYDROSTATIC  
GEAR P/N 23018074, INSTALL
6. RETAINER, LEFT IDLER GEAR BEAR-  
ING P/N 23017878
  - A. BOLT 3/8" - 16 X 1" 6 EA.  
P/N 9409028 AND
  - B. WASHER 13/32" I.D. 6 EA.  
P/N 6769636
  - C. TORQUE - 36 - 43 LB. FT.
7. SHAFT BEVEL GEAR DRIVEN P/N  
23018157

INSTRUCTOR NOTE: MAKE A SUB-ASSEMBLY BY MOUNTING

- A. GEAR, HYDROSTATIC DRIVER P/N  
23018159, ONTO

- B. GEAR, RANGE INPUT DRIVER  
P/N 23018158, PRESS
- C. BEARING ASSEMBLY 2 EA. P/N  
7455769 ONTO BEARING JOURNALS  
OF GEAR, RANGE INPUT DRIVER  
P/N 23018158, INSTALL THIS  
ASSEMBLY INTO

8. CENTER SECTION, ENGAGING  
THE TEETH OF

- A. HYDROSTATIC DRIVER GEAR  
P/N 23018159 WITH
- B. HYDROSTATIC PUMP IDLER GEAR  
P/N 2301816, AND
- C. RANGE INPUT DRIVER GEAR  
P/N 23018158 WITH
- D. RANGE INPUT DRIVE GEAR  
P/N 23018092 WITH
- E. BEARING ASSEMBLY P/N 7455768  
(MOUNTED)

ASSEMBLY OF CENTER SECTION  
INSTALLATION OF LEFT COVER ASSEMBLY  
P/N 23045132

I. INSTALLATION OF LEFT COVER ASSEMBLY  
P/N 23045132

- INSTRUCTOR NOTE: 1) INVERT COVER ASSEMBLY P/N 23045132 WITH EXTERIOR SIDE UPWARD
- 2) ATTACH SLING P/N 12268036 TO LEFT COVER ASSEMBLY WITH TWO "ALL-THREAD BOLTS" & NUTS 3/8" - 16 X 4" IN THE TWO THREADED "JACKING HOLES" UNTIL FLUSH WITH SPLIT LINE, UNDERSIDE OF COVER.
- 3) LEVEL COVER BY ADJUSTING FREE RUNNING NUTS. INSTALL:
- A. GASKET COVER ASSEMBLY P/N 23018076 ONTO COVER SPLIT LINE SURFACE OF CENTER SECTION, THEN INSTALL
  - B. LEFT COVER ASSEMBLY ONTO CENTER SECTION

INSTRUCTOR NOTE: WHILE GUIDING COVER ASSEMBLY, HOLD ONE HAND ON OUTPUT FLANGE, MOVE FLANGE CLOCKWISE AND COUNTER-CLOCKWISE AS COVER IS DECENDING, TO ENGAGE THE SPLINES OF THE OUTPUT PUMP DRIVE GEAR P/N 23018071 AND SPLINES OF THE OUTPUT CARRIER ASSEMBLY P/N 23018275

- 1. LOWER COVER ASSEMBLY SLOWLY ALIGNING ALL INTERFACING COMPONENTS.
- C. INSTALL
  - 1. WASHER FLAT 3/8" 27 EA. P/N 23018196
  - 2. BOLT 3/8" - 16 X 1 1/4", 27 EA. P/N 9409082
  - 3. BRACKET LIFTING P/N 23018077



4. WASHER FLAT 3/8", 2 EA. P/N 23018196
  5. BOLT 3/8" - 16 X 1 1/2", 2 EA. P/N 9408992
  6. TORQUE BOLT, 29 EA. 27-32 LB. FT.
- D. REMOVE "ALL-THREAD BOLTS", SLING AND BOLT P/N 9409060 FROM FLANGE INTERFACE HOLE, THEN

INSTRUCTOR NOTE: ROTATE CENTER SECTION RIGHT SIDE UP.

## SECTION 5

### I. CONTROL VALVE BODIES

#### A. FOUR (4) VALVE BODY ASSEMBLIES

##### 1. INTERNALLY LOCATED

#### B. LOCATION

##### 1. CENTER SECTION - COVER, TRANSMISSION CONTROLS

- A. MAIN CONTROL VALVE BODY
- B. LOCKUP VALVE BODY
- C. PRIORITY VALVE BODY
- D. G2 BACKUP VALVE BODY

##### 2. INPUT MODULE

- A. MAIN PRESSURE REGULATOR
- B. FILTER PUMP VALVE
- C. CONVERTER RELIEF
- D. BYPASS VALVE
- E. OUTPUT PUMP CHECK VALVE
- F. INPUT CHECK VALVE
- G. LUBE REGULATOR VALVE

#### C. DISASSEMBLY

##### 1. REMOVE FROM CENTER SECTION

- A. COVER, TRANSMISSION CONTROLS
- B. MAIN CONTROL VALVE BODY
- C. LOCKUP VALVE BODY
- D. PRIORITY VALVE BODY
- E. G2 BACKUP VALVE BODY
- F. OIL TRANSFER PLATE
- G. WIRING HARNESS
- H. OIL TRANSFER GASKET
- I. GOVERNOR (G2) CHECK BALL

## CONTROL VALVE BODIES

## DISASSEMBLY

(SUGGESTED SEQUENCE)

## I. MAIN CONTROL VALVE BODY

- A. REMOVE ALL SOLENOIDS
- B. MAIN CONTROL VALVE BODY. REMOVE 3 BOLTS THAT RETAINS COVER AND GASKET
- C. REMOVE LOCKUP TIMER VALVES
- D. REMOVE MANUAL SHIFT VALVE AND SPRING
- E. REMOVE SPRING, SPACER AND SOLENOID REGULATOR VALVE
- F. REMOVE (5) BOLTS THAT RETAINS THE OUTSIDE COVER OF THE MAIN CONTROL VALVE BODY
- G. REMOVE SEPARATOR PLATE AND OIL TRANSFER PLATE AND GASKET
- H. REMOVE 2-3 AND 1-2 SHIFT VALVES AND SPRINGS FROM THEIR RESPECTIVE BORES
- I. REMOVE MANUAL SIGNAL PLUG AND VALVE AND SPRING FROM THE 1-2 SIGNAL VALVE BORE
- J. REMOVE 2-3 SIGNAL VALVE, PLUG AND SPRING FROM ITS BORE
- K. REMOVE (6) BOLTS AND WASHERS THAT RETAINS COVER AND GASKET FROM OTHER SIDE OF MAIN CONTROL VALVE BODY
- L. REMOVE 1-2 SIGNAL VALVE PLUG
- M. REMOVE 2-3 SIGNAL VALVE PLUG
- N. REMOVE R2 VALVE AND SPRING
- O. REMOVE (7) BOLTS AND WASHERS THAT RETAINS THE COVER AND GASKET
- P. REMOVE FORWARD - REVERSE VALVE, SPRING AND SIGNAL VALVE
- Q. REMOVE REVERSE INHIBITOR VALVE AND SPRING
- R. REMOVE 1ST AND 2ND CLUTCH TRIMMER VALVES, PLUGS, STOPS AND SPRINGS
- S. REMOVE 3-4 SHIFT VALVE AND SPRING
- T. REMOVE THROTTLE VALVE AND SPRING

## II. LOCKUP VALVE BODY ASSEMBLY

NOTE: (2) SOLENOIDS WERE REMOVED DURING PREVIOUS STEP A. ABOVE.

- A. REMOVE (2) BOLTS AND WASHERS RETAINING COVER ASSEMBLY AND GASKET
- B. REMOVE (2) PLUNGERS FROM NEUTRAL - LOCKUP VALVE BORES
- C. REMOVE THE NEUTRAL VALVE AND SPRING FROM ITS BORE
- D. REMOVE THE G2 SIGNAL PLUG VALVE FROM THE 3-4 SIGNAL BORE
- E. REMOVE CLUTCH TRIMMER VALVE, PLUG, SPRING AND STOP
- F. TURN LOCKUP VALVE BODY OVER
- G. DRIVE PIN FROM OUTSIDE OF BODY TO FREE SLEEVE, WITH SEAL RING, WASHER, THROTTLE VALVE SIGNAL PLUG AND LOCKUP CONTROL VALVE
- H. DRIVE PIN FROM OUTSIDE TO FREE PLUG WITH SEAL RING AND SHIM AND 3-4 CONTROL VALVE

## III. G2 BACKUP VALVE BODY ASSEMBLY

- A. REMOVE (2) BOLTS AND WASHERS RETAINING COVER ASSEMBLY
- B. REMOVE SMALL OVERRIDE VALVE
- C. REMOVE LARGE OVERRIDE VALVE

## IV. PRIORITY VALVE ASSEMBLY

- A. PUNCH PIN FROM EITHER SIDE OF BODY
- B. REMOVE STOP, SPRING, VALVE



## HYDRAULIC SYSTEM

THE HYDRAULIC SYSTEM GENERATES, DIRECTS AND CONTROLS THE FLOW AND PRESSURE OF HYDRAULIC FLUID WITHIN THE TRANSMISSION.

HYDRAULIC FLUID (TRANSMISSION OIL) IS THE POWER TRANSMITTING MEDIUM IN THE TORQUE CONVERTER.

THE OIL VELOCITY PROPELS THE CONVERTER TURBINE. THE FLOW COOLS AND LUBRICATES THE TRANSMISSION.

THE OIL PRESSURE OPERATES THE VARIOUS CONTROL VALVES, CONTROLLED PRIMARILY BY SPRING FORCE CALIBRATED FOR THEIR INTENDED CIRCUIT, AND APPLIES THE CLUTCHES AND BRAKES.

THE OIL FLOW IS ALSO PROVIDED TO THE HYDROSTATIC STEER SYSTEM FOR OPERATING THE HYDROSTATIC PUMP AND MOTOR.

## 5-1 MAIN OIL FILTER ASSEMBLY

## A. DESCRIPTION:

THE MAIN OIL FILTER IS A FULL FLOW TYPE AND IS AN INTEGRAL PART OF THE LEFT HAND COVER ASSEMBLY. IT CONSISTS OF A STAND PIPE, FILTER ELEMENT AND A COVER ASSEMBLY WITH A PRESSURE DIFFERENTIAL SWITCH.

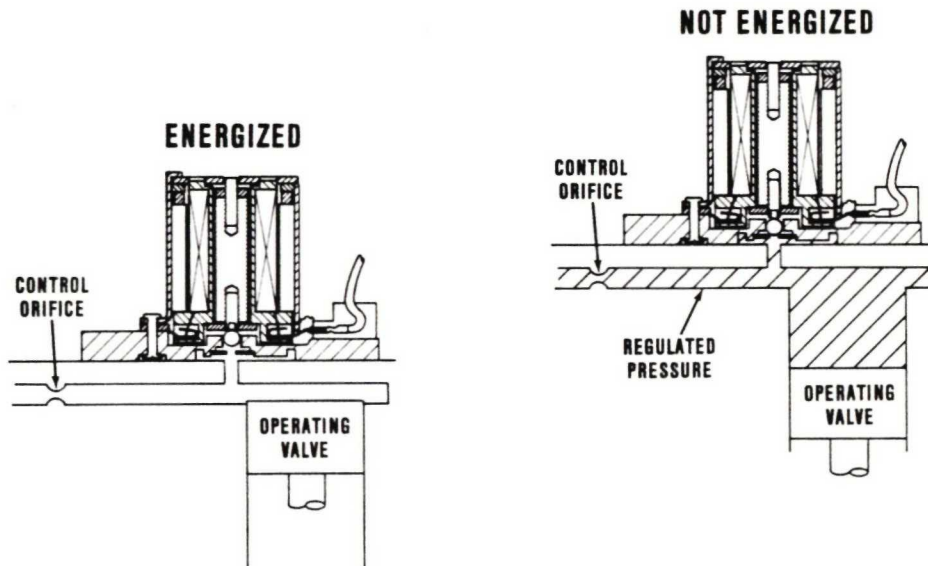
## B. OPERATION:

THE OIL FILTER ASSEMBLY FILTERS OIL FROM THE MAIN OIL PUMP, THROUGH A REPLACEABLE 20 MICRON FILTER ELEMENT.

WHEN THE DIFFERENTIAL PRESSURE ACROSS THE FILTER REACHES AN UNACCEPTABLE LEVEL, A WARNING LIGHT IN THE DRIVERS COMPARTMENT SIGNALS A CLOGGED FILTER AND NEEDS TO BE REPLACED.

X200-4

## TYPICAL SOLENOID OPERATION



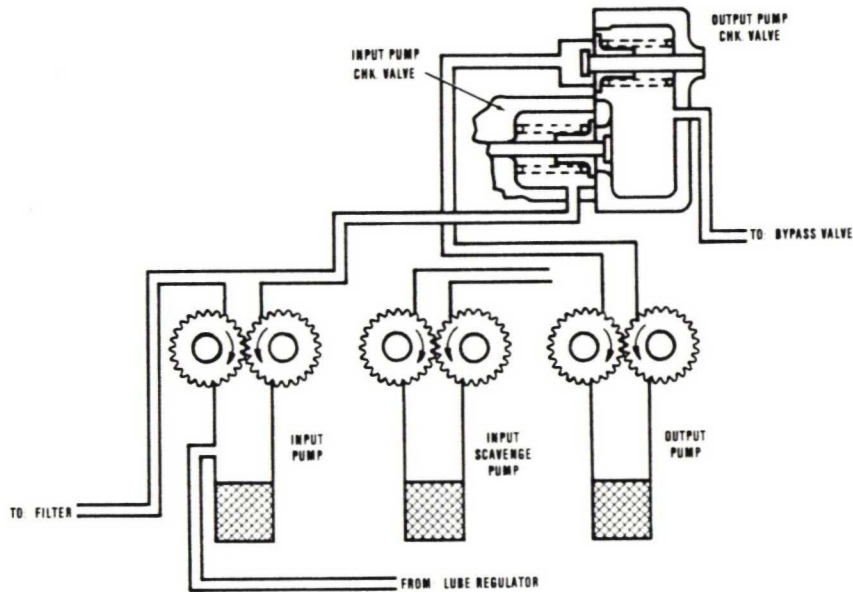
### 5-2 SOLENOID CONTROLS

SEVEN IDENTICAL SOLENOIDS CONTROL PRESSURE AT THE END OF VARIOUS HYDRAULIC CONTROL VALVES. THESE ARE IDENTIFIED AS SOLENOIDS A, B, C, D, E, F AND G.

WHEN A SOLENOID IS NOT ENERGIZED, PERMANENT MAGNETS HOLD THE PLUNGER DOWN WHICH SEATS A CHECK BALL IN THE BASE OF THE SOLENOID. A REGULATED PRESSURE, FED THRU AN ORIFICE, INCREASES AND MOVES THE VALVE AGAINST THE CALIBRATED FORCE OR PRESSURE ON THE OPPOSITE END OF THE VALVE.

IF THE SOLENOID IS ENERGIZED THE ELECTRICALLY ENERGIZED COIL REVERSES THE PERMANENT MAGNETIC FIELD, THEREFORE, OFF-SEATS THE CHECK (BALL) VALVE AND ALLOWS THE OIL TO EXHAUST, PRESSURE THEN DECREASES AND THE VALVE MOVES UPWARD, DUE TO THE CALIBRATED FORCE OR PRESSURE EXERTED ON THE OPPOSITE END OF THE VALVE.

X200-4  
**INPUT PUMPS AND FILTER CIRCUIT**



### 5-3 INPUT PUMPS AND FILTER CIRCUIT

- A. INPUT OIL PUMP, WHICH IS ENGINE DRIVEN, DRAWS OIL FROM THE RESERVOIR AND IS DIRECTED TO THE INPUT PUMP CHECK VALVE TO REINFORCE CALIBRATED SPRING FORCE. DURING TOW START OR WHEN TEMPORARY REDUCTION OF MAIN PRESSURE OCCURS, DURING VEHICLE PROPULSION, THE ONE WAY INPUT PUMP CHECK VALVE ALLOWS OUTPUT PUMP CIRCUITRY TO SUPPLY ADDITIONAL OIL TO THE INPUT PUMP CIRCUITRY.

THE OIL FILTER ASSEMBLY, WHICH IS INTEGRAL TO THE LEFT HAND COVER ASSEMBLY, INCORPORATES A 20 MICRON FILTER ELEMENT.

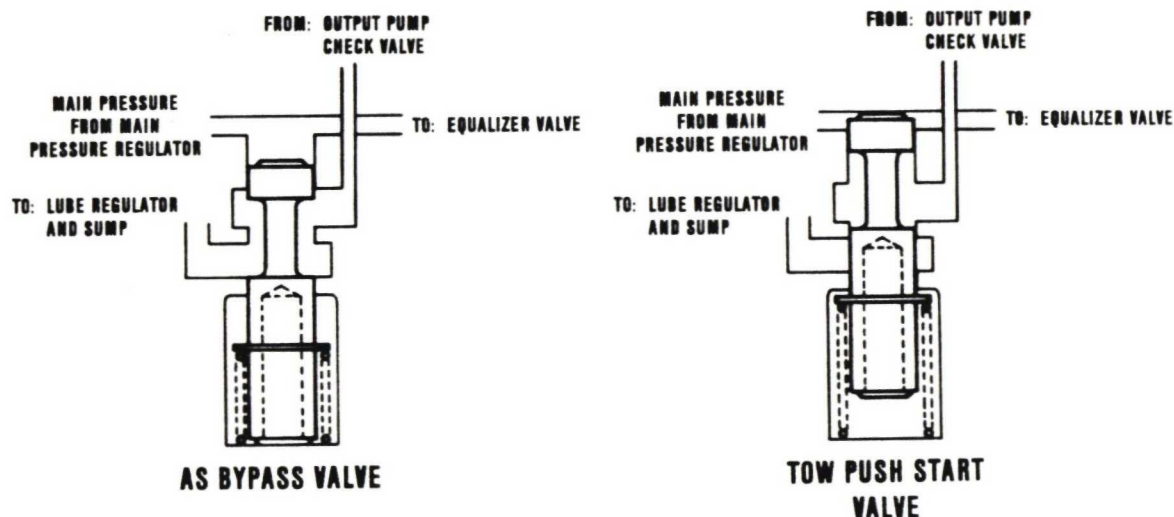
FILTER DUMP VALVE, LOCATED BETWEEN THE INPUT PUMP AND OIL FILTER ASSEMBLY, CAN NOT ACCEPT THE FLOW OF OIL FOR ANY REASON, THE EXCESSIVE PRESSURE DEVELOPED IN THE SYSTEM WILL OPEN THE DUMP VALVE AND RETURN THE OIL TO THE TRANSMISSION RESERVOIR. THIS SAFETY VALVE WORKS IN CONJUNCTION WITH THE FILTER DIFFERENTIAL PRESSURE SWITCH, ( P ) AND WILL NOT OPEN UNTIL AFTER THE DIFFERENTIAL PRESSURE SWITCH IS ACTUATED. THIS IN TURN CAUSES THE LOW OIL PRESSURE WARNING LIGHT TO COME ON IN THE DRIVERS COMPARTMENT INDICATING LOW OIL PRESSURE.

- B. THE OUTPUT PUMP DRIVEN BY THE TRANSMISSION OUTPUT, TURNS ANYTIME THE TRANSMISSION OUTPUTS TURN EITHER FORWARD OR REVERSE, BUT ONLY FUNCTIONS IN THE FORWARD MODE, DRAWS OIL FROM THE RESERVOIR AND DIRECTS THE OIL TO THE OUTPUT PUMP CHECK VALVE, THE BYPASS VALVE AND THE BRAKE COOLANT VALVE.
- C. SCAVENGE PUMP, TANDEM TO THE INPUT OIL PUMP, AND MOUNTED ON THE INPUT OIL PUMP DRIVE AND DRIVEN SHAFTS, SCAVENGES OIL FROM THE SUMPS IN THE GEAR PACK SECTION AND BRAKE POCKETS AND RETURNS THE OIL TO THE TRANSMISSION OIL RESERVOIR FOR USE BY THE INPUT AND OUTPUT OIL PUMPS.



X200-4

## TOW START VALVE (OUTPUT PUMP BYPASS VALVE)



### 5-4 OUTPUT PUMP BYPASS VALVE (TOW START VALVE)

#### A. DESCRIPTION

THE OUTPUT PUMP BYPASS VALVE IS COMPRISED OF A VALVE AND CALIBRATED SPRING.

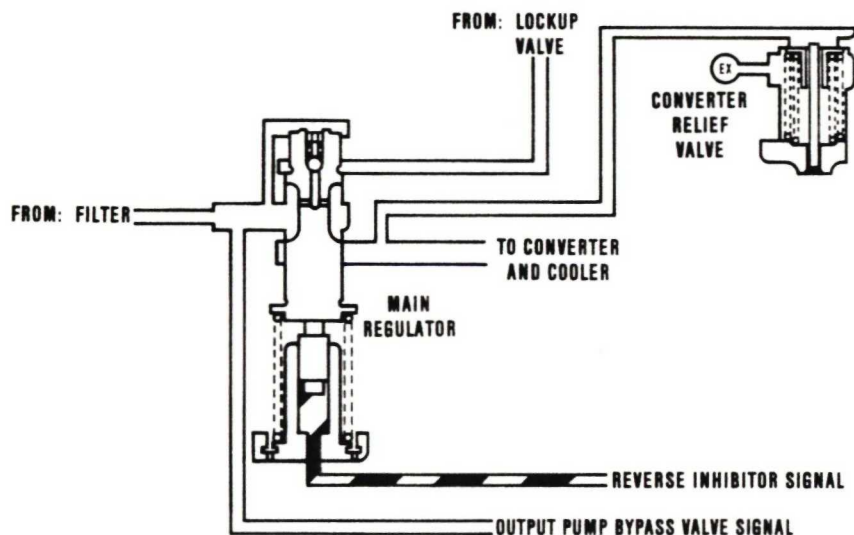
#### B. OPERATION

THE BYPASS VALVE WHICH IS SIGNALLED BY MAIN PRESSURE TO ALLOW OUTPUT PUMP OIL TO BYPASS TO LUBE REGULATOR AND RETURN TO INPUT PUMP RESERVOIR DURING FORWARD MODE.

DURING BRAKING THE BYPASS VALVE ALLOWS THE OUTPUT PUMP CHECK VALVE TO OPEN AND SUPPLY ADDITIONAL OIL FROM OUTPUT PUMP TO THE COOLER.

DURING PUSH START OPERATION OR WHEN VEHICLE IS MOVING AND ENGINE NOT RUNNING, MAIN PRESSURE IS ABSENT. SPRING CLOSSES BYPASS VALVE AND OUTPUT PUMP PRESSURE CAUSES OUTPUT CHECK VALVE AND INPUT CHECK VALVE TO OPEN, ALLOWING OUTPUT PUMP OIL TO SUPPLEMENT COOLER CIRCUIT AND/OR REPLACE INPUT PUMP OIL. AT THIS TIME THE HYDRAULIC SYSTEM WILL FUNCTION NORMALLY EXCEPT AT A LOWER PRESSURE SCHEDULE.

X200-4

**MAIN OIL PRESSURE CIRCUIT****5-5 MAIN OIL PRESSURE CIRCUIT****A. DESCRIPTION:**

MAIN PRESSURE CIRCUIT IS REGULATED BY THE MAIN PRESSURE REGULATOR VALVE FED BY THE FILTER ASSEMBLY. MAIN PRESSURE REGULATOR VALVE IS COMPRISED OF A REGULATOR VALVE (HOUSING A CHECK BALL, SPRING AND RETAINER) CALIBRATED SPRING AND A REVERSE BOOST VALVE IN A BORE UNDER THE REGULATOR VALVE.

**B. OPERATION**

THE REGULATOR VALVE ESTABLISHES A MAIN PRESSURE SCHEDULE. OIL FROM THE FILTER ASSEMBLY FLOWS THROUGH AN ORIFICE TO THE UPPER END OF THE VALVE. THIS ALLOWS HYDRAULIC PRESSURE TO PUSH DOWN ON THE TOP OF THE VALVE AGAINST CALIBRATED SPRING. THUS CONTROLLING THE OIL FLOW THROUGH THE REGULATOR VALVE.

OIL FROM THE FILTER ASSEMBLY ALSO FLOWS INTO THE VALVE BORE AND THROUGH AN INTERNAL PASSAGE TO THE UPPER END OF THE VALVE. WHEN HIGH FLUCTUATIONS IN OIL PRESSURE FROM THE INPUT PUMP OCCUR, HYDRAULIC

PRESSURE OFFSETS THE CHECK BALL AND PUSHES DOWN ON THE VALVE, CORRECTING THE MAIN PRESSURE SCHEDULE. THIS CONTINUES UNTIL OIL PRESSURE FLOWS THROUGH THE ORIFICE DIRECTING PRESSURE TO THE UPPER END OF THE REGULATOR VALVE, OR WHEN THE HIGH FLUCTUATIONS DIMINISH.

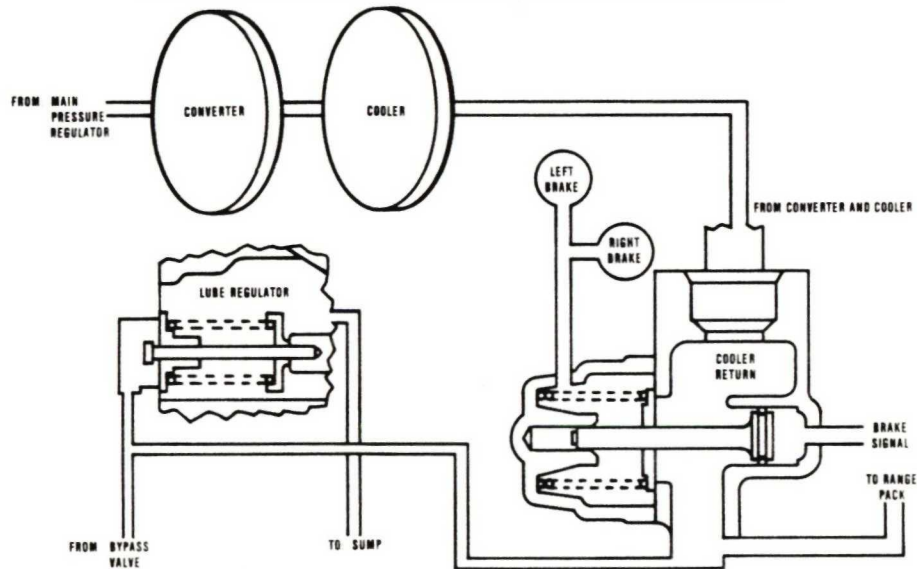
THERE ARE THREE PRESSURES INTERFACING WITH THE REGULATOR VALVE THAT AFFECT MAIN PRESSURE; LOCKUP, REVERSE SIGNAL AND BRAKE SIGNAL. WHEN LOCKUP IS DIRECTED TO THE UPPER LAND AREA OF THE REGULATOR VALVE THE VALVE MOVES DOWNWARD DECREASING MAIN PRESSURE.

WHEN REVERSE OR BRAKE SIGNAL IS DIRECTED TO THE BOTTOM OF THE REGULATOR VALVE, THE VALVE MOVES UPWARD, INCREASING MAIN PRESSURE. THE MAIN REGULATOR VALVE FEEDS THE CONVERTER-IN CIRCUIT WHOSE PRESSURE IS LIMITED BY THE CONVERTER RELIEF VALVE. THE LIMITED PRESSURE IS THEN DIRECTED TO THE CONVERTER, THEN THROUGH THE COOLER, THEN THROUGH THE BRAKE COOLING VALVE TO THE LUBRICATION CIRCUIT WHICH IS CONTROLLED BY THE LUBE REGULATOR VALVE. THE EXCESS COOL OIL IS RETURNED TO THE RESERVOIR.

THE MAIN OIL LINE FROM THE TOP OF THE FILTER ASSEMBLY FEEDS THE MAIN OIL GALLERY. THIS GALLERY ACTS AS A DISTRIBUTION MANIFOLD AND SUPPLIES MAIN OIL PRESSURE TO THE OUTPUT GOVERNOR (G2), HYDROSTATIC STEER UNIT, PRIORITY VALVE, SOLENOID FEED REGULATOR, TV MODULATOR VALVE AND BRAKE APPLY VALVE.

THE FORWARD AND REVERSE VALVE AND FRONT GOVERNOR (G1) ARE ALSO SUPPLIED BY THE MAIN OIL LINE FROM THE FILTER ASSEMBLY.

X200-4

**CONVERTER COOLER LUBRICATION CIRCUIT****5-6 LUBE REGULATOR VALVE****A. DESCRIPTION**

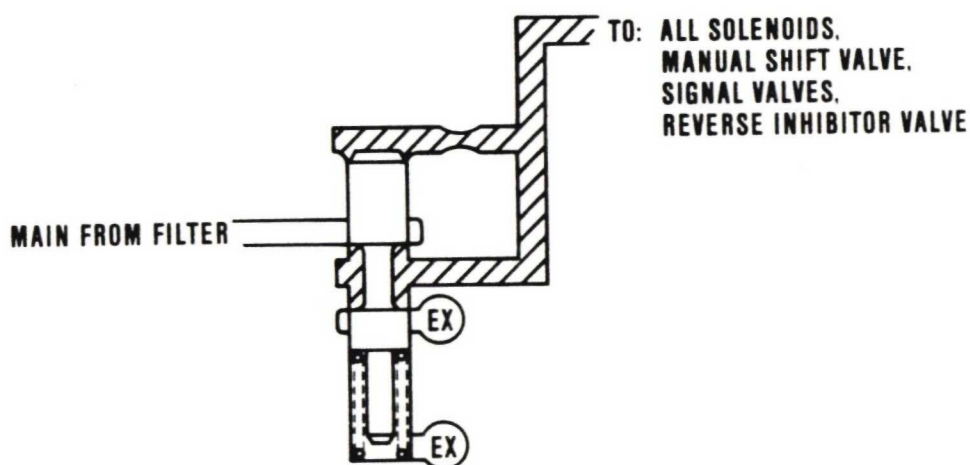
THE LUBE REGULATOR VALVE ASSEMBLY COMPRISES A VALVE AND CALIBRATED SPRING IN A BORE.

**B. OPERATION**

WHEN COOLER OUT PRESSURE EXCEEDS THE CALIBRATED SPRING FORCE, (LUBE PRESSURE) THE LUBE REGULATOR VALVE OPENS AND ALLOWS THE EXCESS COOLER OIL TO ESCAPE TO SUMP. BYPASS OIL FROM PUSH START VALVE IS ALSO DIRECTED TO LUBE REGULATOR VALVE FOR RETURN TO SUMP.



X200-4

**TYPICAL SOLENOID REGULATOR VALVE****5-7 SOLENOID FEED REGULATOR****A. DESCRIPTION**

SOLENOID FEED REGULATOR ASSEMBLY CONSISTS OF A VALVE, CALIBRATED SPRING CONTAINED IN A BORE.

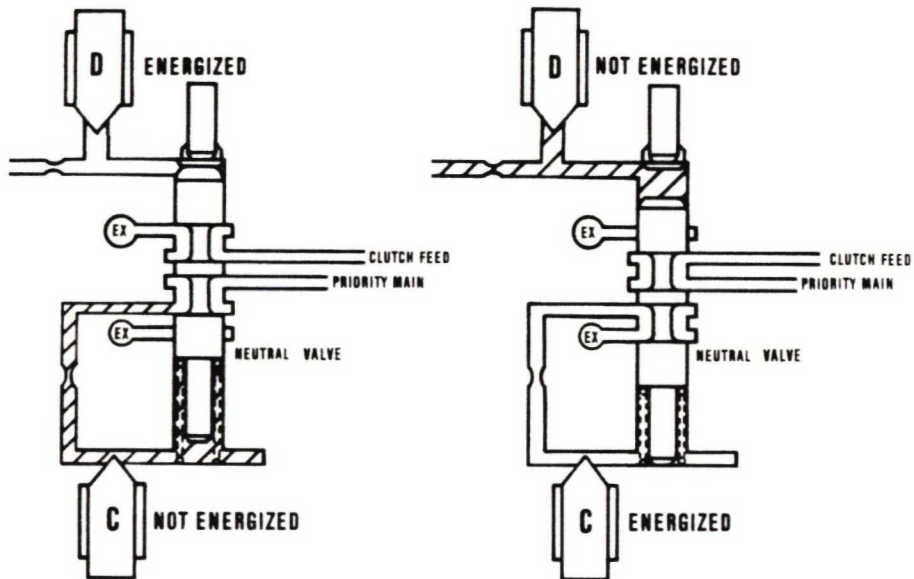
**B. OPERATION**

SOLENOID FEED REGULATOR ESTABLISHES A REGULATED PRESSURE FOR CONTROL FUNCTIONS DERIVED FROM MAIN PRESSURE.

MAIN PRESSURE, FROM FILTER, FEEDS THROUGH VALVE BORE AND THROUGH AN ORIFICE TO THE TOP OF VALVE.

PRESSURE AT THE TOP MOVES THE VALVE DOWNWARD AGAINST CALIBRATED SPRING FORCE ESTABLISHING SOLENOID FEED PRESSURE AT 150 PSI CONSTANT.

X200-4

**TYPICAL NEUTRAL TO RANGE SHIFT****5-8 NEUTRAL SHIFT VALVE****A. DESCRIPTION**

CONSISTS OF A VALVE CALIBRATED SPRING IN A BORE OF THE LOCKUP VALVE BODY ASSEMBLY CONTROLLED BY SOLENOID "C" AND "D".

**B. OPERATION**

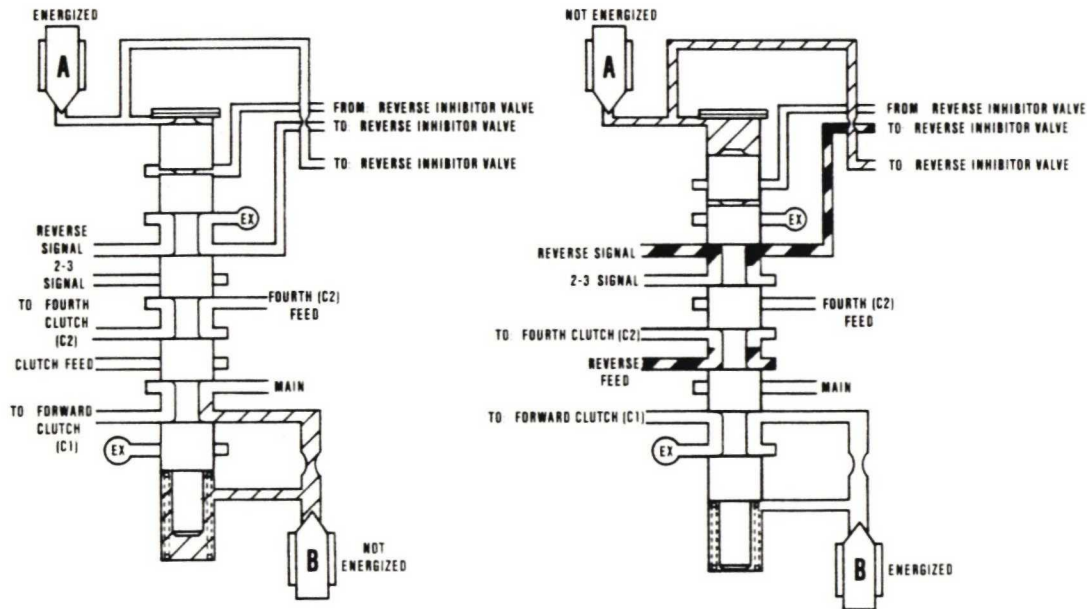
SOLENOID FEED IS DIRECTED TO SPRING END OF VALVE BY SOLENOID "C" TO ASSIST SPRING AND WHEN IT IS ENERGIZED SOLENOID FEED IS EXHAUSTED.

PRIORITY MAIN OPEN TO CLUTCH FEED TRANSMISSION IS IN A RANGE.

SOLENOID FEED IS ALSO DIRECTED TO THE OPPOSITE END OF VALVE BY SOLENOID "D". WHEN SOLENOID "D" IS ENERGIZED, SOLENOID FEED IS EXHAUSTED AND SPRING ASSISTED BY SOLENOID FEED, ON OTHER END OF VALVE, HOLDS VALVE UPWARD EXHAUSTING CLUTCH FEED. THE TRANSMISSION IS IN NEUTRAL.

X200-4

## TYPICAL FORWARD & REVERSE CIRCUIT



### 5-9 FORWARD AND REVERSE VALVE

#### A. DESCRIPTION

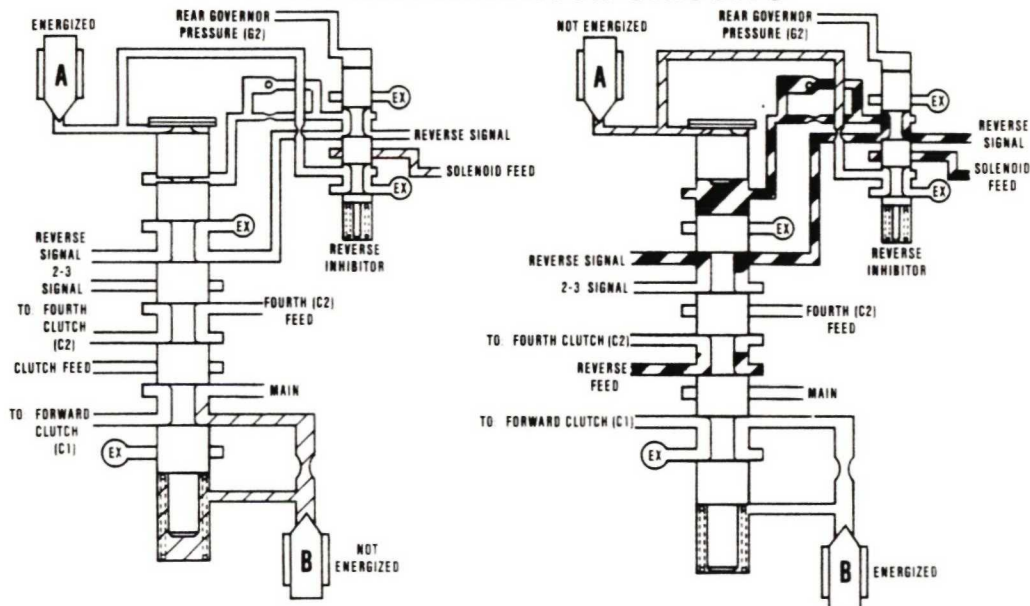
FORWARD AND REVERSE VALVE CONSISTS OF A VALVE, PLUG AND CALIBRATED SPRING IN A BORE OF THE MAIN VALVE BODY AND CONTROLLED BY SOLENOIDS "A" AND "B".

#### B. OPERATION

SOLENOID "A" ENERGIZED - SOLENOID "B" NOT ENERGIZED VALVE UP IN BORE  
- TRANSMISSION IN FORWARD RANGE.

SOLENOID "A" NOT ENERGIZED - SOLENOID "B" ENERGIZED VALVE DOWN IN BORE  
- TRANSMISSION IN REVERSE.

X200-4

**TYPICAL INHIBITOR CIRCUITS****5-10 REVERSE INHIBITOR VALVE****A. DESCRIPTION:**

REVERSE INHIBITOR VALVE CONSISTS OF A VALVE, PLUG AND CALIBRATED SPRING IN A BORE OF MAIN CONTROL BODY CONTROLLED BY OUTPUT GOVERNOR (G-2) PRESSURE ON TOP OF VALVE AND CALIBRATED SPRING ON BOTTOM OF VALVE.

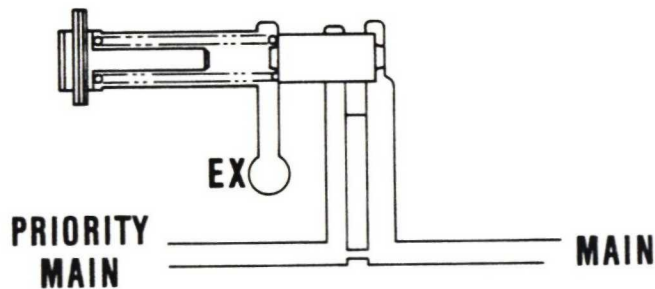
**B. OPERATION:**

THE REVERSE INHIBITOR VALVE PROHIBITS THE FORWARD-REVERSE VALVE FROM FORCED DIRECTIONAL SHIFTS AT EXCESSIVE OUTPUT SHAFT SPEEDS.

OUTPUT GOVERNOR PRESSURE (G2)(OUTPUT SHAFT SPEED) OPPOSES VALVE SPRING FORCE AND PREVENTS MOVEMENT OF THE FORWARD & REVERSE VALVE AT A SPEED WHERE THE GOVERNOR PRESSURE IS HIGH ENOUGH TO KEEP THE VALVE FROM MOVING BY SPRING FORCE.



X200-4

**PRIORITY VALVE****5-11 PRIORITY VALVE CIRCUIT****A. DESCRIPTION:**

CONSISTS OF A VALVE, STOP AND CALIBRATED SPRING LOCATED IN THE PRIORITY VALVE BODY ASSEMBLY.

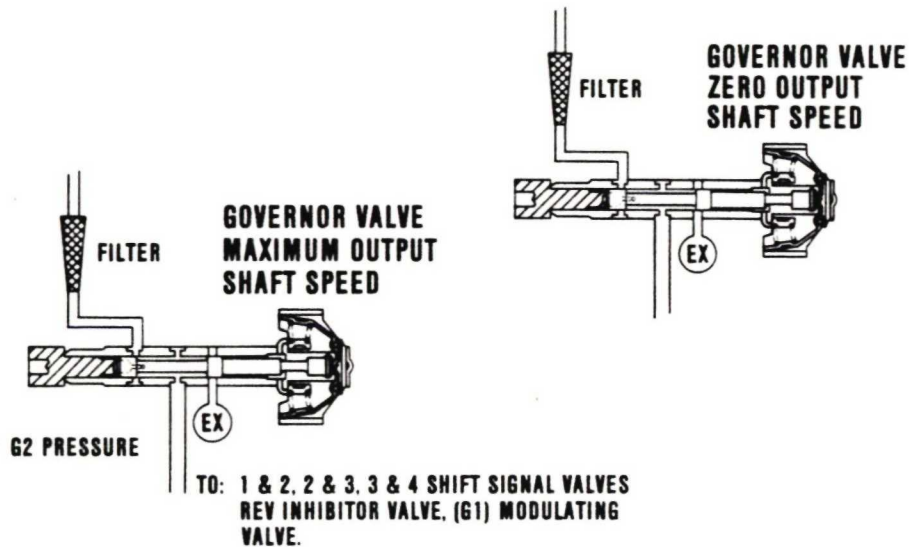
**B. OPERATION**

PROVIDES MAIN FLOW FEED PRIORITY TO THE CONTROL FUNCTIONS, WHILE LIMITING MAIN FLOW AVAILABILITY TO THE RANGE CLUTCHES, DURING CLUTCH FEED OR IN THE EVENT OF CLUTCH LEAKAGE.

MAIN PRESSURE ENTERS PRIORITY VALVE BORE AND MOVES VALVE AGAINST CALIBRATED SPRING WHICH OPENS FEED TO RANGE CLUTCHES.

SUDDEN TEMPORARY LOSS OF MAIN PRESSURE DURING RANGE SHIFTS OR BRAKE APPLY CAUSES SPRING FORCE TO CLOSE VALVE AND INTERRUPTS FEED TO CLUTCHES. RANGE CLUTCHES ARE NOW FED THROUGH ORIFICE UNTIL RECOVERY OF MAIN PRESSURE.

X200-4  
**GOVERNOR (G2) CIRCUIT**



## 5-12 OUTPUT SPEED GOVERNOR (G-2)

### A. DESCRIPTION

THE OUTPUT SPEED GOVERNOR (G-2) IS A CENTRIFUGAL FLYWEIGHT TYPE CONSISTING OF A GOVERNOR VALVE FLYWEIGHTS AND SPRINGS ON ONE END AND HELICAL GEAR ON THE OTHER LOCATED IN A VALVE BODY ADJACENT TO THE RANGE OUTPUT SHAFT.

THE GOVERNOR (G-2) SENSES OUTPUT ROTATIONAL SPEED. CENTRIFUGAL FORCE OF FLYWEIGHTS CONTROLS THE POSITION OF THE GOVERNOR VALVE TO OBTAIN CALIBRATED HYDRAULIC PRESSURE WHICH CONTROLS TRANSMISSION RANGE SHIFTS.

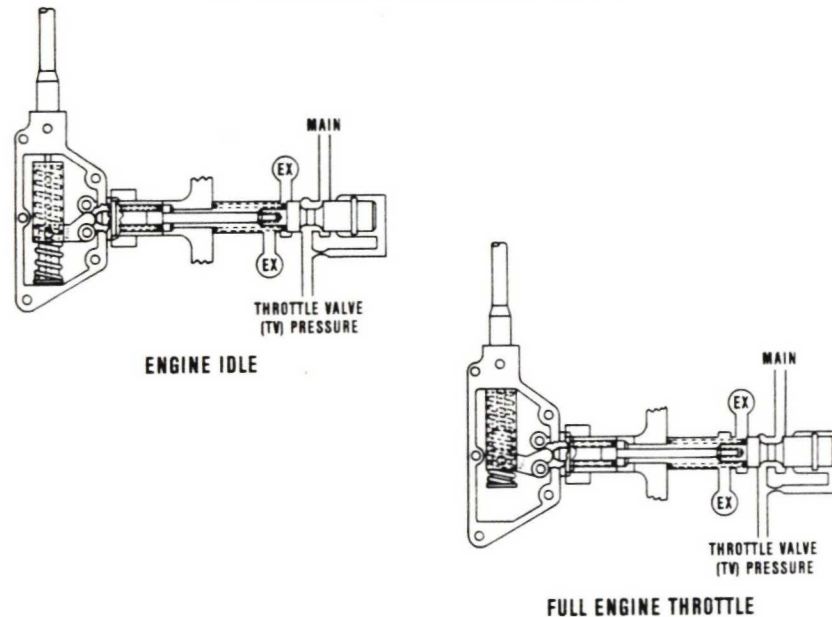
### B. OPERATION

ROTATION OF THE OUTPUT SHAFT CAUSES THE GOVERNOR TO ROTATE AND THE CENTRIFUGAL FORCE CAUSES THE FLYWEIGHTS TO MOVE THE GOVERNOR VALVE TO THE LEFT. THIS FORCE IS OPPOSED BY GOVERNOR FEED (MAIN PRESSURE) WHICH RESISTS THE CENTRIFUGAL FORCE THE FLYWEIGHTS CREATING GOVERNOR PRESSURE (G-2)

THIS PRESSURE IS DIRECTLY PROPORTIONAL TO OUTPUT SHAFT SPEED.

X200-4

## TYPICAL THROTTLE VALVE CIRCUIT



## 5-13 THROTTLE VALVE CIRCUIT (T.V.)

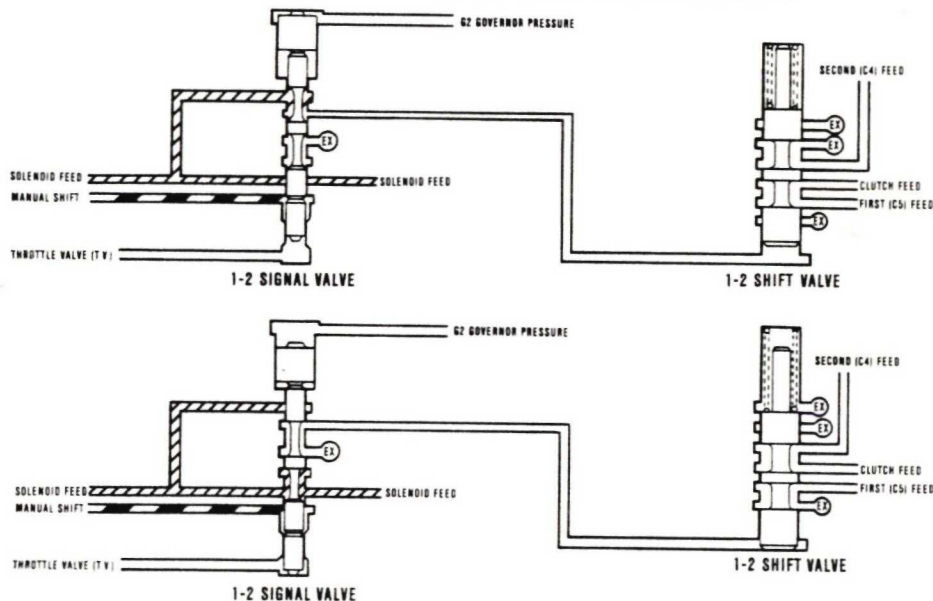
## A. DESCRIPTION:

CONSISTS OF VALVE, THROTTLE VALVE PLUG AND CALIBRATED SPRING LOCATED IN THE MAIN CONTROL VALVE BODY ASSEMBLY.

## B. OPERATION:

REGULATED MAIN FLOWS TO THIS VALVE WHICH PROVIDES A MODULATED PRESSURE ACCORDING TO THROTTLE POSITION. AT IDLE AND PARTIAL THROTTLE (T.V.) PRESSURE IS RELATIVELY LOW, AT FULL THROTTLE PLUNGER MOVES VALVE THEREBY INCREASING THROTTLE VALVE PRESSURE. THROTTLE VALVE PRESSURE IS DIRECTED TO THE 1-2, 2-3 AND 3-4 SHIFT SIGNAL VALVES AND TO THE LOCKUP VALVE.

### TYPICAL SIGNAL AND SHIFT VALVE CIRCUIT



## 5-14 SIGNAL VALVE AND SHIFT VALVE

### A. DESCRIPTION:

THE SIGNAL VALVES CONSISTS OF A G2 PLUG, VALVE AND THROTTLE VALVE PLUG. THE SHIFT VALVE CONSISTS OF A VALVE AND A CALIBRATED SPRING.

### B. OPERATION:

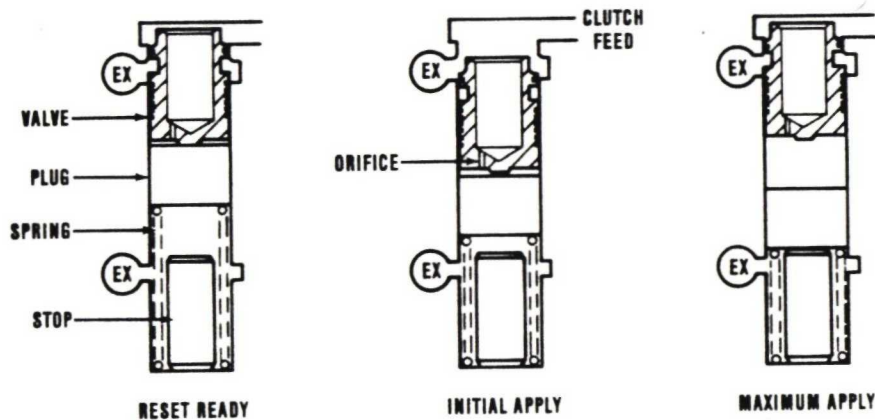
THROTTLE VALVE PRESSURE SEATS THE SIGNAL VALVE AGAINST THE G2 PLUG VALVE. SOLENOID MAIN FLOWS THROUGH (BETWEEN LAND AREAS) THE SIGNAL VALVE (THIS PRESSURE IS NOW CALLED SHIFT SIGNAL PRESSURE) TO THE SHIFT VALVE. SHIFT SIGNAL PRESSURE SEATS THE SHIFT VALVE AGAINST THE CALIBRATED SPRING. A CLUTCH IS NOW FED THROUGH TWO LAND AREAS OF THE SHIFT VALVE.

WHEN G2 PRESSURE IS SUFFICIENT ENOUGH, IT OVERCOMES THROTTLE VALVE PRESSURE, PUSHING THE SHIFT SIGNAL VALVE AGAINST THROTTLE VALVE PRESSURE. WHEN THE SHIFT SIGNAL VALVE MOVES, IT SUMPS SIGNAL PRESSURE, THEREBY CAUSING THE CALIBRATED SPRING TO PUSH THE SHIFT SIGNAL VALVE AGAINST THE DECREASING SIGNAL PRESSURE. THIS SUMPS ONE CLUTCH AND BRINGS ON ANOTHER CLUTCH.



X200-4

## TYPICAL TRIMMER OPERATION



### 5-15 TRIMMER VALVES

#### A. DESCRIPTION:

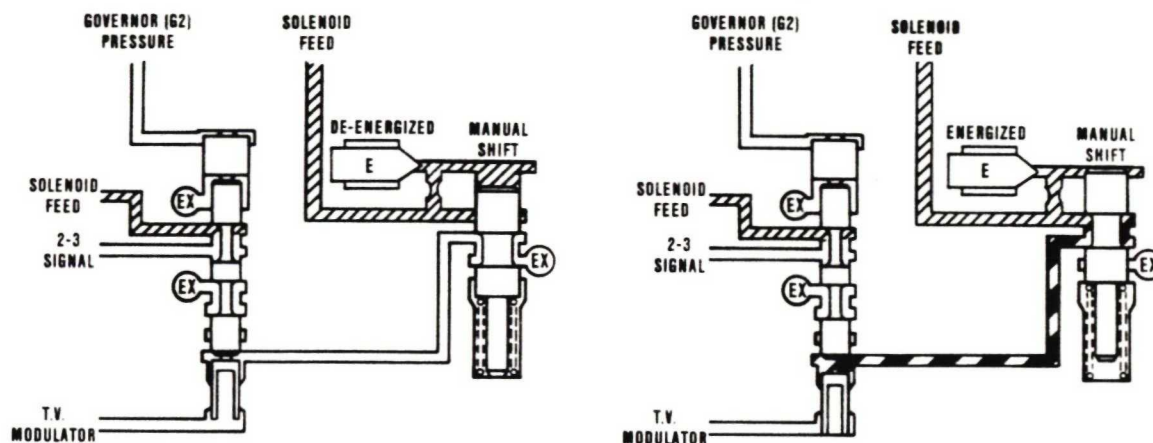
CONSISTS OF AN ORFICED TRIMMER, PLUG, SPRING AND STOP. 1-2, 2-3 LOCATED IN MAIN CONTROL VALVE BODY ASSEMBLY. 3-4 LOCATED IN LOCKUP VALVE BODY ASSEMBLY.

#### B. OPERATION:

WHEN CLUTCH PRESSURE IS DIRECTED TO A TRIMMER VALVE, THE VALVE AND PLUG MOVE DOWN TOGETHER. AT THIS TIME THE TRIMMER UNCOVERS THE EXHAUST PORT. CLUTCH PRESSURE CONTINUES TO FLOW THROUGH THE ORIFICE, PUSHING THE PLUG AGAINST THE STOP. THE PRESSURE IS THEN GREATER ON THE BOTTOM OF THE VALVE AND WILL PUSH IT BACK UP STOPPING THE EXHAUST. THIS PROCEDURE OF EXHAUSTING PARTIAL CLUTCH PRESSURE ONLY TAKES LESS THAN 1 SECOND IN ACTUAL OPERATION AND AVOIDS SHIFT SHOCK BY REGULATING INTIAL CLUTCH APPLY.

X200-4

## TYPICAL MANUAL SHIFT CIRCUIT



### 5-16 MANUAL SHIFT CIRCUIT

#### A. DESCRIPTION:

CONSISTS OF VALVE AND CALIBRATED SPRING IN BORE OF MAIN CONTROL VALVE BODY ASSEMBLY CONTROLLED BY SOLENOID "E".

#### B. OPERATION:

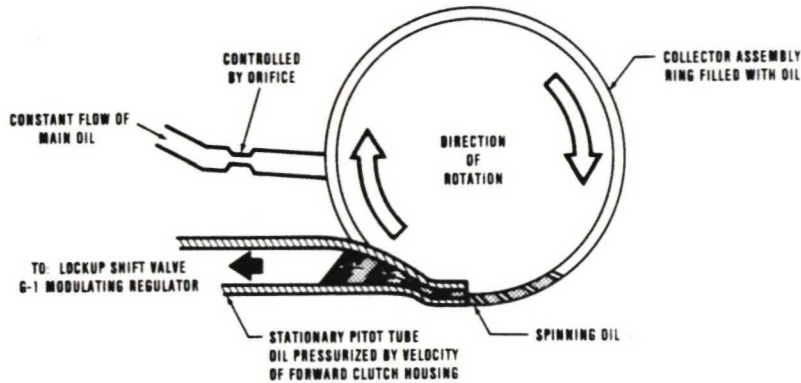
SOLENOID "E" DE-ENERGIZED, SOLENOID SIGNAL PRESSURE PUSHES MANUAL SHIFT VALVE DOWN AGAINST CALIBRATED SPRING. SOLENOID FEED DEAD HEADS AT LAND AREA ON MANUAL SHIFT VALVE. MANUAL SHIFT PRESSURE LINE IS OPENED TO SUMP.

SOLENOID "E" ENERGIZED, SOLENOID SIGNAL PRESSURE SUMPS AT SOLENOID "E". CALIBRATED SPRING THEN PUSHES MANUAL SHIFT VALVE UP. SOLENOID SIGNAL PRESSURE FLOWS INTO MANUAL SHIFT CIRCUIT.

MANUAL SHIFT PRESSURE FLOWS TO THE 1-2, 2-3, AND 3-4 SHIFT SIGNAL VALVES. IT FLOWS BETWEEN THE THROTTLE VALVE PLUGS AND SHIFT SIGNAL VALVES. THIS PREVENTS UPSHIFTS ABOVE THE RANGE WHICH IS SELECTED BY OPPOSING (G2) PRESSURE.

X200-4

# **FLUID VELOCITY GOVERNOR - SCHEMATIC** **G1 GOVERNOR**



## 5-17 FLUID VELOCITY GOVERNOR (G1)

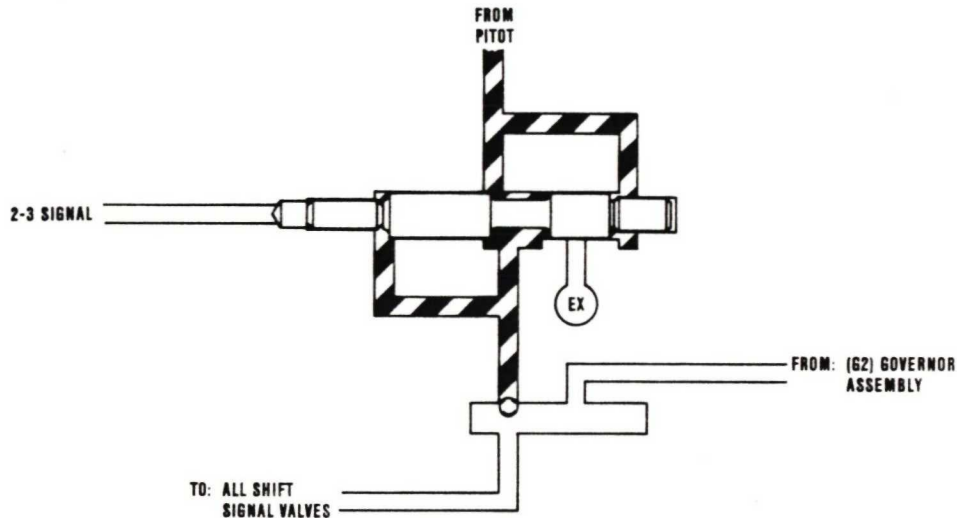
### A. DESCRIPTION:

VANED OIL COLLECTOR ASSEMBLY, THE PITOT IS AN INTEGRAL PART OF FORWARD CLUTCH (C1) HOUSING ASSEMBLY SENSING CONVERTER TURBINE SPEED.

### B. OPERATION:

ROTATION OF THE VANED COLLECTOR ASSEMBLY, LOCATED ON THE FORWARD CLUTCH HOUSING, DIRECTS OIL AGAINST AND INTO THE PITOT ORIFICE. THIS PRODUCES A PRESSURE IN THE FRONT GOVERNOR CIRCUIT WHICH IS DIRECTLY PROPORTIONAL TO ROTATIONAL SPEED OF THE CONVERTER TURBINE. THIS PRESSURE IS DIRECTED TO THE LOCKUP SHIFT VALVE AND G1 MODULATING REGULATOR.

X200-4

**TYPICAL G1 MODULATING VALVE****5-18 G1 MODULATING REGULATING CIRCUIT****A. DESCRIPTION:**

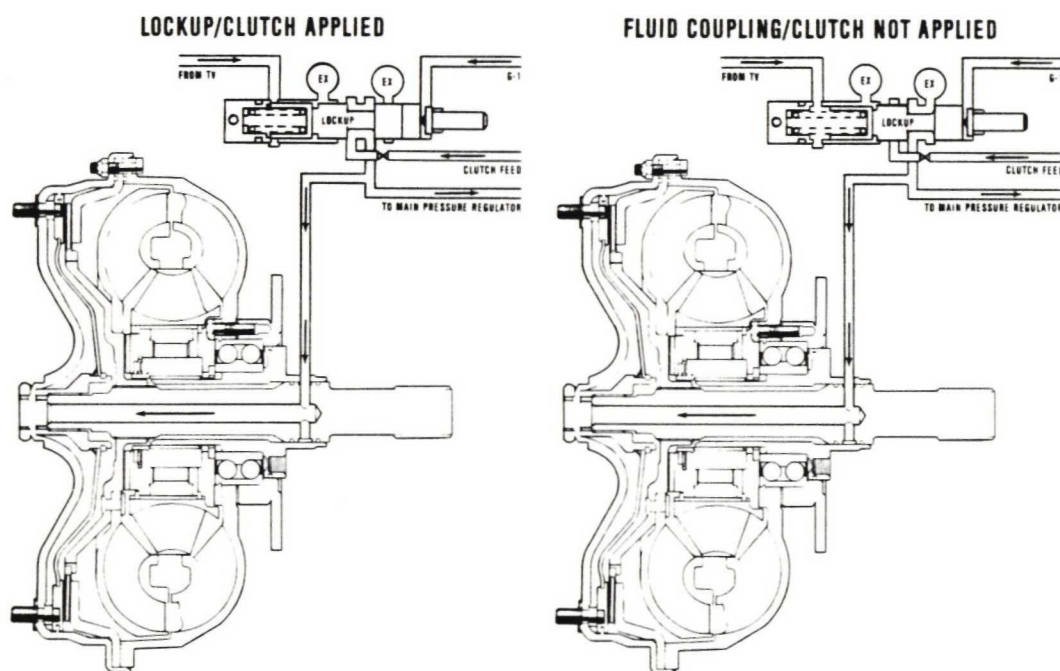
MODULATING REGULATOR AND OVERRIDE VALVE LOCATED IN THE G2 BACKUP VALVE BODY ASSEMBLY.

**B. OPERATION:**

G1 MODULATING REGULATING PRESSURE IS DIRECTED TO TWO EQUAL LAND AREAS OF THE VALVE. HYDRAULIC PRESSURE DIRECTED TO EITHER END OF THE VALVE AFFECTS THE FLOW. PRESSURE FLOWING THROUGH THE VALVE IS LOWER IN 1ST AND 2ND RANGE WHEN 2-3 SIGNAL PRESSURE (AT LEFT OF VALVE) IS SUMPED THE VALVE MOVES IN BORE, G1 PRESSURE INCREASES.



## X200-4 CONVERTER LOCKUP CLUTCH OPERATION



### 5-19 LOCKUP CLUTCH CIRCUIT

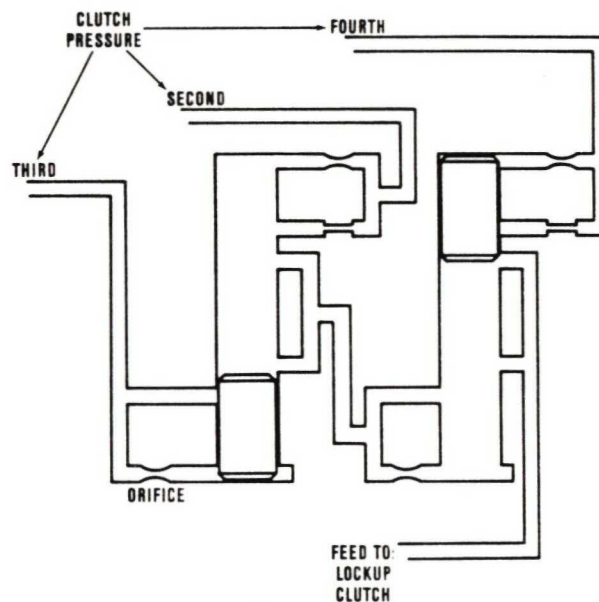
#### A. DESCRIPTION:

CONSISTS OF LOCKUP CONTROL SLEEVE, CALIBRATED SPRING, THROTTLE VALVE SIGNAL PLUG, LOCKUP CONTROL VALVE AND PUSH START PLUNGER. LOCATED IN THE LOCKUP CONTROL VALVE BODY ASSEMBLY.

#### B. OPERATION:

(T.V.) MODULATOR PRESSURE IS DIRECTED TO THE LEFT OF THE LOCKUP VALVE; IT INCREASES AS THROTTLE POSITION INCREASES. (G1) FRONT PITOT PRESSURE IS DIRECTED TO THE RIGHT OF THE LOCKUP VALVE, IT INCREASES AS TURBINE SPEED INCREASES. WITH THE VALVE SEATED BY SPRING FORCE; CLUTCH FEED DEAD HEADS AT A LAND AREA OF THE LOCKUP VALVE. WHEN (G1) PRESSURE OVERCOMES THE CALIBRATED SPRING FORCE AND (T.V.) MODULATOR PRESSURE; IT PUSHES THE VALVE LEFTWARD, ALLOWING CLUTCH FEED TO FILL THE LOCKUP CLUTCH CIRCUIT.

### TYPICAL LOCKUP TIMER OPERATION



#### 5-20 LOCKUP CLUTCH TIMER CIRCUIT

##### A. DESCRIPTION:

CONSISTS OF TWO CYLINDRICAL VALVES LOCATED IN THE MAIN CONTROL VALVE BODY ASSEMBLY.

##### B. OPERATION:

WHEN SECOND (C4), THIRD (C3), OR FOURTH (C2) CLUTCH IS APPLIED, CLUTCH PRESSURE IS SENT TO THE LOCKUP TIMER VALVES. IN SECOND (C4) RANGE THE LOCKUP CLUTCH TIMER VALVE IS CYCLED DOWN BY SECOND CLUTCH PRESSURE TO CHARGE THE LOCKUP FEED LINE. LOCKUP OCCURS IN SECOND RANGE WHEN (G1) PRESSURE OVERCOMES LOCKUP SHIFT VALVE CALIBRATED SPRING FORCE.

WHEN THE TRANSMISSION SHIFTS TO THIRD RANGE, SECOND CLUTCH (C4) PRESSURE IS EXHAUSTED, RELEASING LOCKUP CLUTCH. THIRD CLUTCH (C3) PRESSURE PUSHES ON THE OPPOSITE END OF THE TIMER VALVE TO REAPPLY LOCKUP CLUTCH.

THIS RELEASE OF LOCKUP AND DELAY IN REAPPLICATION ALLOWS SHIFTS TO BE SMOOTHER.

## BRAKE SYSTEM

### I. SERVICE BRAKES

THE SERVICE BRAKE PEDAL SUPPLIES THE BRAKE SIGNAL TO THE TRANSMISSION TO HYDRAULICALLY APPLY THE SERVICE BRAKES TO SLOW OR STOP THE VEHICLE.

SERVICE BRAKES MUST BE USED TO SLOW OR STOP THE VEHICLE.

THE TRANSMISSION HAS TWO BRAKE PACKS, EACH ONE MOUNTED INTERNALLY AND LOCATED IN THE CENTER RIGHT & RIGHT COVER. THE BRAKE PACKS ARE OIL COOLED AND APPLIED EITHER HYDRAULICALLY OR MECHANICALLY. THE SAME BRAKE PACKS ARE USED FOR THE SERVICE BRAKE AND THE PARKING BRAKE SYSTEMS.

THE FOOT OPERATED SERVICE BRAKE PEDAL MECHANICALLY SIGNALS THE HYDRAULIC OPERATION OF BRAKES IN THE TRANSMISSION. WHEN THE BRAKE PEDAL IS APPLIED (BY FOOT PRESSURE), MECHANICAL LINKAGE FROM THIS PEDAL ROTATES THE TRANSMISSION HYDRAULIC BRAKE APPLY SHAFT.

INSIDE THE TRANSMISSION, THE MECHANICAL FORCE ACTUATES THE HYDRAULIC BRAKE APPLY VALVE TO CONTROL HYDRAULIC PRESSURE, IN DIRECT RATIO TO PEDAL PRESSURE, (MODULATED) TO SIMULTANEOUSLY APPLY AND COOL THE BRAKE PACKS.

### II. PARKING BRAKE

THE PARKING BRAKE CONTROL LEVER, WHEN ACTIVATED, RETAINS THE BRAKE APPLY SHAFTS IN THE APPLIED POSTION.

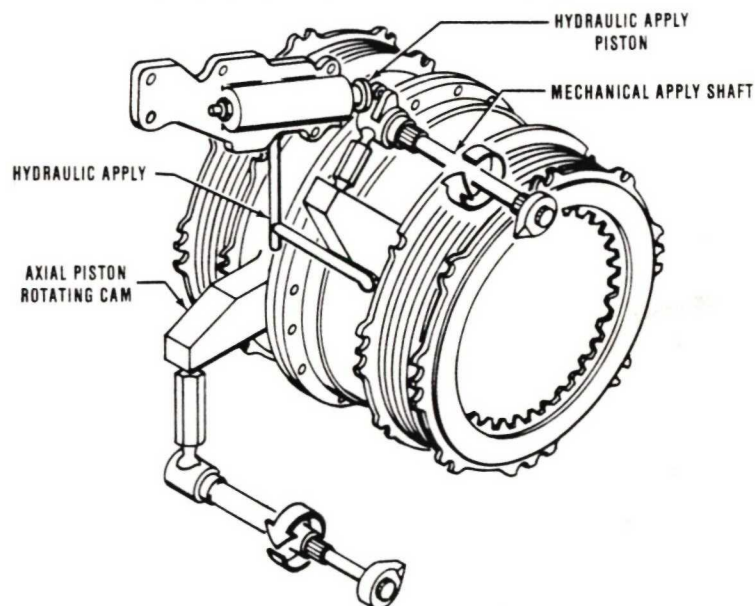
CAUTION: THE PARKING BRAKE MUST BE USED TO KEEP THE VEHICLE FROM MOVING WHEN PARKED. THE TRANSMISSION IN N (NEUTRAL) SETTING, ENGINE EITHER RUNNING OR SHUT DOWN, DOES NOT LOCK THE TRANSMISSION.



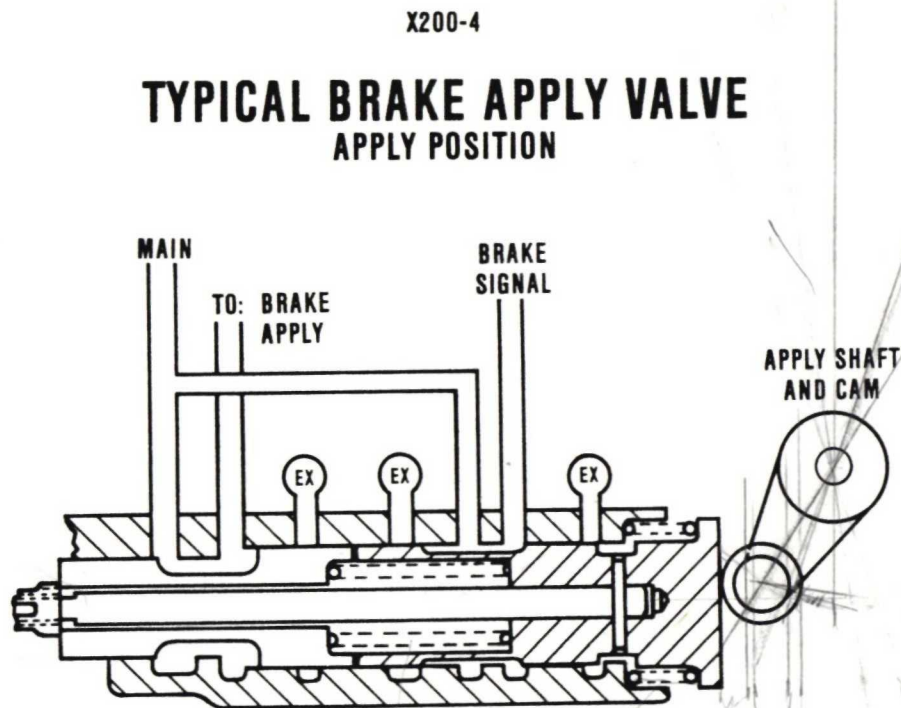
**CAUTION:** THE PARKING BRAKE SYSTEM SHOULD NOT BE USED WHEN THE VEHICLE IS MOVING EXCEPT IN EMERGENCY.

**NOTE:** IF THE ENGINE STOPS WHEN VEHICLE IS MOVING THE DRIVER CAN STILL USE THE SERVICE BRAKES. THE VEHICLE WILL NOT RESPOND AS QUICKLY TO THE SERVICE BRAKES AS IT WOULD IF THE ENGINE WERE RUNNING. THE OUTPUT DRIVEN PUMP IS NOW SUPPLYING THE TRANSMISSION OIL PRESSURE. AT APPROXIMATELY 3 TO 5 MPH THE SERVICE BRAKES WILL BECOME INEFFECTIVE. AT THIS SPEED THE PARKING BRAKE IS USED TO STOP THE VEHICLE.

X200-4  
**TYPICAL SCHEMATIC  
BRAKE APPLY SYSTEM**







## 5-22 BRAKE APPLY REGULATOR VALVE

### A. DESCRIPTION:

CONSISTS OF A SPRING, BRAKE APPLY VALVE, SPRING, REGULATING VALVE ROD AND REGULATING VALVE.

### B. OPERATION:

THE BRAKE APPLY REGULATOR IS HELD IN "OFF" POSITION BY SPRING FORCE WHICH BLOCKS MAIN PRESSURE FROM ENTERING THE BRAKE APPLY CIRCUIT AND BRAKE SIGNAL CIRCUIT.

AS SOON AS BRAKE APPLY IS CALLED FOR; MOVEMENT OF THE BRAKE APPLY VALVE DIRECTS MAIN PRESSURE TO THE BRAKE SIGNAL CIRCUIT AND THEN THE BRAKE APPLY CIRCUIT.

SECTION 6  
X200  
STEER SYSTEM

I. GENERAL EXPLANATION

- A. THE X200 STEER SYSTEM CONSIST MAINLY OF A VARIABLE-VOLUME HYDROSTATIC PUMP, A FIXED-VOLUME HYDROSTATIC MOTOR, A STEER CONTROL VALVE SYSTEM, GEARING TO DRIVE THE PUMP, AND GEARING BY WHICH THE MOTOR PRODUCES STEER ACTION
- B. THE HYDROSTATIC PUMP IS DRIVEN CONTINUOUSLY WHILE THE ENGINE IS OPERATING THROUGH A GEAR TRAIN CONNECTING THE CONVERTER TURBINE TO THE HYDROSTATIC PUMP. DURING STRAIGHT TRAVEL, THE HYDROSTATIC PUMP PRODUCES NO FLOW OR PRESSURE. WHEN STEER IS DESIRED, THE PUMP WILL PRODUCE FLOW FROM EITHER OF TWO PORTS, DEPENDING UPON WHETHER RIGHT OR LEFT STEER IS DESIRED. THE AMOUNT OF FLOW PRODUCED DEPENDS UPON THE DEGREE OF STEER DESIRED. THE HYDROSTAT PUMP ROTATES ANYTIME THE CONVERTER TURBINE ROTATES.
- C. FLOW FROM EITHER PORT OF THE PUMP IS DIRECTED TO A PORT IN THE HYDROSTATIC MOTOR. THIS PORT BECOMES THE INPUT OF THE MOTOR. THE REMAINING PORT IS THE MOTOR OUTPUT, AND RETURNS FLOW TO THE PUMP INPUT. THUS, THE INPUTS AND OUTPUTS OF THE PUMP AND MOTOR ARE REVERSED WHEN STEERING IS CHANGED FROM LEFT TO RIGHT, OR RIGHT TO LEFT. THE DIRECTION IN WHICH THE HYDROSTATIC MOTOR ROTATES IS DETERMINED BY WHETHER RIGHT OR LEFT STEER IS APPLIED.
- D. THE MECHANICAL OUTPUT OF THE MOTOR IS CONNECTED BY GEARS TO A DIFFERENTIAL ARRANGEMENT WHICH DRIVES SUN GEARS OF TWO PLANETARY GEAR SETS IN OPPOSITE DIRECTIONS. THIS DIFFERENTIAL ARRANGEMENT IS STATIONARY DURING STRAIGHT TRAVEL AND THE SUN GEARS ACT AS REACTION ELEMENTS IN THE PLANETARY SETS PROVIDING EQUAL ROTATION TO THE SUN GEARS IN THE OUTPUT PLANETARIES. WHEN STEER IS APPLIED, THE DIFFERENTIAL SUN GEARS ARE DRIVEN IN OPPOSITE DIRECTIONS. THUS, ONE OF THEM ADDS SPEED TO ONE OUTPUT SUN GEAR WHILE THE OTHER SUBTRACTS SPEED FROM THE OPPOSITE OUTPUT SUN GEAR. THIS SPEEDS UP ONE POWER TRAIN OUTPUT, WHILE SLOWING DOWN THE OPPOSITE OUTPUT AN EQUAL AMOUNT.



- E. BECAUSE THE STEER GEAR TRAIN HAS A FIXED MECHANICAL RATIO (AS DOES THE OUTPUT PLANETARY SUN GEARS), WHILE THE OUTPUT PLANETARY RING GEAR SPEED RATIO CHANGES WITH EACH RANGE SHIFT, STEERING IS MORE PRO-  
NOUNCED IN LOWER RANGES. IN NEUTRAL, PIVOT STEER OCCURS.

## II. OIL SOURCE

- A. OIL IS SUPPLIED TO THE HYDROSTATIC STEER SYSTEM BY MAIN PRESSURE ORIGINATING AT THE MAIN PRESSURE PUMP. THE OIL PASSES THROUGH THE MAIN FILTER, MAIN OIL GALLERY AND ENTERS THE SYSTEM AT THE INTAKE SIDE OF THE MANIFOLD AND FLOWS THROUGH PRESSURE RELIEF VALVE AND PRESSURE LIMITER VALVE TO SERVO VALVE. THE MAIN PRESSURE PUMP SUPPLIES ALL THE OIL VOLUME AND PRESSURE REQUIRED TO CHARGE THE PUMP AND CONTROL VALVES.
- B. TWO CHECK VALVES ARE PROVIDED IN THE LINE BETWEEN THE MAIN PRESSURE REGULATOR AND THE HYDROSTATIC PUMP. ONE CHECK VALVE WILL BE OPEN AT ALL TIMES TO PROVIDE ADDITIONAL OIL TO THE HYDROSTATIC PUMP CIRCUIT AS REQUIRED TO REPLENISH OIL LOST IN LEAKAGE, DURING OVERLOAD, OR IN CONTROL FUNCTIONS. THE OTHER VALVE REMAINS CLOSED. THE DIRECTION OF PUMP DISPLACEMENT DETERMINES WHEN EACH VALVE IS OPENED OR CLOSED. OIL IS SUPPLIED THROUGH THE OPEN VALVE TO THE INPUT SIDE OF THE HYDRO-  
STATIC PUMP.

## III. CONTROL CIRCUIT

- A. THE SERVO SLEEVE IS A ROTATING SLEEVE VALVE WITH PORTS TO DIRECT CON-  
TROL PRESSURE TO THE CONTROL PISTON. THE SERVO SLEEVE IS LINKED TO THE PUMP SWASHPLATE (MECHANISM WHICH CONTROLS THE PUMP PISTON STROKE). THE LINK TRANSMITS THE PARTIAL MOVEMENT OF THE SWASHPLATE TO THE SERVO SLEEVE.
- B. CENTERED WITHIN THE SERVO SLEEVE IS THE MANUALLY CONTROLLED SERVO VALVE WHICH, WHEN ROTATED, THE VALVE DIRECTS CONTROL PRESSURE TO EITHER THE FRONT OR BACK OF THE CONTROL PISTON. CLOCKWISE ROTATION OF THE SPLINED STEER CONTROL SHAFT FROM THE NORMALLY CENTERED POSITION ROTATES THE MOTOR IN THE SAME DIRECTION AS THE PUMP. IN THE PRESENT, FRONT DRIVE VEHICLE APPLICATION, MOTOR ROTATION SAME AS THE PUMP SLOWS THE RIGHT TRANSMISSION OUTPUT GIVING A LEFT STEER. FOR THIS APPLICA-  
TION THE PUMP ROTATES CCW. WHEN THE STEER CONTROL SHAFT IF ROTATED CLOCKWISE, OIL IS PORTED TO THE BACK (ROD END) OF THE CONTROL PISTON CAUSING THE PUMP SWASHPLATE ANGLE TO MOVE IN THE SAME DIRECTION AS THE FIXED MOTOR SWASHPLATE ANGLE.

ROTATING THE STEER CONTROL SHAFT COUNTERCLOCKWISE, PROVIDES MOTOR ROTATION OPPOSITE OF PUMP ROTATION CAUSING A RIGHT STEER IN THIS VEHICLE APPLICATION.

- C. WHEN STEER IS APPLIED, THE SERVO VALVE IS ROTATED TO THE EXTENT REQUIRED TO PRODUCE THE DESIRED STEER. THIS DIRECTS PRESSURE TO THE CONTROL PISTON WHICH CONTROLS THE PUMP PISTON STROKE. FOR STEER IN ONE DIRECTION, IT WILL BE TO THE FRONT OF THE CONTROL PISTON; FOR STEER IN THE OTHER DIRECTION, IT WILL BE TO THE BACK OF THE PISTON.
- D. THE PRESSURIZED CONTROL PISTON WILL MOVE THE SWASHPLATE TO A POSITION WHICH WILL CAUSE THE HYDROSTATIC PUMP PISTONS TO RECIPROCATE. THE LENGTH OF THEIR STROKE WILL CORRESPOND TO THE DEGREE OF STEER APPLIED, AND THE HYDRAULIC OUTPUT OF THE HYDROSTATIC PUMP WILL BE DIRECTLY PROPORTIONAL TO THE STROKE.
- E. TO PREVENT THE CONTROL PISTON FROM CONTINUING ITS TRAVEL BEYOND THE STEER DEGREE DESIRED, THE SERVO SLEEVE IS SO DESIGNED THAT IT CUTS OFF FLOW TO THE CONTROL PISTON AS SOON AS THE SWASHPLATE REACHES THE SAME ANGLE AS THE SERVO VALVE. THE SWASHPLATE WILL THEN REMAIN AT THIS POSITION UNTIL THE SERVO VALVE IS AGAIN MOVED. THUS, A SMALL ROTATION OF THE SERVO VALVE WILL IMPART A SMALL (AND EQUAL) ROTATION TO THE SWASHPLATE; A GREATER ROTATION OF THE SERVO VALVE WILL IMPART A GREATER ROTATION TO THE SWASHPLATE. ACTUALLY, THE SERVO SLEEVE "FOLLOWS" THE SERVO VALVE AND "CATCHES UP" WITH IT WHEN THE SERVO VALVE STOPS.
- F. A PRESSURE COMPENSATING VALVE IS PROVIDED IN THE PUMP AND MOTOR ASSEMBLY. UNDER NORMAL CONDITION THE VALVE WILL REMAIN IN THE POSITION SHOWN. UNDER CONDITIONS WHICH OVERLOAD THE HYDROSTATIC PUMP, (APPROX. 6000 PSI) THE EXCESSIVE OUTPUT PRESSURE WILL PUSH THE VALVE TO A POSITION WHICH EXHAUSTS THE CONTROL PISTON CIRCUIT ACTUATING THE CONTROL PISTONS. THIS ACTION OVER-RIDES STEER CONTROL TO THE EXTENT OF REDUCING STEER TO THE DEGREE POSSIBLE UNDER OVERLOAD CONDITIONS. WITH THE PRESSURE TO THE CONTROL PISTON EXHAUSTED, THE FORCE OF THE PISTONS ON THE SWASHPLATE DRIVES THE SWASHPLATE TO A REDUCED FLOW CONDITION UNTIL THE OVERLOAD IS ELIMINATED. STEERING IS DEGRADED OR NOT FUNCTIONAL WHEN THE PRESSURE COMPENSATING VALVE IS ACTUATED.



## HYDROSTATIC STEER UNIT

## PRINCIPLES OF OPERATION

THE VARIABLE DISPLACEMENT PUMP CONVERTS MECHANICAL ROTATION TO HYDRAULIC OIL FLOW WHICH IS ROUTED TO A FIXED DISPLACEMENT HYDROSTATIC MOTOR.

THE HYDROSTATIC MOTOR CONVERTS HYDRAULIC OIL FLOW TO MECHANICAL ROTATION.

THE HYDROSTATIC UNIT PROVIDES INFINITELY VARIABLE SPEED CONTROL TO THE COMBINED PLANETARIES.

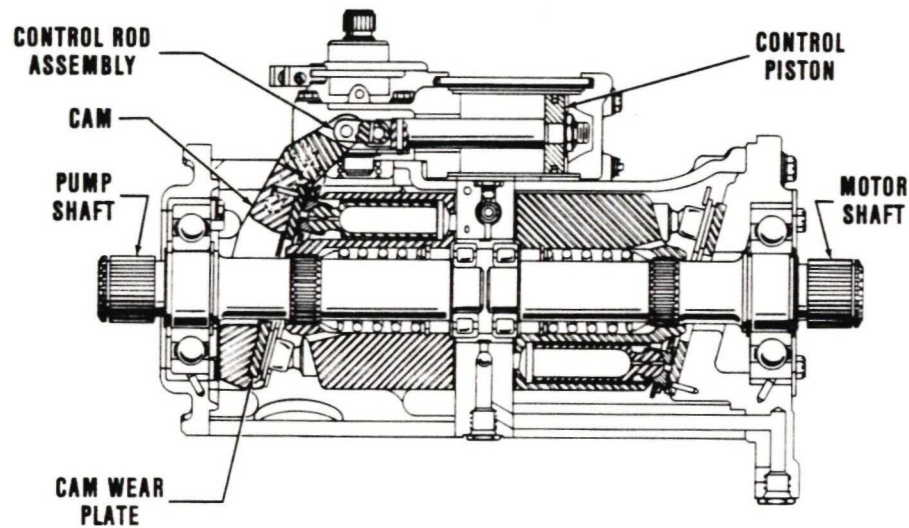
## ADVANTAGES

POSITIVE STEER CONTROL INDEPENDENT OF GROUND CONDITIONS INFINITELY VARIABLE FROM NO STEER, (STRAIGHT) TO MAXIMUM STEER, (TURN) WITH PIVOT STEER CAPABILITY.

"NO STEER MODE" WILL MAINTAIN STRAIGHT MOTION REGARDLESS OF GROUND CONDITION.

RESULTS ARE STABLE CONTROL, HIGH MANEUVERABILITY AND MINIMUM AMOUNT OF DRIVER TRAINING

## HYDROSTATIC STEER FULL LEFT DISPLACEMENT



### OPERATION OF HYDROSTATIC UNIT - FULL LEFT DISPLACEMENT

#### PUMP CONTROL PISTON

HYDRAULIC OIL PRESSURE IS DIRECTED TO RIGHT SIDE OF CONTROL PISTON (ROD END) WHICH MOVES THE SWASH PLATE; TOP HALF TO LEFT, BOTTOM HALF TO RIGHT.

THE PISTON ASSEMBLY ROTATING COUNTER-CLOCKWISE, DRIVEN BY INPUT GEARING CONVERTER DRIVEN.

THE HYDRAULIC OIL FLOWS INTO THE PISTON ASSEMBLY VIA THE HYDROSTAT MANIFOLD.

THE PUMP'S PISTON BORES FILL WITH OIL,

NOTE: VOLUME AREA OF THE PISTON BORES INCREASING. (LEFT TO RIGHT, BOTTOM HALF)

THE PISTON ASSEMBLIES CONTINUE TO ROTATE COUNTER-CLOCKWISE.

HYDRAULIC OIL IN PISTON BORES ARE FORCED INTO DRILLINGS.

THE VOLUME AREA DECREASING CAUSES A HIGH PRESSURE WHICH IS DIRECTED TO HYDROSTATIC MOTOR THROUGH DRILLINGS.

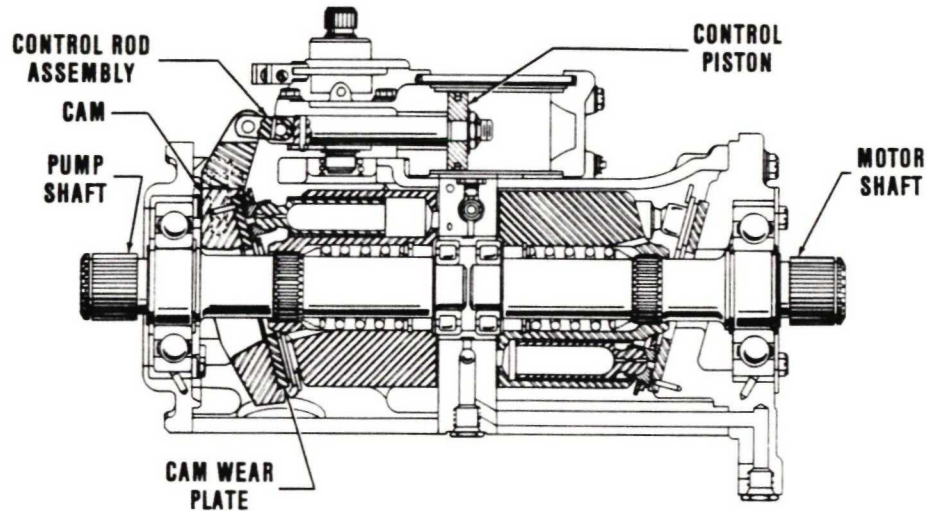
## MOTOR

High pressure oil from pump flows into motor piston bores and forces pistons against inner wall of motor which rotates hub and piston assembly toward least resistance (counter-clockwise rotation).

NOTE: Volume area between piston and cups increasing. (left to right, top half)

Hydraulic pressure is directed back to hydrostatic pump for a continuous flow cycle.

## HYDROSTATIC STEER FULL RIGHT DISPLACEMENT



### FULL RIGHT DISPLACEMENT

#### PUMP CONTROL PISTON

HYDRAULIC OIL PRESSURE IS DIRECTED TO THE LEFT SIDE OF CONTROL PISTON WHICH MOVES SWASH PLATE, TOP HALF RIGHT, BOTTOM HALF LEFT. THE PISTON ASSEMBLY ROTATING COUNTER-CLOCKWISE DRIVEN BY INPUT GEARING CONVERTER DRIVEN.

HYDRAULIC OIL FLOWS INTO PISTON BORES THROUGH DRILLINGS

PISTON BORES FILL WITH OIL AND,

NOTE: VOLUME AREA BETWEEN PISTON BORES INCREASING (RIGHT TO LEFT, TOP HALF)

PISTON ASSEMBLY CONTINUES TO ROTATE COUNTER-CLOCKWISE.

HYDRAULIC OIL IN PISTON BORES ARE FORCED INTO DRILLINGS WITH VOLUME AREA DECREASING CAUSES A HIGH PRESSURE,

DIRECTED TO HYDROSTATIC MOTOR.

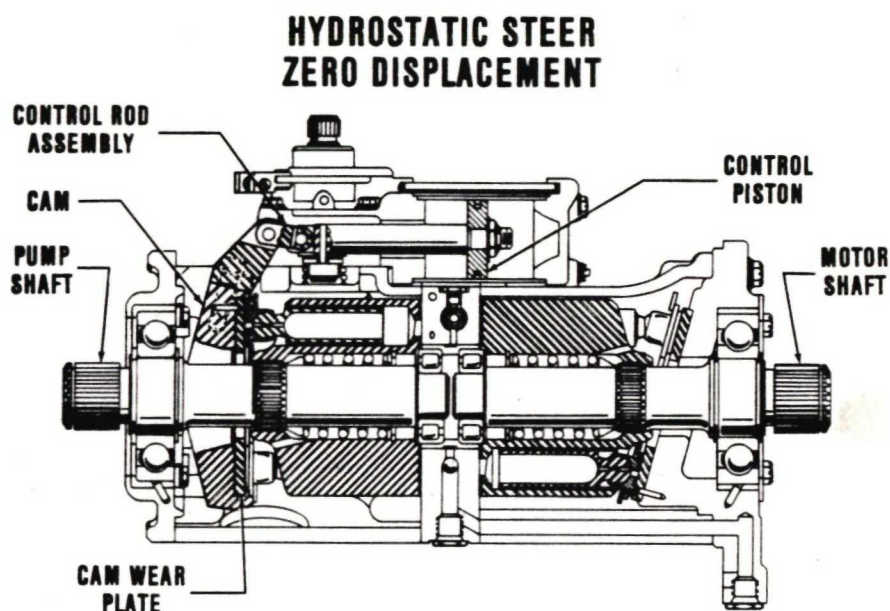


## MOTOR

HIGH PRESSURE OIL FROM PUMP FLOWS INTO MOTOR PISTON BORES FORCING PISTONS AGAINST INNER WALL OF MOTOR AND ROTATES HUB AND PISTON ASSEMBLY TOWARD LEAST RESISTANCE, (CLOCKWISE ROTATION).

NOTE: VOLUME AREA BETWEEN PISTON AND CUPS INCREASING. (LEFT TO RIGHT, BOTTOM HALF)

OIL PRESSURE NOW DIRECTED BACK TO HYDROSTATIC PUMP FOR A CONTINUOUS FLOW CYCLE.



## OPERATION OF HYDROSTATIC UNIT - ZERO DISPLACEMENT

### PUMP CONTROL PISTON

CONTROL PRESSURE NOT PRESENT, SWASH PLATE CENTERED.

PISTON ASSEMBLY ROTATING COUNTER-CLOCKWISE DRIVEN BY INPUT GEARING CONVERTER DRIVEN.

HYDRAULIC OIL FLOWS INTO PISTON BORES THROUGH DRILLINGS.

PISTON BORES FILL WITH OIL,

NOTE: VOLUME AREA BETWEEN PISTONS AND BORES EQUAL

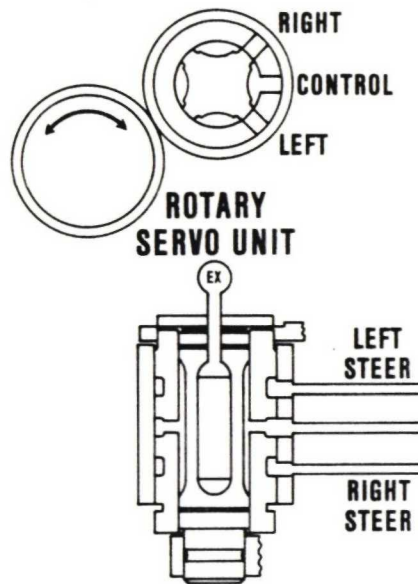
NO HIGH PRESSURE DIRECTED TO HYDROSTATIC MOTOR

MOTOR

MAIN PRESSURE, ONLY PRESSURE PRESENT

ZERO DISPLACEMENT OF PUMP SWASH PLATE NO HIGH PRESSURE TO ROTATE MOTOR ASSEMBLY.

## TYPICAL ROTARY SERVO UNIT



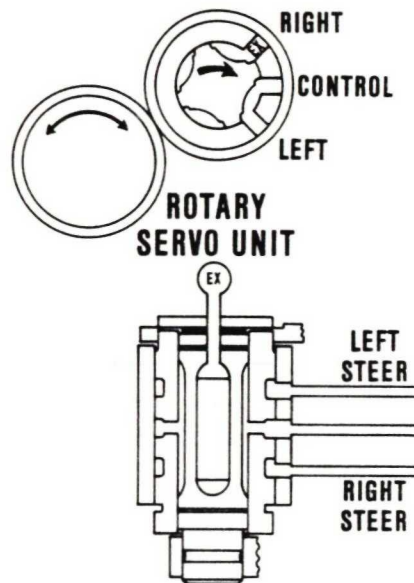
### ROTARY SERVO UNIT

#### DESCRIPTION

SERVO SLEEVE AND ROTATING SLEEVE VALVE WITH SIX PORTS CENTERED ON SAME AXIS AS SWASH PLATE, AND CONNECTED TO SWASH PLATE BY PIN, WHICH TRANSMITS MOVEMENT OF SWASH PLATE TO SERVO SLEEVE.

SERVO VALVE IS CENTERED WITHIN SERVO SLEEVE AND IS MANUALLY CONTROLLED BY STEER LEVER MOVEMENT, WHICH EXHAUSTS PRESSURE AND CONTROLS PRESSURE FLOW

## ROTARY SERVO UNIT CLOCKWISE ROTATION



### OPERATION

#### CLOCKWISE ROTATION OF SERVO VALVE

DIRECTS CONTROL PRESSURE TO THE RIGHT SIDE OF CONTROL PISTON (ROD END) AND EXHAUSTS PRESSURE FROM THE LEFT SIDE OF CONTROL PISTON.

CONTROL PRESSURE MOVES PISTON TO LEFT WHICH MOVES SWASH PLATE TO LEFT (TOP LEFT)

THE SERVO SLEEVE IS MECHANICALLY CONNECTED TO SWASH PLATE AND TRANSMITS MOVEMENT OF SWASH PLATE TO SERVO SLEEVE.

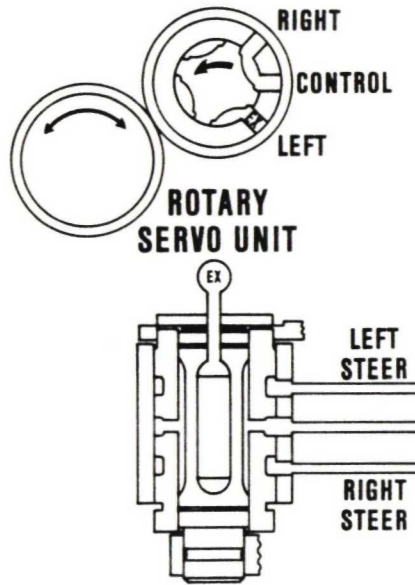
THE SWASH PLATE STOPS WHEN SAME ANGLE AS SERVO VALVE IS ACCOMPLISHED.

THIS CUTS OFF FLOW TO RIGHT SIDE OF CONTROL PISTON AND REMAINS AT THIS POSITION UNTIL SERVO VALVE IS AGAIN MOVED.

INSTRUCTOR NOTE: A SMALL ROTATION OF THE SERVO VALVE WILL IMPART A SMALL (AND EQUAL) ROTATION TO THE SWASH PLATE A GREATER ROTATION OF THE SERVO VALVE WILL IMPART A GREATER ROTATION OF THE SWASH PLATE.



## ROTARY SERVO UNIT COUNTERCLOCKWISE ROTATION



### COUNTERCLOCKWISE ROTATION OF SERVO VALVE

DIRECTS CONTROL PRESSURE TO LEFT SIDE OF CONTROL PISTON AND EXHAUSTS PRESSURE FROM THE RIGHT SIDE OF CONTROL PISTON.

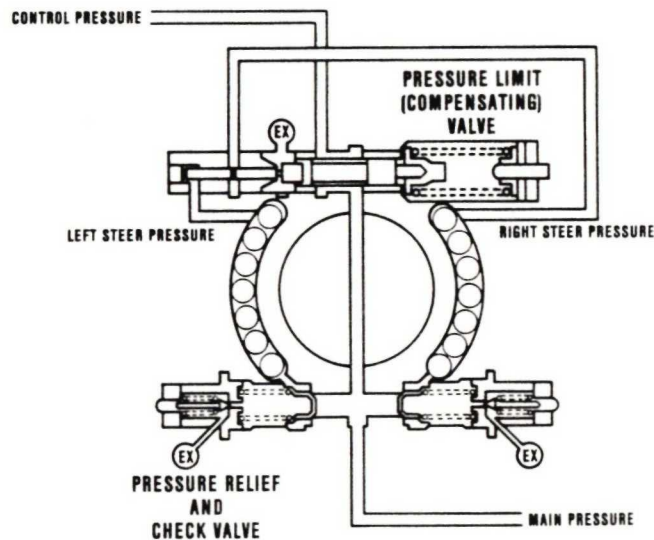
CONTROL PRESSURE MOVES PISTON TO THE RIGHT AND MOVES SWASH PLATE TO THE RIGHT.

THE SERVO SLEEVE IS MECHANICALLY CONNECTED TO SWASH PLATE AND TRANSMITS MOVEMENT OF THE SWASH PLATE TO THE SERVO SLEEVE.

THE SWASH PLATE STOPS WHEN SAME ANGLE AS SERVO VALVE IS ACCOMPLISHED.

THIS CUTS OFF FLOW TO LEFT SIDE OF CONTROL PISTON AND REMAINS AT THIS POSITION UNTIL SERVO VALVE IS AGAIN MOVED.

## PRESSURE LIMIT (COMPENSATING) VALVE AND PRESSURE RELIEF AND CHECK VALVE



### OPERATION

#### NORMAL CONDITION OPERATION - LEFT STEER

THE CONTROL PRESSURE FROM SERVO UNIT ENTERS THE PRESSURE LIMIT VALVE AT THE TOP LEFT PORT AND IS DIRECTED THROUGH THE VALVE FROM THE DESIGNATED CONTROL PISTON

HIGH PRESSURE FROM LEFT KIDNEY ENTERS LEFT END OF VALVE ASSEMBLY.

THE VALVE STAYS IN POSITION SHOWN, UNTIL AN OVERLOAD CONDITION OCCURS.

#### OVERLOAD CONDITION OPERATION - LEFT STEER

HIGH PRESSURE FROM LEFT KIDNEY EXCEEDING APPROXIMATELY 6000 PSI, DUE TO EXCESSIVE RESTRICTION AT THE MOTOR, (FULL LEFT STEER) ENTERS LEFT END OF VALVE ASSEMBLY AND FLOWS THROUGH DRILLED PASSAGE MANIFOLD, PUSHING VALVE RIGHTWARD.

THIS INTERRUPTS LEFT SERVO CONTROL PRESSURE AND ALLOWS PRESSURE TO EXHAUST.

THIS PRESSURE OVERRIDES STEER CONTROL AND REDUCES STEER TO DEGREE POSSIBLE UNDER OVERLOAD CONDITIONS.

## NORMAL CONDITION OPERATION - RIGHT STEER

THE CONTROL PRESSURE FROM SERVO UNIT ENTERS THE PRESSURE LIMIT VALVE AT SECOND PORT, RIGHT OF LEFT ROD ON LEFT, DIRECTED THROUGH THE VALVE FROM THE DESIGNATED CONTROL PISTON.

THE HIGH PRESSURE FROM RIGHT KIDNEY ENTERS RIGHT END OF VALVE ASSEMBLY.

THE VALVE STAYS IN POSITION SHOWN UNTIL AN OVERLOAD CONDITION OCCURS

## OVERLOAD CONDITION OPERATION - RIGHT STEER

HIGH PRESSURE FROM RIGHT KIDNEY EXCEEDING APPROXIMATELY 6000 PSI, DUE TO EXCESSIVE RESTRICTION AT MOTOR, (FULL RIGHT STEER) ENTERS LEFT END OF VALVE ASSEMBLY, SECOND PORT, AND FLOWS THROUGH DRILLED PASSAGE MANIFOLD, PUSHING VALVE RIGHTWARD, THIS INTERRUPTS RIGHT SERVO CONTROL PRESSURE AND ALLOWS PRESSURE TO EXHAUST.

THIS PRESSURE OVERRIDES STEER CONTROL AND REDUCES STEER TO DEGREE POSSIBLE UNDER OVERLOAD CONDITIONS.

OUTPUT COVER ASSEMBLIES  
TRANSMISSION DISASSEMBLY

SUGGESTED SEQUENCE - DISASSEMBLY OF LEFT OUTPUT HOUSING

I. LEFT OUTPUT COVER ASSEMBLY P/N 23018292

- A. REMOVE (1)  $1/2$  - 20 X  $3\ 1/4$ " BOLT AND WASHER THAT RETAINS THE OUTPUT FLANGE (MECHANICS 7C)
- B. REMOVE THE OUTPUT FLANGE (MECHANICS 7C)
- C. REMOVE (2) HOOK TYPE SEAL RINGS FROM LONG OUTPUT SHAFT.
- D. REMOVE SNAPRING THAT RETAINS LONG OUTPUT SHAFT AND BEARING ASSEMBLY.
- E. REMOVE LONG OUTPUT SHAFT AND BEARING ASSEMBLY.
- F. REMOVE (3)  $5/16$  - 18 X  $3/4$ " BOLTS THAT RETAINS THE TUBE ASSEMBLY OIL TRANSFER.
- G. REMOVE TUBE ASSEMBLY.

NOTE: FOR LEFT OUTPUT COVER ASSEMBLY REASSEMBLY; REVERSE ORDER OF DISASSEMBLY PROCEDURES MENTIONED ABOVE.



RIGHT HAND OUTPUT COVER  
DISASSEMBLY  
SUGGESTED SEQUENCE

I. RIGHT HAND OUTPUT COVER ASSEMBLY

- A. REMOVE (1) 1/2 - 20 X 3 1/4" BOLT AND WASHER THAT RETAINS THE OUTPUT COVER FLANGE (MECHANICS 7C)
- B. REMOVE THE OUTPUT COVER FLANGE (MECHANICS 7C)
- C. WRAP TAPE AROUND SPLINES OF LEFT & RIGHT AND BRAKE APPLY SHAFT.
- D. REMOVE LEFT HAND BRAKE APPLY SHAFT.
- E. REMOVE THE SLEEVE FROM THE OUTPUT (SHORT) SHAFT.
- F. REMOVE 3 BOLTS AND WASHERS THAT RETAINS THE BRAKE COOLANT VALVE BODY.
- G. REMOVE BRAKE COOLANT VALVE BODY.
- H. REMOVE 5 BOLTS AND WASHERS THAT RETAINS THE BRAKE APPLY REGULATOR VALVE BODY ASSEMBLY.
- I. REMOVE 14 BOLTS AND WASHERS THAT RETAINS THE BRAKE SUPPORT ASSEMBLY.
- J. REMOVE R.H. BRAKE APPLY SHAFT.
- K. REMOVE BRAKE APPLY CAM SHAFT.
- L. REMOVE INNER AND OUTER BRAKE ADJUSTING LINKS.
- M. REMOVE SNAPRING, SPRING AND WASHER.
- N. REMOVE LOCKNUT THAT RETAINS CAM FOLLOWER.
- O. REMOVE ROTATING CAM.
- P. REMOVE (2) SPRINGS AND BOLTS.
- Q. REMOVE INNER AND OUTER SEALS IF NEEDING REPLACEMENT.
- R. REMOVE (8) CAM BALLS.
- S. REMOVE (2) BOLTS AND WASHERS AND RETAINERS.
- T. REMOVE (3) BOLTS AND WASHERS.
- U. REMOVE R.H. BRAKE SUPPORT ASSEMBLY.

- V. REMOVE CLUTCH PLATES
- W. REMOVE CARRIER ASSEMBLY.
- X. REMOVE SPRING RETAINER PLATE.
- Y. REMOVE SPRING PINS.
- Z. REMOVE R.H. STEER AND OUTPUT SUN GEAR.
- AA. REMOVE R.H. STEER GEAR.
- AB. REMOVE (1) BOLT.
- AC. REMOVE RETAINING PLATE.
- AD. REMOVE R.H. STEER IDLER GEAR.
- AE. REMOVE THRUST WASHER AND SNAP RING.
- AF. REMOVE OUTPUT SHAFT.
- AG. REMOVE BRAKE REACTION PINS.

REASSEMBLY - REVERSE PROCEDURE OF DISASSEMBLY SEQUENCE.

7-4  
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TROUBLESHOOTING

200-112

REFERENCE MATERIAL

X200-4 STUDENT STUDY GUIDE

X200-4 STUDENT WORK BOOK

WALL CHART

X200-4 HYDRAULIC SCHEMATIC

PRODUCT KNOWLEDGE

SYSTEMATIC SEARCH

PERIODIC CHECKS

DIPSTICK MARKINGS

MAIN PRESSURE (OPERATIONAL)

ADJUSTMENTS

SERVICE BRAKES

STEER CENTERING

SELECTOR IN HOLD RANGE

SELECTOR IN "D"

SELECTOR IN "D" (LOCKUP)



## TROUBLESHOOTING

## I. PRODUCT KNOWLEDGE IS ESSENTIAL IN DETERMINING CAUSE OF TROUBLE

## A. SYSTEMATIC SEARCH FOR AND LOCATION OF:

## 1. MALFUNCTIONS IN:

A. ENGINE

B. TRANSMISSION

## 2. THAT AFFECT TRANSMISSION PERFORMANCE

## B. IF MALFUNCTION OCCURS:

## 1. CHECK FIRST FOR:

A. PROPER OIL LEVEL

B. OIL FILTER

(1) PRESSURE DROP DOES NOT EXCEED 50<sup>+</sup>  
10 P.S.I.

C. SHIFT SELECTOR IS FUNCTIONING PROPERLY

(1) ELECTRICALLY

## II. PERIODIC CHECKS

## A. IMPORTANCE OF PROPER OIL LEVEL

## 1. TRANSMISSION OIL

A. APPLIES CLUTCHES

(1) RANGE &amp; BRAKE

B. OPERATES HYDROSTATIC STEER UNIT

C. LUBRICATES AND:

D. COOLS TRANSMISSION

## 2. LOW OIL LEVEL

A. POOR PERFORMANCE

## 3. HIGH OIL LEVEL

A. OVERHEATING

## 4. AERATION (FOAMING)

A. IMPROPER OIL

B. LOW OIL LEVEL

C. HIGH OIL LEVEL

## B. OIL LEVEL CHECK PROCEDURE (STATIC)

1. TRANSMISSION AT OPERATING TEMPERATURE  
220°F - 250°F.

## 2. ENGINE STOPPED

3. REMOVE DIPSTICK
4. WIPE CLEAN
5. REINSERT
6. DIPSTICK MARKINGS
  - A. FULL MARK - CORRECT
  - B. ADD/LOW MARK - ADD OIL
    - (1) BRING LEVEL TO FULL MARK

INSTRUCTOR NOTE: APPROXIMATELY ONE GALLON OF OIL IS REQUIRED TO RAISE THE LEVEL ON DIPSTICK FROM ADD TO FULL MARK.

7. COLD OIL CHECK (STATIC)
  - A. FULL MARK (COLD OIL)
    - (1) TWO INCHES BELOW FULL MARKS OF STATIC CHECK
- C. MAIN PRESSURE SCHEDULE
  1. 280-325 P.S.I. NEUTRAL & REVERSE (600 RPM)
  2. 190-210 P.S.I. FORWARD CONVERTER (600 RPM)
  3. 140-160 P.S.I. FORWARD LOCKUP (2800 RPM)

### III. ADJUSTMENT

- A. BRAKE MECHANISM
  1. INTERNAL ADJUSTMENT CHECK
    - A. LEFT HAND - BRAKE PACK
      - (1) APPLY 40 LB. FT. TORQUE TO BRAKE APPLY SHAFT
      - (2) BRAKE INDICATOR SHOULD POINT TO APPLY MARK ON COVER PLATE
- B. BRAKE ADJUSTMENT
  1. MUST BE TIGHTENED IF INDICATOR IS AT OR PAST READJUST MARK
  2. MUST BE LOOSENED IF INDICATOR DOES NOT REACH APPLY MARK
- C. INDICATOR POINTS TO ADJUST
  1. REMOVE COVER
  2. USING 11/16" COMBINATION WRENCH
  3. TURN ADJUSTING LINK RIGHT (COUNTER-CLOCKWISE, TIGHTENS)

4. TURN ADJUSTING LINK LEFT (CLOCKWISE, LOOSENS)
- D. ALTERNATLY TURN ADJUSTING LINK WITH COMBINATION WRENCH AND APPLY TORQUE WRENCH AT 40 LB. FT. UNTIL INDICATOR LINES UP OPPOSITE APPLY MARK

#### IV. INTERNAL ADJUSTMENT CHECK

- A. RIGHT HAND - BRAKE PACK
  1. APPLY 40 LB. FT. TORQUE TO BRAKE APPLY SHAFT
  2. BRAKE INDICATOR SHOULD POINT TO APPLY MARK ON COVER PLATE
- B. BRAKE ADJUSTMENT
  1. SCREWDRIVER TURNED CLOCKWISE IN SLOTTED TIP LOOSENS BRAKE
  2. SCREWDRIVER TURNED CLOCKWISE IN SLOTTED TIP TIGHTENS BRAKE
- C. INDICATOR POINTS TO ADJUST
  1. REMOVE COVER
  2. USING SCREWDRIVER
  3. TURN SLOTTED TIP IN ADJUSTING LINK (COUNTER-CLOCKWISE, TIGHTENS)
  4. TURN SLOTTED TIP IN ADJUSTING LINK (CLOCKWISE, LOOSENS)
- D. ALTERNATLY TURN ADJUSTING LINK 1/5 TURN (50°) WITH SCREWDRIVER AND APPLY TORQUE WRENCH AT 40 LB. FT. ON SHAFT UNTIL INDICATOR LINES UP OPPOSITE APPLY MARK
- E. STEER CENTERING ADJUSTMENT
  1. ADJUSTED AT INITIAL BUILD
    - A. PRECISE STEER CENTERING
      - (1) STEER SHAFT SPRING LOADED
    - B. HYDROSTATIC PUMP AT:
      - (1) ZERO DISPLACEMENT
    - C. STEER SHAFT AT:
      - (1) NO STEER POSITION

2. HYDROSTATIC UNIT UNLESS:
  - A. OVERHAULED OR:
  - B. DISASSEMBLED AND REBUILT
  - (1) SHOULD NEVER REQUIRE ADJUSTMENT
3. ADJUSTMENT
  - A. REMOVE ACCESS PLUG AND GASKET
  - B. LOOSEN LOCKNUT
  - C. TURN ADJSUTING SCREW 1/8 TURN AT A TIME
  - D. IF RIGHT TRACK HAD FORWARD TENSION, TURN ADJUSTING SCREW COUNTER-CLOCKWISE
  - E. IF LEFT TRACK HAD FORWARD TENSION, TURN ADJSUTING SCREW CLOCKWISE
  - F. TIGHTEN LOCKNUT 140-156 LB. IN.
4. RECHECK ADJUSTMENTS
  - A. LEAVE STEERING WHEEL IN CENTER POSITION
  - B. INCREASE ENGINE SPEED 1000 RPM
  - C. SLOWLY INCREASE SPEED TO 2800 RPM
  - D. KEEP REPEATING ADJUSTMENTS UNTIL BOTH TRACKS REMAIN SLACK AT ALL ENGINE SPEEDS
  - E. INSTALL NEW GASKET
  - F. INSTALL PLUG AND TORQUE TO 50-60 LB. FT.

WARNING: CLEAR THE AREA BEFORE CHECKING ADJUSTMENT. VEHICLE MAY PIVOT STEER IF ADJUSTMENT IS NEEDED AND INJURE PERSONNEL.

- F. STEER LINKAGE
  1. VISUALLY INSPECT
    - A. FULL TRAVEL
    - (1) BOTH DIRECTIONS
    - B. RETURN TO CENTER
    - (1) POSITIVE



## TROUBLESHOOTING GUIDE

### I. SELECTOR IN HOLD RANGE

#### A. STARTS IN ANOTHER RANGE

##### 1. ELECTRICAL

##### A. SHIFT CONTROL

(1) LOOSE CONNECTION

(2) BROKEN WIRE

##### B. HARNESS

(1) CIRCUIT WIRE

(A) BROKEN

(B) SHORTED

##### C. SOLENOID "E"

(1) INOPERATIVE

(A) CONNECTION LOOSE OR BROKEN

(B) FAILED

#### B. SHIFTS VERY LATE (AGAINST GOVERNOR)

##### 1. HYDRAULICALLY

##### A. HOLD PRESSURE

(1) HIGH

##### 2. T.V. MODULATOR

##### A. NEEDS ADJUSTMENT

##### B. GOVERNOR G2

(1) FAILED

(2) IMPROPER SCHEDULE

#### C. STAYS IN NEUTRAL (REGARDLESS OF SELECTOR POSITION)

##### 1. ELECTRICAL

##### A. FAILURE IN POWER SYSTEM

##### B. SOLENOID "C"

(1) FAILED

### II. SELECTOR IN "1-4"

#### A. NO UPSHIFTS WITHIN MODE OF OPERATION

##### 1. HYDRAULIC

##### A. OUTPUT GOVERNOR

(1) MALFUNCTION

(2) FILTER RESTRICTED

B. RANGE SHIFTS - NOT CORRECT (PART THROTTLE ONLY)

1. HYDRAULIC

A. EARLY SHIFT

(1) MODULATOR SETTING

(A) TOO LOW

B. LATE SHIFT

(1) MODULATOR SETTING

(A) TOO HIGH

(2) MODULATOR SPRING

(A) WEAK OR BROKEN

C. EITHER EARLY OR LATE

(1) GOVERNOR G2

(A) WRONG SCHEDULE

III. SELECTOR IN "1-4"

A. NO LOCKUP SHIFT

1. HYDRAULIC

A. PITOT TUBE ASSEMBLY

(1) LOOSE

(2) ORIFICE RESTRICTED

B. PITOT FEED ORIFICE

(1) ORIFICE RESTRICTED

(2) LOW SIGNAL MAIN PRESSURE

C. LOCKUP SHIFT VALVE

(1) STUCK CLOSED

D. LOCKUP CLUTCH TIMER

(1) STUCK

B. LOCKUP SHIFT AT IMPROPER SPEEDS (IN OR OUT)

1. HYDRAULIC

A. MODULATOR SETTING INCORRECT

B. LOCKUP SHIFT VALVE

(1) SPRING WEAK OR BROKEN

(2) STICKING

C. LOCKUP CLUTCH CUTOFF VALVES (RANGE)

(1) STICKING

D. LOW G1 PRESSURE

C. SHIFT CYCLING ON UPSHIFT

1. HYDRAULIC

- A. LOW OIL LEVEL
- B. CLUTCH APPLY MALFUNCTION
  - (1) HIGHER OF TWO CLUTCHES
  - (2) EXCESSIVE LEAK
    - (A) PISTON SEALS
    - (B) CLUTCH APPLY LINE
    - (C) SHAFT SEALS
    - (D) JUMPER TUBES

D. HIGH OIL TEMPERATURE LIGHT COMES ON

1. ELECTRIC

- A. DEFECTIVE ELECTRICAL SENDING SYSTEM

2. HYDRAULIC

- A. OIL LEVEL
  - (1) HIGH
  - (2) LOW
- B. OIL COOLER CLOGGED
  - (1) EXTERNALLY
  - (2) INTERNALLY
- C. PLUGGED OIL FILTER
- D. BRAKES DRAGGING
  - (1) ADJUSTMENT IMPROPER
    - (A) LINKAGE
    - (B) BRAKE CLUTCH CLEARANCE

E. STATOR WILL NOT FREEWHEEL

E. VEHICLE WILL NOT STOP PROPERLY

1. LINKAGE

- A. SERVICE BRAKES
  - (1) NOT ADJUSTED PROPERLY
  - (2) BRAKE APPLY LEVER NOT INSTALLED PROPERLY

2. HYDRAULIC

- A. BRAKE CLEARANCE IMPROPER
- B. WORN BRAKE CLUTCH PLATES
- C. BRAKE APPLY REGULATOR
  - (1) MALFUNCTION

FINAL INSPECTION TEST LOG  
AND  
ACCEPTANCE TEST PROCEDURE (A.T.P.)

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THIS SEGMENT OF P.O.I. WILL BE HELD AT DDA PLANT #3 TEST AREA  
(INSTRUCTOR TO SUPPLY DETAILS), SAFETY GLASSES REQUIRED  
(FURNISHED BY DDA)

CLASS MATERIAL:

P.O.I. SHEET

SAFETY GLASSES

X200-4 STUDENT WORKBOOK

STUDENT'S NOTEBOOK & PENCIL

F.I.R. FORM

A.T.P. TRANSMISSION

A.T.P. HYDROSTATIC STEER UNIT



9-2

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DEPOT SUPPORT TRAINING CLASS

EXPERIMENTAL TEST

CONTROLS FLOW BENCH

- o DISCUSSION OF CONTROLS TESTS

AUTOMATIC DURABILITY STANDS

- o DURABILITY CYCLE
- o POWER USED IN CYCLE
- o RELIABILITY OF COMPONENTS

X200-4 ACCEPTANCE TEST

- o TEST REQUIREMENTS
- o QUALIFICATION OF TRANSMISSION

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**Detroit Diesel Allison**  
Division of General Motors Corporation