The purpose of this manual is to provide a basic understanding of the powershift drive lines employed in Galion graders and cranes. Specific function, purpose and operation of each component in the drive lines are discussed in depth.

It is hoped that this manual will provide both service and sales personnel a valuable reference to Galion powershift drive lines in general. It should be mentioned that this manual only covers the basic aspects of the powershift drive lines which are employed by Galion. Please refer to the pertinent Galion Parts Book or Shop Manual section when dealing with particular models of Galion powershift motor graders or cranes.

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Galion T-model motor graders (Grade-O-Matic) and A-series hydraulic cranes employ a powershift drive line. This type of drive line consists of a torque converter and powershift transmission, and in the grader application an output shaft governor. Each specific drive line configuration for these particular models of graders and cranes will be discussed later in this manual. First, however, it is necessary to discuss the function and purpose of the basic components of this type drive line.

TORQUE CONVERTER

A torque converter is a device which operates solely on fluid principles. Basically it is two "fans" within a fluid media which are only connected by the fluid itself. Let's analyze what a torque converter consists of and how it operates by building a simple model.

First, let's place two common household electric fans face to face.

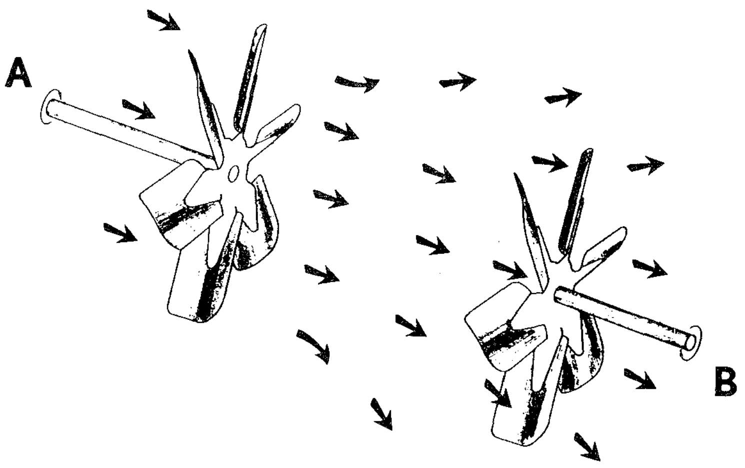

Fig. 1

Now, if we turn on the fan at the left (A) electricity will cause it to rotate. As it rotates, it will cause a motion of air in the direction of the opposing fan (B). When the velocity of the air from the left fan (A) develops, air striking the fins of the right fan (B) will cause it to rotate also. What we have obtained thus far is a simple "fluid coupling".

In this example we have an input of electricity into the left fan causing it to rotate, while the right fan rotates causing an output. Actually the output of the right fan can be measured since its motor will act as a generator. However, we will only be interested in how much rotation is created at the right fan (B) which is indirectly caused by the rotation of the left fan (A).

The efficiency of this configuration can be measured by counting how many times the left fan must rotate to accomplish one revolution of the right fan (input vs. output). We can see that in the above example, the efficiency will be quite low, especially when the left fan just begins to rotate the right, due to the lost "wind" missing the right fan. Also, as the air passes through the right fan, the "wind's" motion is merely lost to the atmosphere. If we can capture, direct and re-direct this lost "wind" by some means, our efficiency would be very much increased.

To provide a more efficient system, we will confine the air leaving the left fan so that all the air in motion passes between the blades or fins of the right fan. In this case, all of the force of the air is striking the blades of the right fan causing rotation.

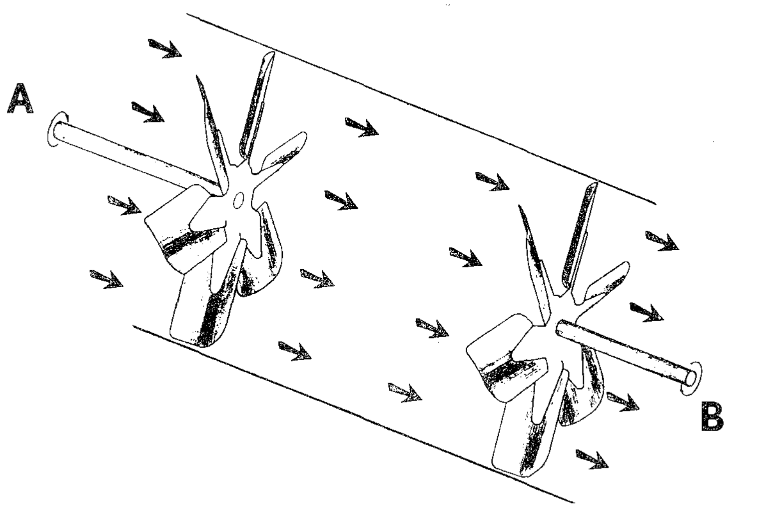

Fig. 2

Also, let's add to our efficiency by capturing the air leaving the right fan and introducing this air again to the intaking side of the left fan (see figure 3). What we have basically added is a reaction member, our air duct, to re-direct the air. This re-directed air will then affect the left fan in two ways. First, when the left fan is initially rotated and the right is still stationary, the re-directed air will help the left fan rotate. This in turn, will create more of a "wind velocity" or force to start the right fan rotating.

Second, when the left fan has caused the right to rotate at near the same speed (r.p.m.), the re-directed air does not significantly aid the left fan but simply passes through it. What this means is that it has enough force to rapidly start the right fan rotating and also rotate both left and right fans at nearly the same speed. With our additions to help efficiency we have built a very basic "torque converter".

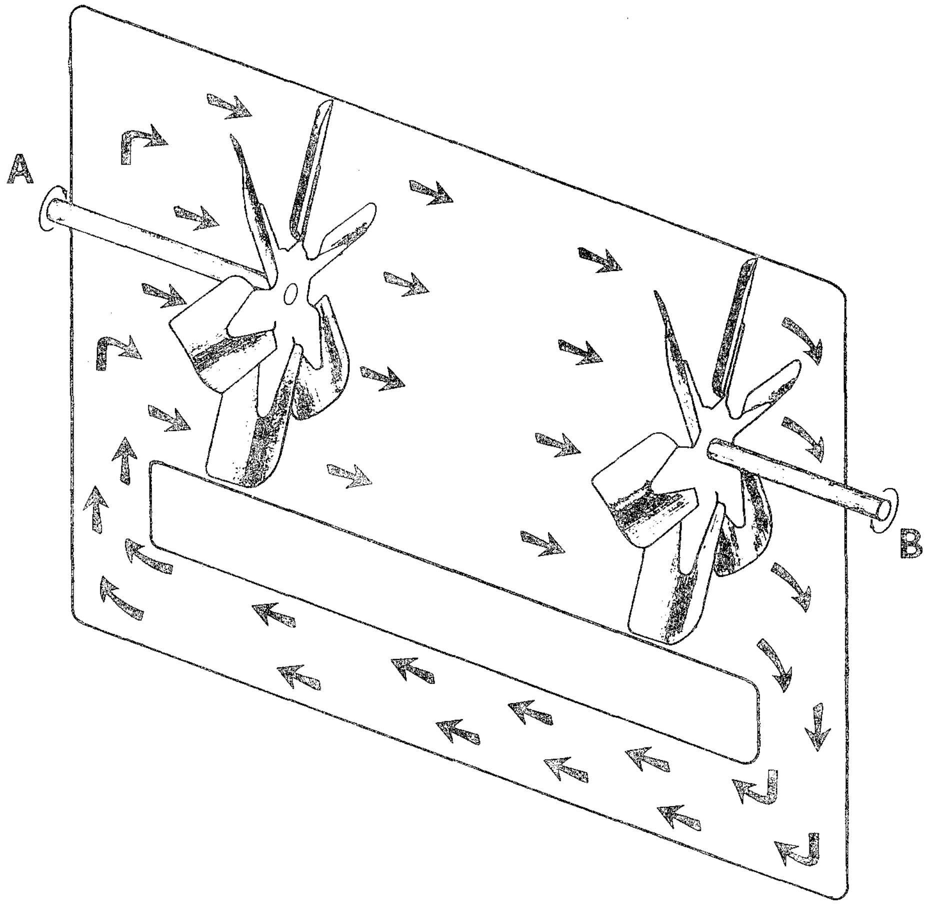

Fig. 3

A modern torque converter consists of basically the same components as we mentioned before. These components are:

1. The impeller (or pump) which is the driving member connected to an engine or motor.

2. The turbine which is connected to the output shaft of the torque converter and called the driven member.

3. A reaction member (or stator) which is stationary within the torque converter and does not rotate.

4. A housing to contain the above three members of the torque converter.

5. A fluid to be used in a similar manner as the air we used in the previous example. This fluid is similar in composition to a premium hydraulic oil.

All of the above components are assembled in a configuration such as that below:

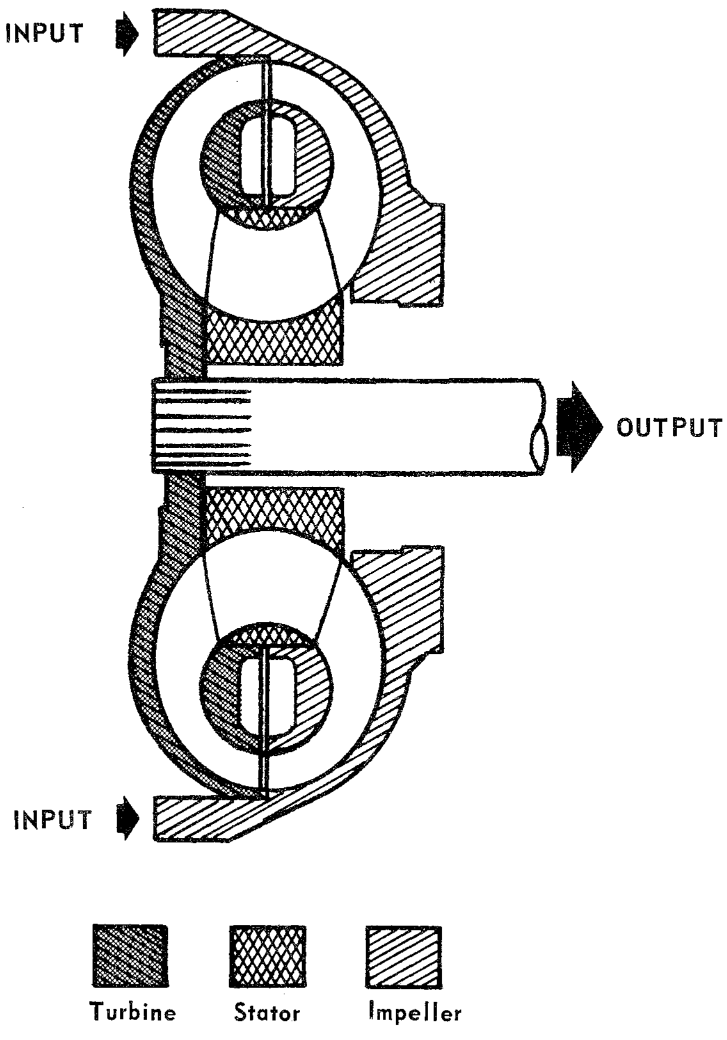

Fig. 4

This type of configuration is a typical "3-member, single stage" torque converter. Its three members are the impeller, turbine, and stator, and it is called single stage because within this type there is basically one flow pattern. Some torque converters contain multiple numbers of turbine(s) and stator(s) and thus would be called a higher number "stage". Staging corresponds directly to the torque multiplication ratio of a particular torque converter.

IMPELLER

The torque converter will be mounted in a drive line between the engine and transmission. The impeller of a torque converter will be connected to an engine and will be considered the driving member. (The turbine of a torque converter is called the driven member). As you can see in Figure 4 the three components combined appear as a large "donut", which contains oil or fluid for transmission of force (and rotation). The impeller section may appear as being mounted backwards, but must be in this configuration to enable installation of accessory drives from the engine through the torque converter, i.e., charge pump, hydraulic pump (See page 27). This compact three member "donut" performs the same function as our previous basic example.

The picture below shows a typical impeller from a modern torque converter.

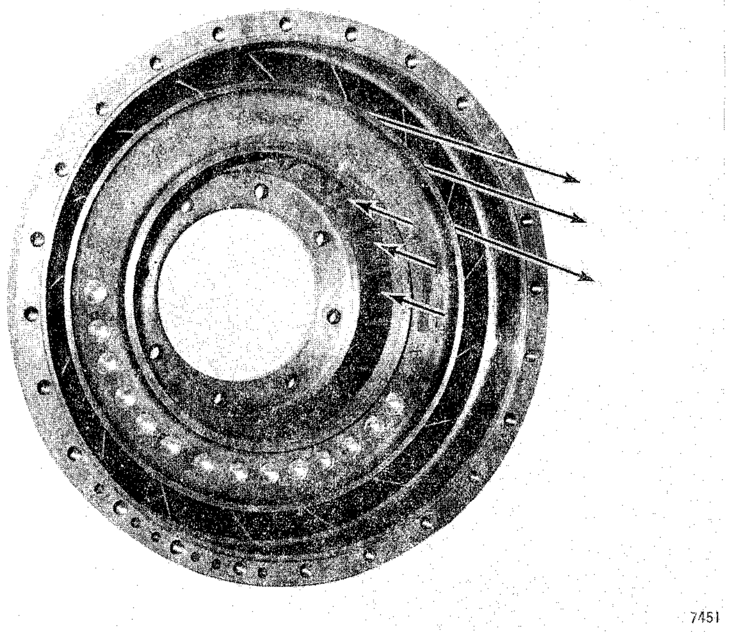

Fig. 5

When the engine and impeller rotate, centrifugal force of the impeller and each blade throws the oil from the inside diameter, between the blades and around the curvature, to the outer diameter of the impeller. At this point, the oil is then directed to the turbine member.

The pitch of the blades in the impeller determine the velocity of the fluid exiting the impeller. The higher the velocity of oil, the higher the force and inturn torque created. Variance of pitch is necessary in both impeller and turbine, in order for torque converters to be suited to different applications.

The diameter of the impeller must also correspond to the amount of power driving it. Too large or small a diameter can cause an inefficient transfer of power within the torque converter. Consequently this is why a torque converter <u>must</u> be engineered to be compatible with a particular power source.

TURBINE

The turbine from a modern torque converter is shown in the picture below.

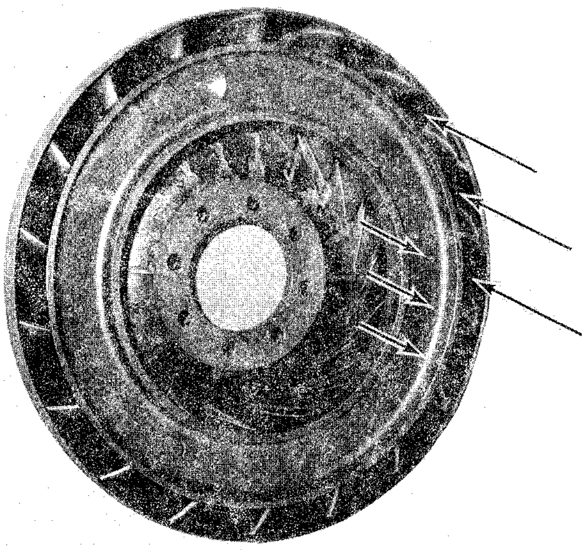

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Fig. 6

The oil flow discharged from the impeller discussed before is received by the outer diameter of the turbine. Since the velocity of the oil propelled by the impeller is very high, a force striking the blades of the turbine will cause it to rotate also. The oil within the turbine is then traveling from the outer diameter, between the blades and around the turbine curvature, and finally exits at the inner diameter.

It should be noted that there is no mechanical connection between the impeller and turbine of a torque converter. There is however, a fluid connection between these components. The force of the fluid from the impeller striking the turbine is the only reason for transmission of rotation.

Also, since there is only a fluid connection, the impeller and engine can be rotating and yet the turbine may not be rotating. In this instance, we call the torque converter in a "stall condition". Stall speed is the maximum speed (r.p.m.) of the impeller and engine when the turbine is fixed in place and not rotating. When a torque converter is in the above condition, the oil from the impeller is striking the turbine with the greatest force. Therefore, we can say that in the stall condition, the torque converter is creating the greatest torque multiplication.

In the other condition when the impeller and turbine are rotating together at the same speed, there is no torque multiplication -- only a 1 to 1 transfer of a torque as in a fluid coupling. This is simply because the fluid from the impeller is not striking the turbine with as much force -- only enough to maintain the turbine rotation.

STATOR

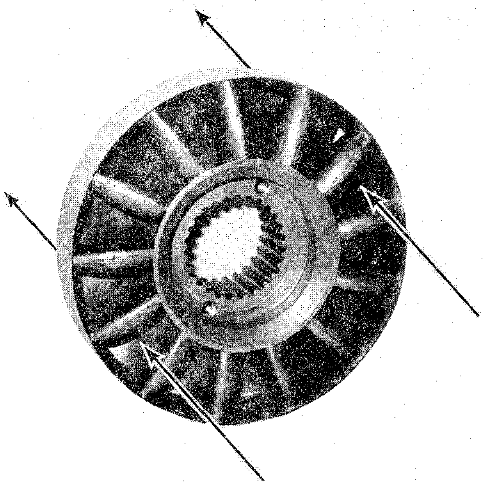

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Fig. 7

The stator is the reaction member of the modern torque converter. Its function is very much like the reaction member in our basic torque converter discussed previously. Once the fluid exits the turbine in the modern torque converter, (at the inner diameter) it enters the stator member. The stator member contains blades which re-direct the oil flow in such a manner as to aid the impeller's rotation. This member captures much of the lost energy of the fluid leaving the turbine. It then directs this energy to help the impeller rotate.

The stator in the modern torque converter is stationary and does not rotate with either impeller or turbine. This enables all of the fluid energy to be captured and used to initially start the turbine rotating. In this instance, the stator can be considered the torque multiplication member. However, when the turbine is rotating at near the same speed as the impeller, the stator will act as only a carrier of fluid since there is no torque multiplication occurring.

Thus, the oil within the torque converter will travel from impeller, to turbine, to stator, and finally return to the impeller again. The combined flow within these members is on page 8, Figure 8.

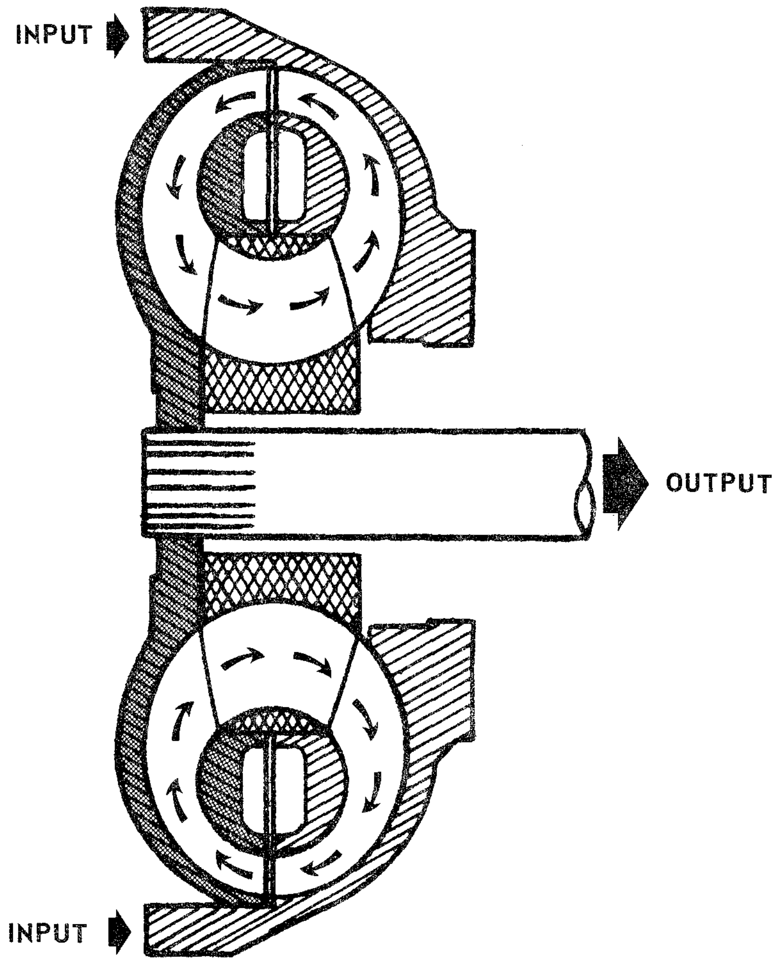


Fig. 8

In Summary:

A torque converter and its component members, impeller, turbine, and stator, provide a fluid connection within a drive line. Since there is no mechanical connection, such as the function of "clutch", there is the small tendency for slippage within the torque converter. This means that input vs. output efficiency and fuel economy will not be quite as high as with a mechanical connection (85% vs. 90%). However, for movement of heavy loads where a high output torque is required at start up, the torque converter has a definite advantage over a direct mechanical type connection (clutch). Multiplication of torque and the lack of wearing components in the torque converter allows for excellent transfer of power to initially start movement of heavy loads. Actually, one can think of torque converters as automatically supplying the correct torque ratio for any load. With a direct mechanical connection, correct torque ratios can only be obtained by selecting the proper gear ratios in a transmission. This is one advantage of the torque converter.

A second advantage to the torque converter over a direct mechanical connection is the lack of clutch plates to engage or disengage and in turn wear; there is only a fluid connection in the torque converter. The end product of a slipping clutch is burned out clutch plates. The end product of a slipping torque converter, such as in stall condition, is the shearing of oil between the impeller and turbine. This shearing action creates heat which is simply carried away and dissipated by the fluid at a cooler. This means that less maintenance and replacement of component parts are needed in a torque converter as opposed to direct mechanical connection.

However, it should be noted that a torque converter held in stall condition for an excessive period of time can cause damage. The excessive and rapid heat build-up within the torque converter can cause the oil to break-down in composition and in turn, lose its lubricating capabilities for other various components in a drive line. For this reason, a torque converter should have a temperature gauge to indicate this heat. As a rule, for every 1 second a torque converter is held in stall condition, the oil will increase 1 degree in temperature; therefore, we limit a stall condition to last no more than 30 seconds, in order to prevent component damage. Under normal operating conditions, the torque converter should operate within a heat range compatible with the system.

Another advantage to a torque converter over a direct mechanical connection is the elimination of shock loading to the drive line. Compensation for shock loading is provided since the oil between the impeller and turbine can "shear" as mentioned before. With a mechanical connection, shock loading cannot be compensated in any way and component damage within the drive line can result.

OUTPUT SHAFT GOVERNOR

An output shaft governor is a device used to regulate a constant output shaft speed of a torque converter. For varying loads of any type on an output shaft, the output shaft governor will indirectly (through the engine) speed up or slow down the input shaft to maintain the constant output shaft speed.

Simply stated, this device functions exactly the same as a "cruise control" in an automobile. The driver would determine a ground speed which he would desire to travel and would then use his cruise control to maintain this pre-determined speed. Should his automobile encounter an uphill on downhill grade, the output shaft governor will actuate the engine, faster or slower, to maintain that pre-determined speed.

COMPONENTS OF A SIMPLE OUTPUT SHAFT GOVERNOR

There are many different types and designs of output shaft governors available from various manufacturers. More complicated types employ electrical sensors, as well as others which employ tachometer drives with spinning balls. However, one of the most simple designs of an output shaft governor uses spinning weights, a spring, and actuating levers. This is the type which Galion employs on its powershift motor graders to obtain constant ground speed. Since all types of output shaft governors operate to produce a constant output shaft speed, we will only discuss the operation and function of the simplest type such as that used by Galion.

In Figure 9 we have a schematic drawing showing the components of a simple output shaft governor. This drawing is meant only to represent function and operation and not mechanical detail.

This type of output shaft governor is connected to the output shaft of the torque converter employed on Galion graders. As the impeller of the torque converter drives the turbine and output shaft, the spider and shaft assembly of the output shaft governor above rotates. The weights connected to this shaft are then subjected to the centrifugal force of the spinning. This means that as the output shaft rotates, these weights can pivot. We will designate these weights as either "falling in" or "falling out" depending on the speed of rotation and in turn centrifugal force.

Resting on the lever arm of each weight is a sliding sleeve which also rotates, but, more importantly, will move up and down depending on how much the weights fall in or out. The throttle control lever arm above the sliding sleeve can then be actuated indirectly by the shaft rotation, the weights falling in or out, and the sliding sleeve moving up or down. As the throttle control lever arm is actuated, the engine throttle (fuel pump) will actuate providing more or less fuel to the engine and in turn, regulate its speed in r.p.m.

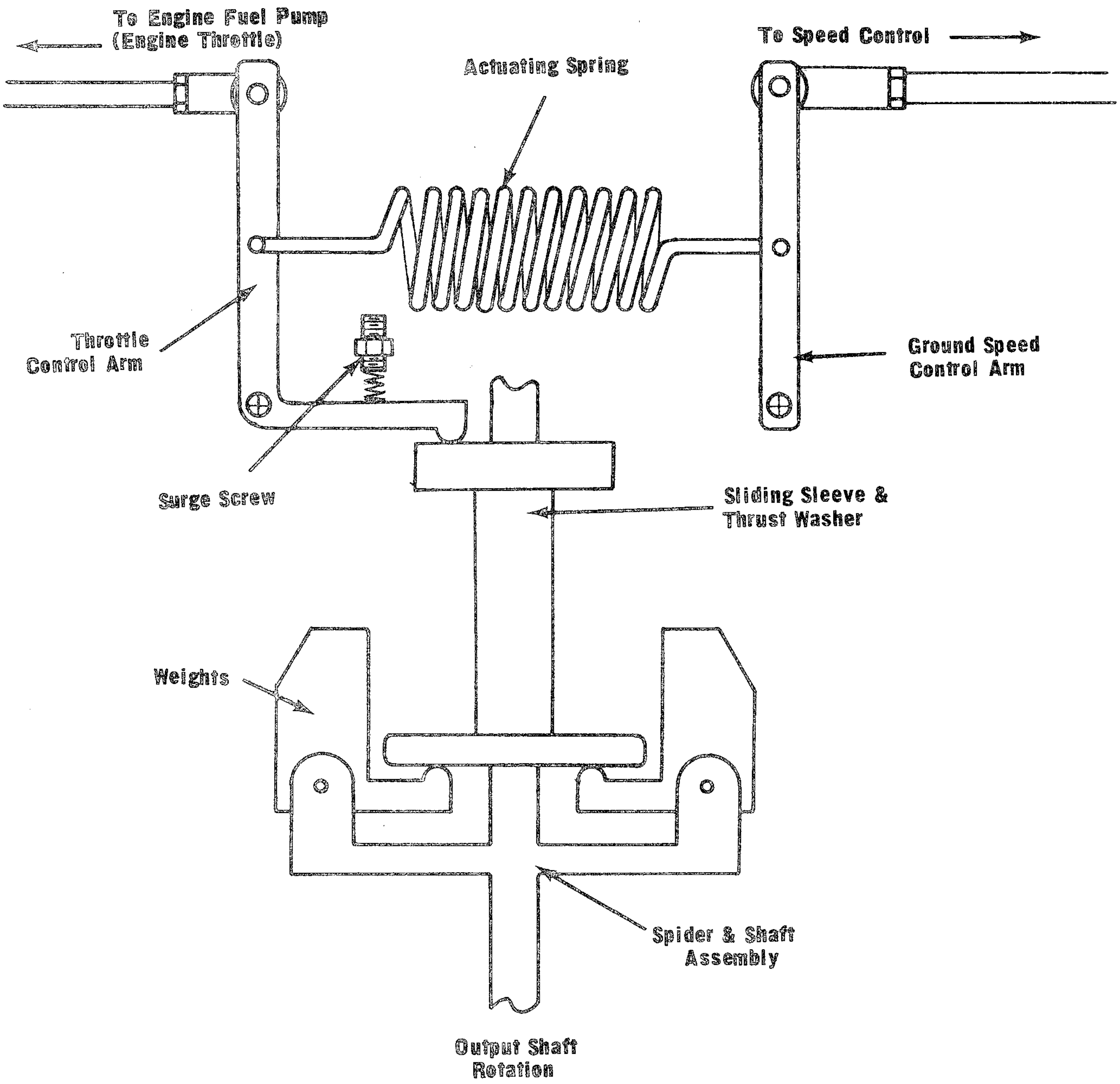


Fig. 9

The key to the output shaft governor is the actuating spring between the throttle control lever arm and the ground speed control arm. When the ground speed control lever is pulled, a spring tension is set. The combined action of the spinning weights must balance with the tension of the spring. The result of this balancing effect will be a constant output shaft speed.

Another important component in this simple output shaft governor is the surge screw and dampening spring. This eliminates the speed surging of the engine by dampening the action of the throttle control arm lever. Just as the shock absorbers in your car dampen the spring motion, the surge screw dampens the "fluttering" of the throttle control arm lever and in turn, the engine speed surging.

OPERATION OF THE SIMPLE OUTPUT SHAFT GOVERNOR

Let's assume that an output shaft governor has been installed in a motor grader with a torque converter and powershift transmission. In this case, as the wheels of the machine encounter loads, the output shaft and output shaft governor will also be affected. The following sequence of drawings and explanations show the operation of the output shaft governor.

1. When an operator desires to maintain an even ground speed, regardless of the load conditions on the moldboard, it is to his advantage to use the output shaft governor. In this case, let's suppose an operator has selected a gear ratio in his transmission and has selected 2 mph with his ground speed control lever. Let's assume his machine is in the configuration below with material windrowing from the blade.

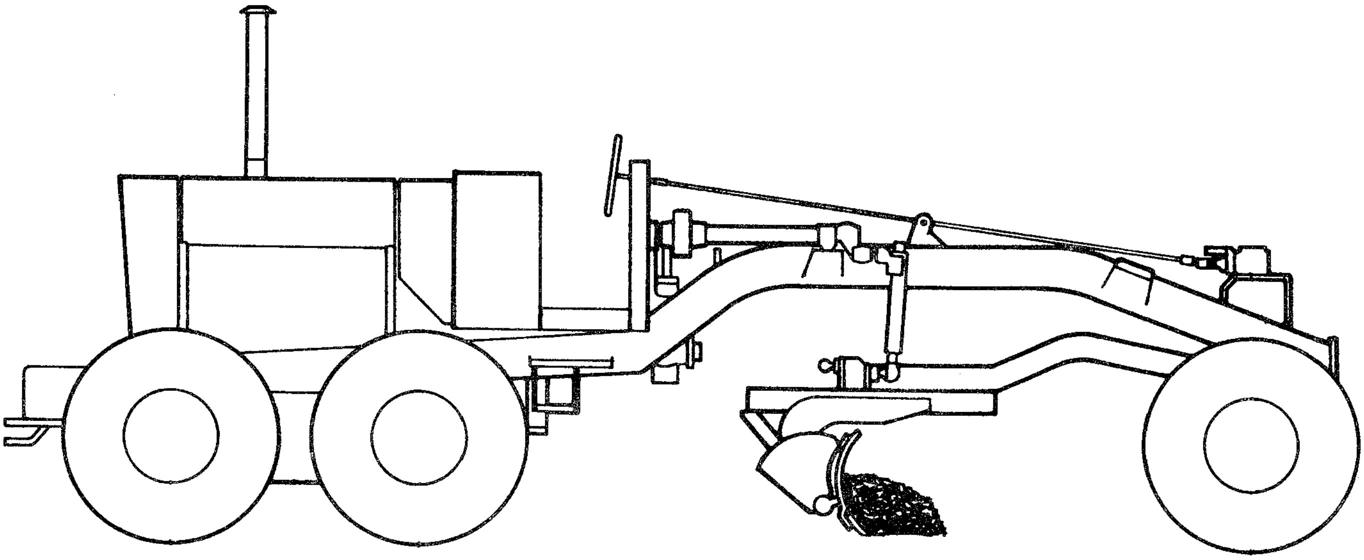


Fig. 10

With the machine engaged in gear and his speed control lever set, the operator needs only to be concerned with his blade controls. In the condition as above with "even" loading of the blade taking place, the output shaft governor will have its weights as in figure 11.

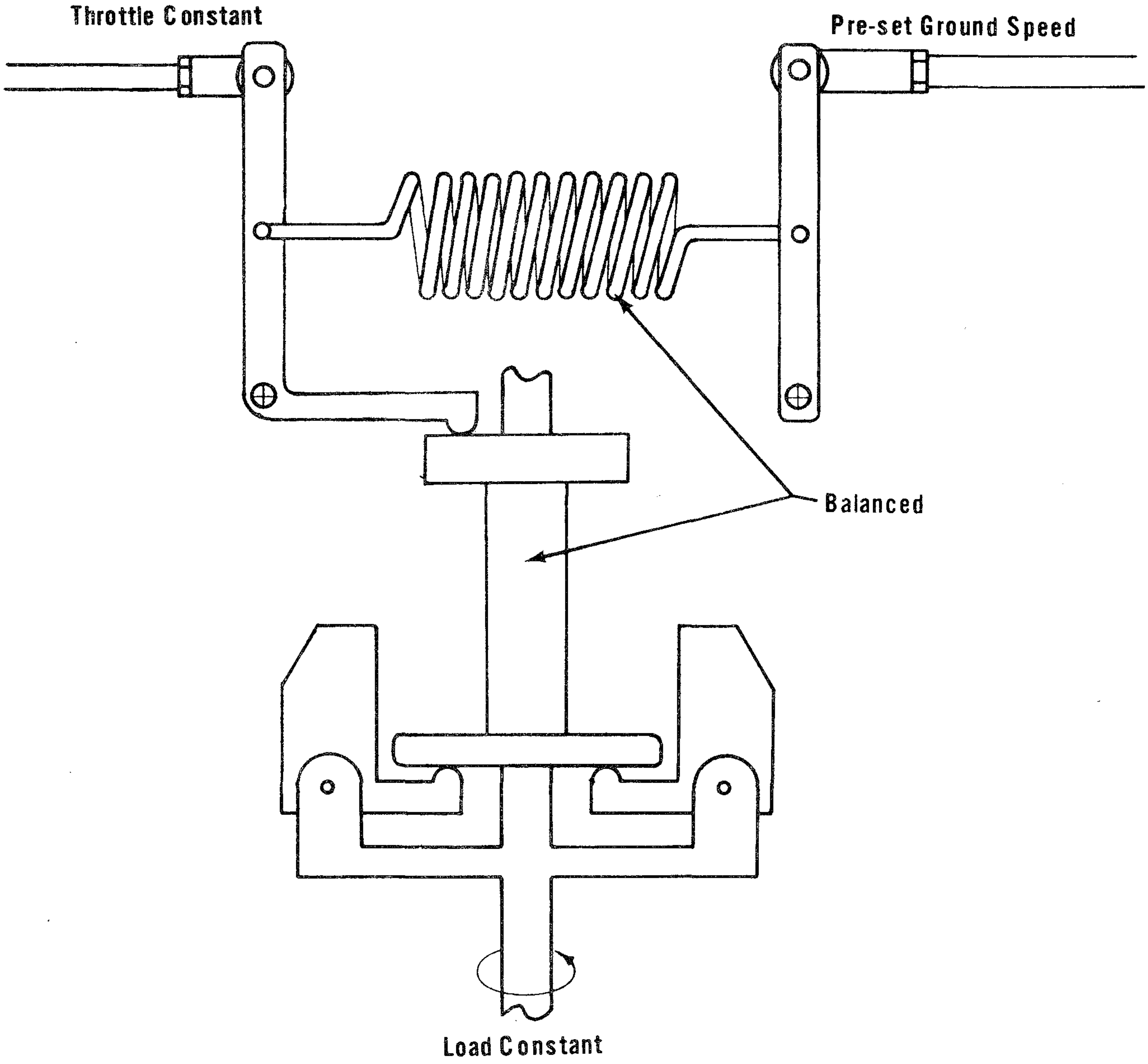


Fig. 11

When the operator sets his speed control lever for the desired speed in a particular gear, he has actually created a tension on the actuating spring. This spring tension causes the throttle control arm to move and the engine to raise in speed (r.p.m.). As the engine picks up speed, output is transmitted through the torque converter. Since the output shaft governor is connected to the output shaft of the torque converter, the weights of the output shaft governor will also rotate. As these weights rotate, the centrifugal force will cause the weights to "fall out" and thus raise the sliding sleeve against the throttle control lever arm. When the weights have fallen out to a midpoint position, the spring tension and the centrifugal force of the spinning weights will <u>balance</u>. It is this configuration that the output shaft (and grader) are meeting <u>constant</u> load conditions. And since there is constant load, the engine speed <u>will also</u> remain <u>constant</u>.

2. However, Let's assume now that the motor grader in our previous example encounters a heavier load as shown below:

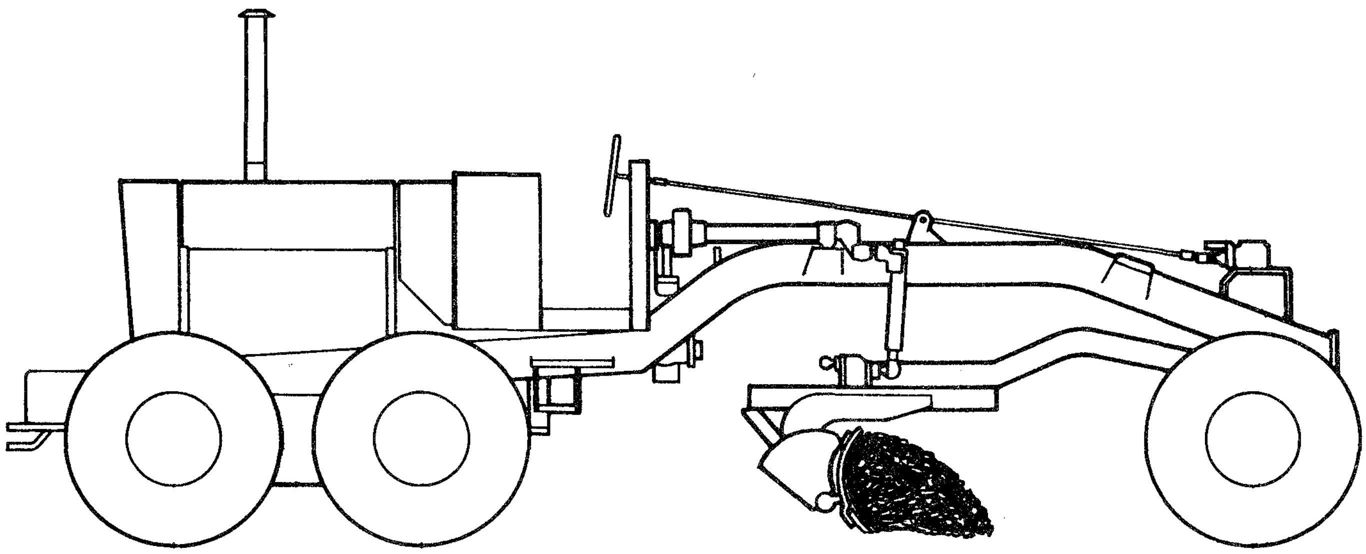


Fig. 12

In order for the grader to maintain a constant ground speed, the engine must raise in rpm and horsepower to drive the machine through the load. This is precisely the function of the output shaft governor.

Immediately as the grader slows down in ground speed, the output shaft governor's weights begin to "fall in" as in figure 13.

Actually the weights fall in because the spider and shaft assembly of the governor has slowed in rotation. As the weights fall in, the actuating spring is allowed to pull the engine throttle control arm, and in turn, calling for more fuel at the engine. It should be noted that the actuating spring will pull the throttle linkage only as far as the weights have fallen in. In fact, should the wheels of the machine stop completely, and the output shaft, then the weights will have fallen in completely. This would then allow the actuating spring to pull the throttle linkage to "full fuel" position in order to counteract the load.

In the above example where the output shaft has completely stopped and the weights have fallen in completely, the engine and torque converter will be put in a "stall" condition. The engine will be in "full fuel" and full speed position while there is no output shaft rotation. Due to the principles of a torque converter, the greatest amount of torque will be produced at this point to overcome the load.

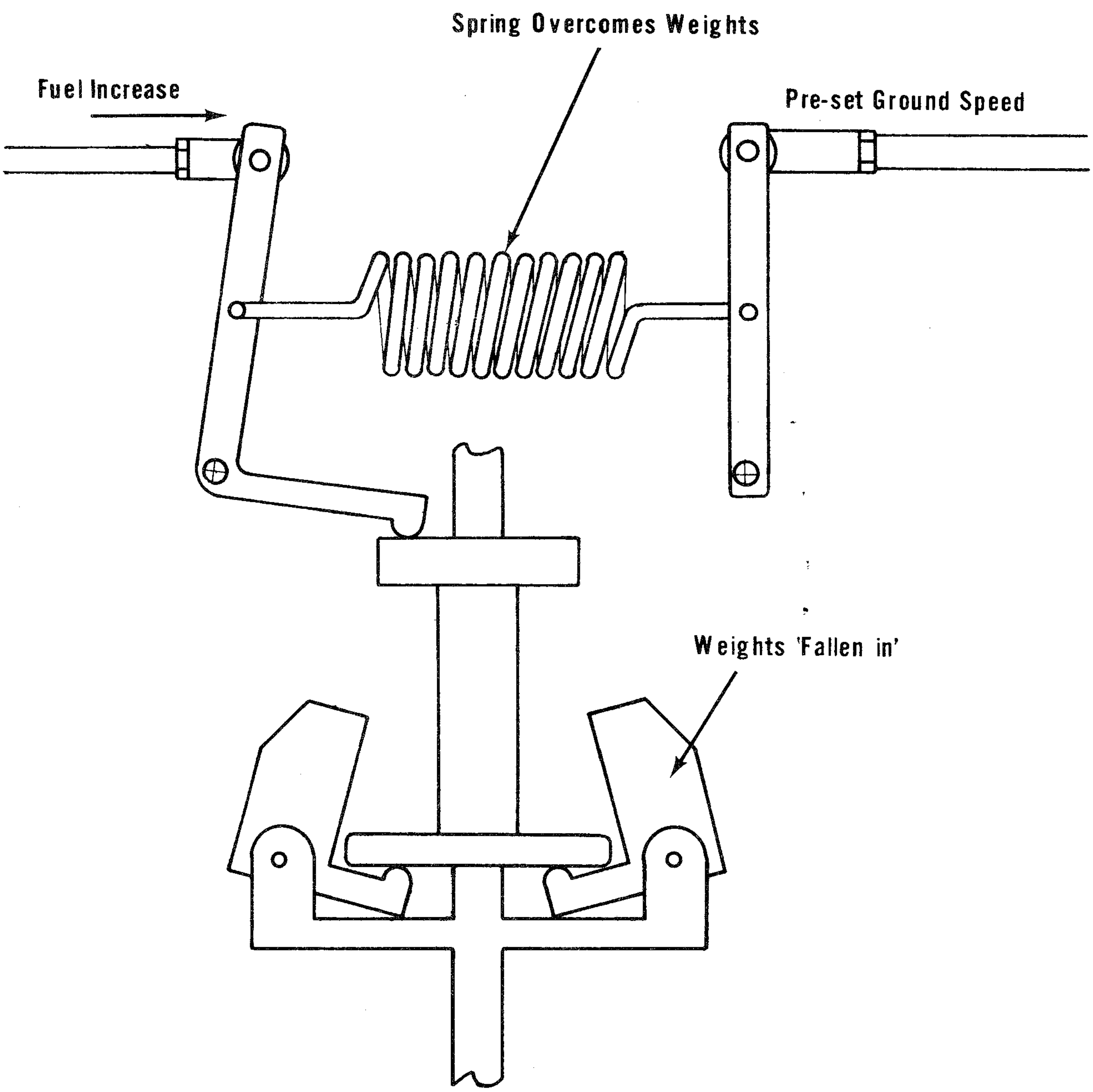


Fig. 13

The balancing effect between the spinning weights (and centrifugal force) and the actuating spring tension regulates the fueling of the engine in such a manner that the output torque and horsepower requirements are always perfectly matched to particular load conditions. To the operator, this means that he no longer has to manually adjust his throttle for an increased load. Therefore, he can direct his attention to other functions as may be required.

3. Let's assume now that the motor grader encounters less load after the previous heavier load condition. In this case the grader will be in the condition as depicted below:

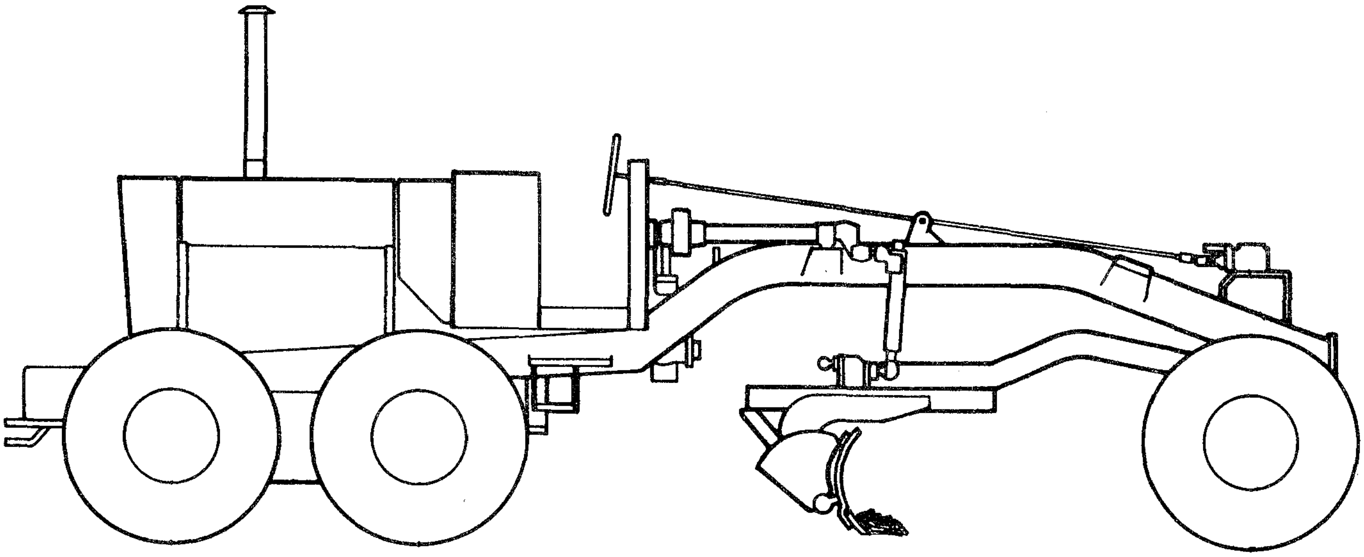


Fig. 14

When the grader passes from the heavier load discussed previously to a lighter load, the engine speed must be reduced. Otherwise the increased engine speed will increase the ground speed since less load is encountered. The following drawing shows the condition of the output shaft governor immediately after the grader has passed through the heavier load and into a light load.

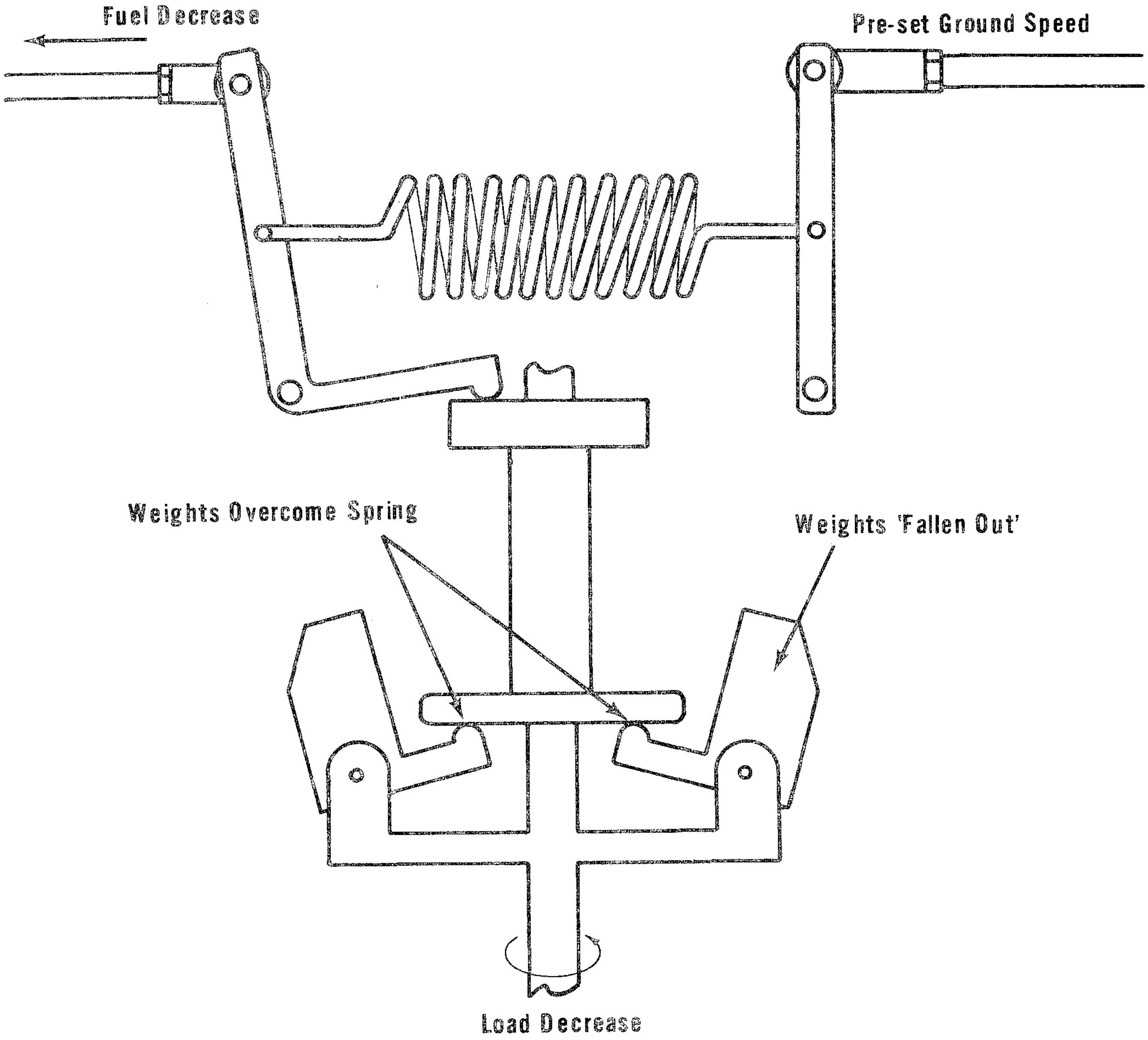


Fig. 15

As you can see the increased speed of the output shaft and machine has caused the weights of the governor to fall out. Here the centrifugal force of the weights has overcome the tension of the actuating spring, and, through the sliding sleeve, has moved the throttle linkage to slow the engine down. The governor has really sensed the load condition on the output shaft and in turn decreased the fueling to the engine. As a result, the engine will decrease in speed but the ground speed will remain constant.

In Summary:

The functioning of the output shaft governor can be summarized in three statements.

A) When the speed control lever has been set, the governor actuating spring tension has also been set. The speed of the output shaft and governor weights must balance with the tension of the actuating spring. This balancing affect is the means by which the output shaft speed in relation to engine speed is regulated.

B) Should the load condition on the output shaft (and machine) increase, then the output shaft will decrease in speed and cause the governor weights to "fall in". This means the tension on the actuating spring will overcome the centrifugal force of the spinning weights. When this takes place, the actuating spring will move the throttle linkage to increase fueling to the engine and thus engine speed. Thus, the governor will balance the engine speed and horsepower to the increased load in order to maintain the pre-set constant ground speed desired.

C) Should the load condition on the output shaft (and machine) decrease, then the output shaft will increase in speed and cause the governor weights to "fall out". This means the centrifugal force of the spinning weights will overcome the tension on the actuating spring. When this takes place, the lever arms of the weights will move the throttle linkage to decrease fueling to the engine and thus engine speed. Here the governor will reduce engine speed and horsepower to balance with the decreased load condition. The end result will be a constant ground speed even though the load condition has varied.

The drawing below shows the combined operation of the output shaft governor during varying load conditions. It should be noted that any particular constant ground speed is attained by setting more or less tension on the actuating spring.

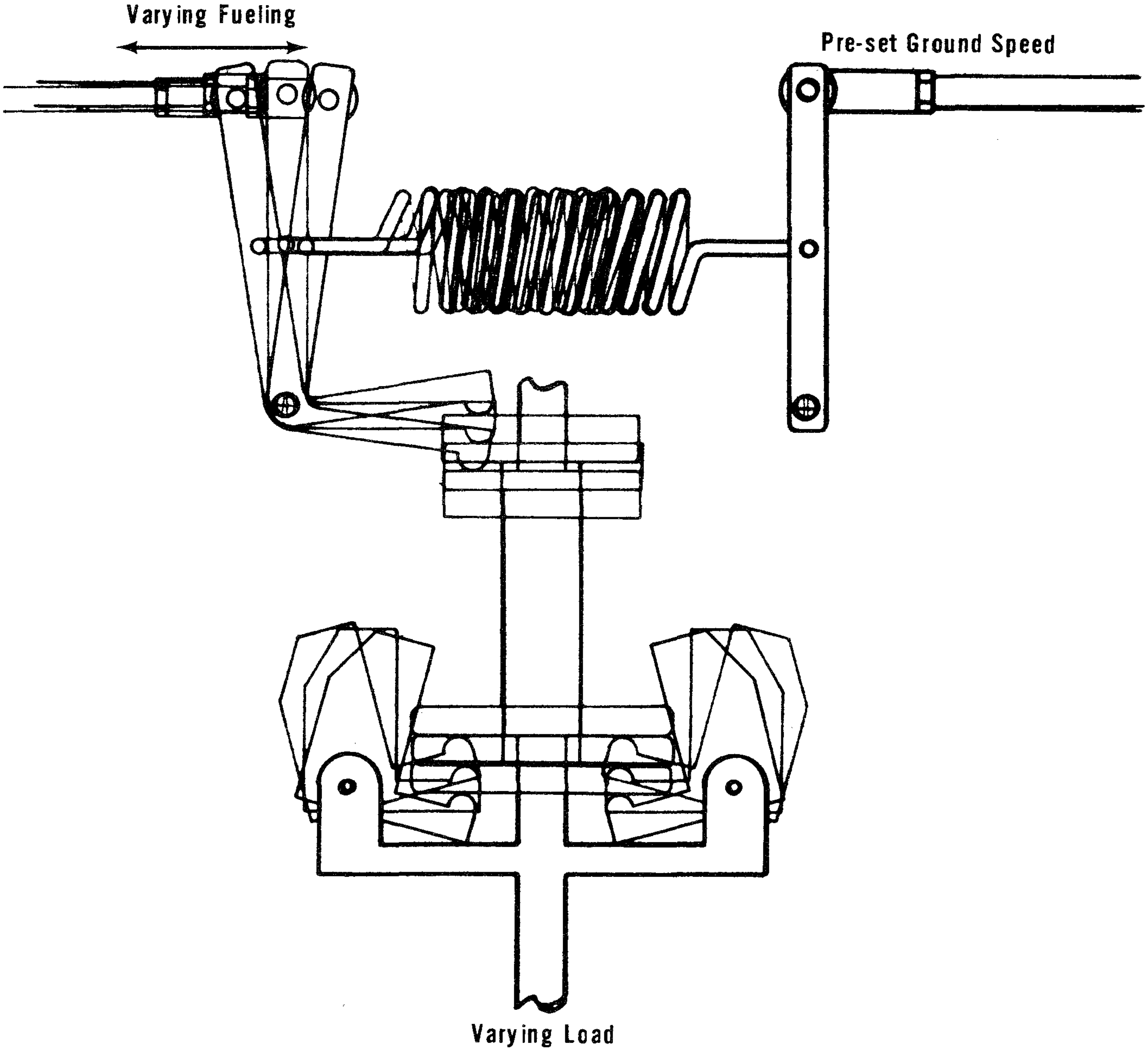


Fig. 16

PROPER OPERATION WITH AN OUTPUT SHAFT GOVERNOR

Since the ground speed control lever in the operator's compartment is not directly connected to the engine fuel pump, it is therefore not an engine hand throttle. Nor can it be considered one. It is merely a ground speed control selector. The operator sets the control lever to the desired speed and then the output shaft governor, in turn, controls the fuel pump which supplies just sufficient fuel to the engine to obtain that speed. If the operator would pull his speed control lever back to a full speed position, the output shaft governor would, in turn, put the engine fuel pump in a full position and no fluctuation of engine speed or governor action could be expected. In this condition, fuel consumption will be relatively high since the engine is at a quite high r.p.m.

Let's assume the following road speeds can be obtained at full governed engine speed:

Gear	Ground Speed/Low Idle	Ground Speed/High Idle
1st	1.0 mph	3.5 mph
2nd	2.5 mph	6.5 mph

If an operator desires to maintain roads or spread fill at 3.5 mph, then it would be improper operation to operate the machine in first gear with the ground speed control in the full position. Fuel consumption would be relatively high, and, perhaps more importantly, the engine would not have a "reserve" in speed to pull through a heavier load. In this case the output shaft governor would be of little benefit to the operator.

Proper operation would be to select second gear and then set the ground speed control to approximately one-third of full position to obtain 3.5 mph. In this position, the combination of the output shaft governor and torque converter will automatically select the most effective engine speed and drive ratio regardless of load conditions imposed upon the machine. Engine horsepower and speed can be automatically balanced with the varying load conditions due to the "reserve" engine rpm available for use by the governor. For instance, any time the motor grader incurs a load which tends to slow it down, the output shaft governor will immediately bring up the engine speed to the necessary power requirements to maintain the pre-set constant ground speed.

DECELERATOR

The output shaft governor action can be "overruled" by the decelerator. A pedal is provided in the operator's compartment to override the governor and manually regulate fueling of the engine. When the decelerator is depressed, the output shaft governor senses the output shaft slowing and in turn actuates the throttle control linkage at the governor for more fuel at the engine. However, the governor is "tricked" through the use of a split shaft linkage and spring assembly incorporated in the throttle linkage between the fuel pump and governor. This allows for the governor to call for more fuel and faster engine speed while the decelerator manually controls fueling of the engine.

The use of the decelerator is very important whenever braking a machine with an output shaft governor. One must remember that applying the brakes on a machine equipped with an output shaft governor is the same as applying a load to the output shaft. For this reason it is extremely important to decelerate the machine prior to applying the brakes. If the brakes were applied, without the use of the decelerator, the output shaft governor would sense the load. The increased engine speed would therefore drive the machine through the brakes.

Moreover, the use of the decelerator allows the operator to have a manual control of his ground speed if he so desires. In this instance, he could control his speed by setting his speed control lever to any position and use his decelerator to obtain manually any ground speed below that lever position. However, the operator will have an easier time controlling his blade functions if the fueling to the engine is done automatically.

One other important use of the decelerator is "inching" the machine. With the use of the decelerator, the operator can actually motivate his machine at a speed slower than the lowest setting speed for the output shaft governor. This means that he can "inch" his machine in close quarters, for example, with the decelerator rather than slipping a clutch as in the case of a direct drive type machine.

POWERSHIFT TRANSMISSIONS

The "automatic" transmission in an automobile consists of really two independent sections. The first section is a torque converter connected to the engine. The output of the torque converter (turbine) is then connected to a second section. This second section enables various gear ratios and forward and reverse directions. The selecting of gear and direction within this section of the transmission is done in most cases by hydraulic shifting. Through various design features, the transmission is shifted hydraulically to accomplish the proper selection of a gear ratio for a given engine speed and/or throttle setting. Since hydraulic shifting of gears takes place within this second section, we call this portion the "powershift" section of the "automatic transmission".

There are many different designs of powershift transmissions both for automotive and heavy equipment uses. For instance, the automatic transmission used in various automobiles contains planetary gears for selection of gear ratios as shown below.

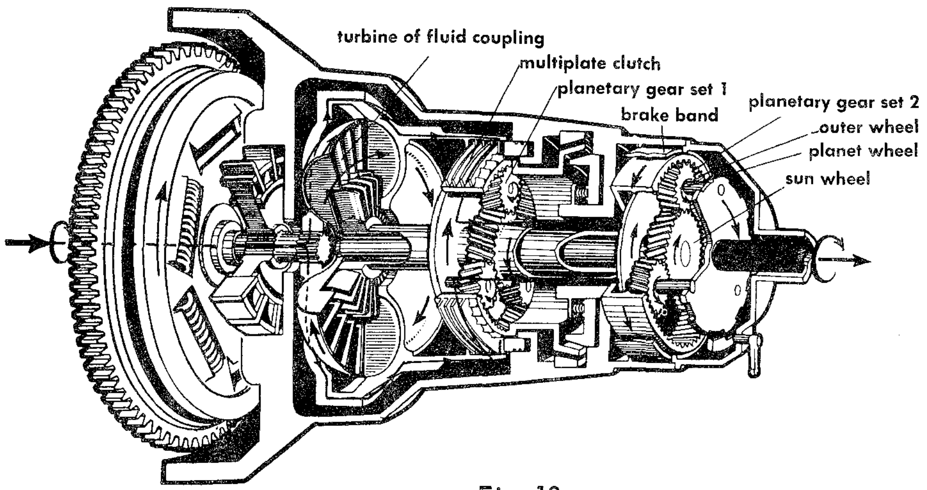


Fig. 18

HYDRA-MATIC TRANSMISSION

As you can see, the transmission of force is effected in the mechanical part by means of planetary gear sets. By the use of brake bands or multiplate clutches, any of the three components of each planetary gear set, sun gear, planet gears and carrier, and ring gear, can be locked to the housing of the transmission. The "locking" technique of planetary gears accomplishes various gear ratios and directions of rotation as shown below.

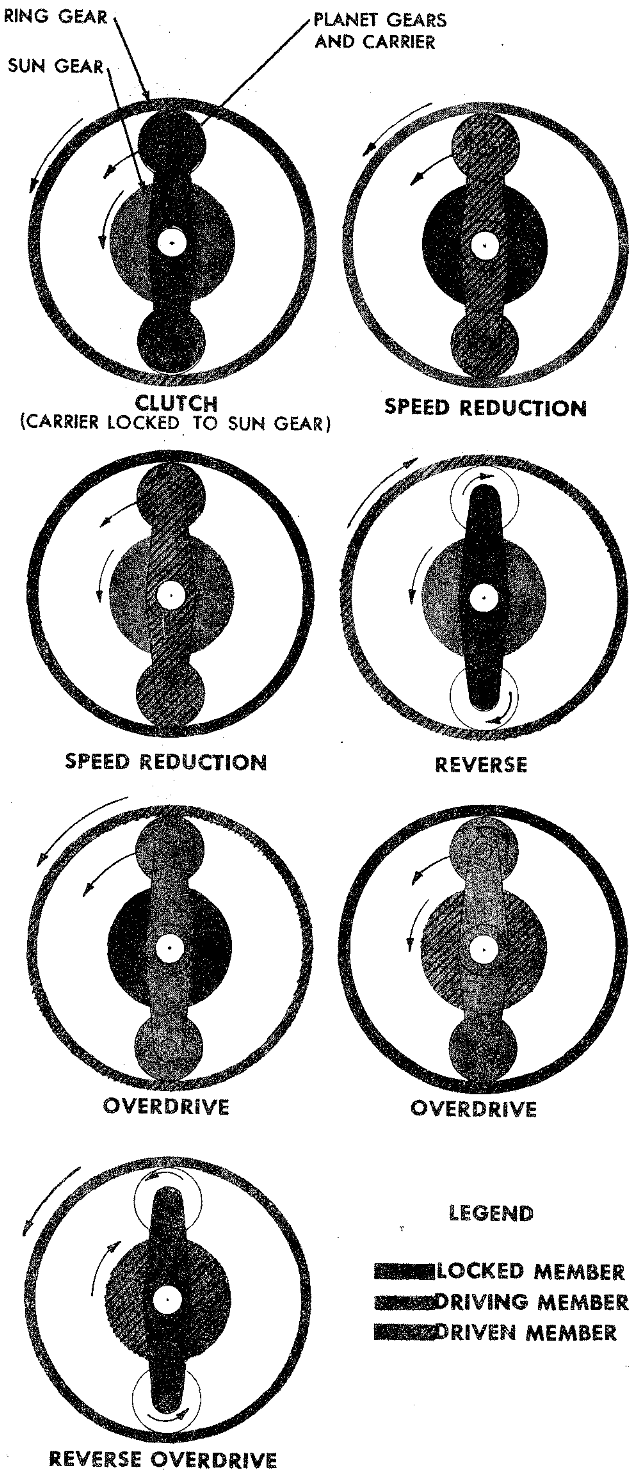


Fig. 19

PLANETARY GEARING

Under certain circumstances the brake bands used to lock the components of the planetary gears lose their holding capability. In this case, we many times hear the terminology, "tightening the bands", to eliminate the problem of a slipping transmission.

In other designs of transmissions, mini-clutches are used to enable gear ratio changes. Some transmissions even use a combination of brake bands and mini-clutches with planetary gears. However, most heavy equipment "powershift" transmissions employ "clutch packs". These clutch packs function hydraulically to engage or disengage one gear to another. One basic drawing of a common type clutch pack is shown below.

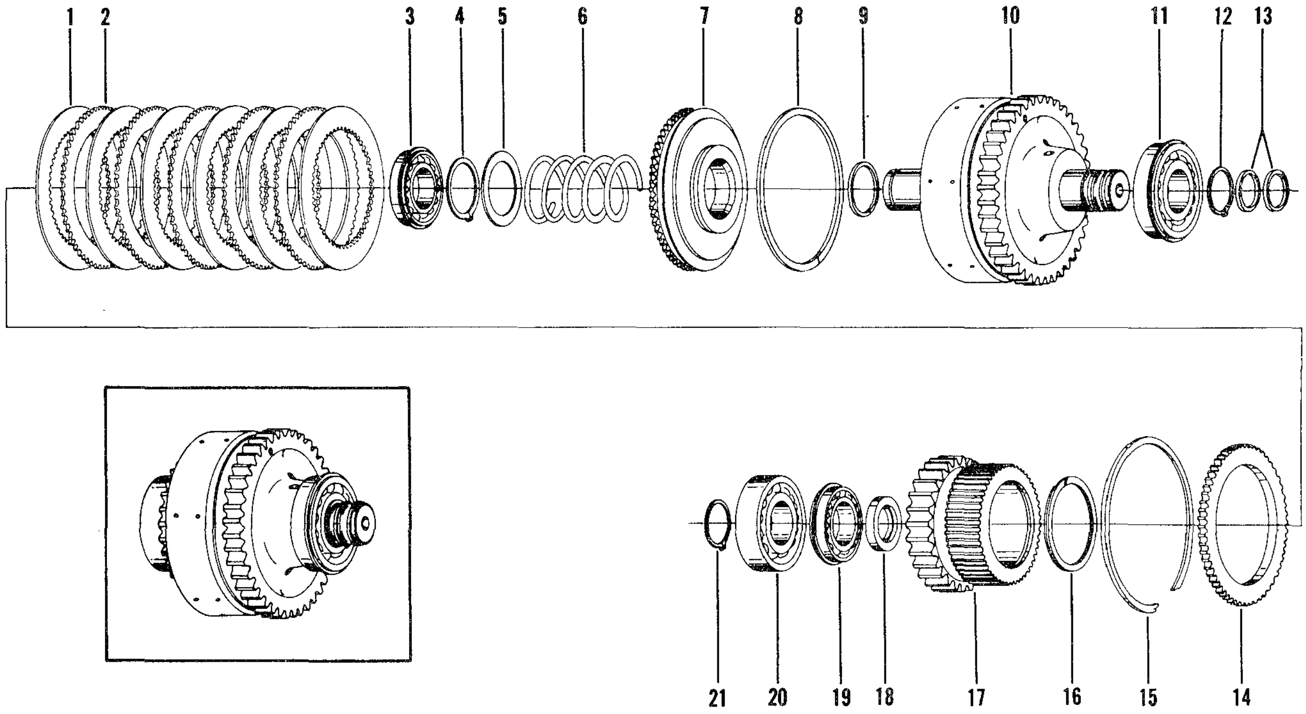


Fig. 20

CLUTCH PACK

As you can see, one side of the clutch pack consists of a drum (10) with one gear and shaft connected to it. The other side of the clutch pack consists of an internal hub (17) which fits into the drum of the other side. Hydraulic pressure actuates a piston (7), against clutch plates (1 & 2) and back-up plate (14), to engage both sides of the clutch pack together. This means that when a clutch pack is "pressurized", it is engaged and thus locking the gear of each side together. The gears of the clutch pack will rotate together and a gear ratio will be accomplished according to the size of these gears. Actually, one can think of the clutch pack as a "hydraulic shifting collar" as in a manual transmission.

On the other hand, when the clutch pack is not "pressurized", the two sides are disengaged. This allows the two gears to rotate freely, at different speeds, or even in opposite directions. Moreover, one gear or the other, but not both at the same time, can transmit output and rotation from other clutch packs within the transmission.

Transmissions contain various numbers of clutch packs depending on the speed ranges needed for the particular application. One typical arrangement of clutch packs within a transmission is shown below.

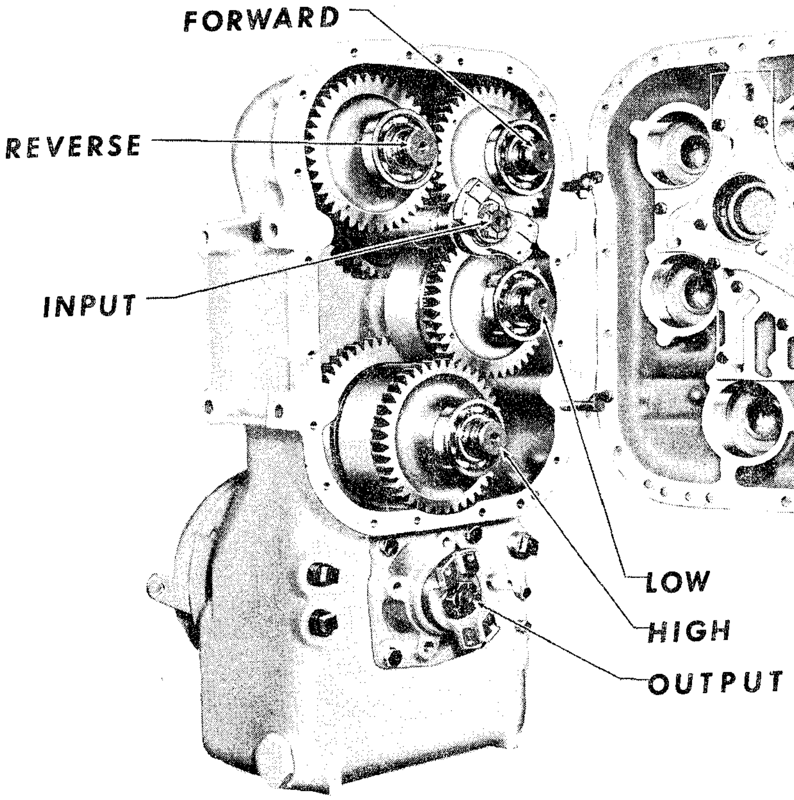


Fig. 21

POWERSHIFT TRANSMISSION

It is important to note that with the use of a torque converter in conjunction with a powershift transmission, the need for a manual "foot operated" clutch is eliminated. Due to the ability of a torque converter to "slip" and the hydraulic actuation of the powershift transmission, an operator of either an automobile or heavy equipment need not depress a clutch pedal to change gear ratios. In the heavy equipment application, changing of gears only requires movement of a shift lever. In an automobile shifting is accomplished automatically through the use of a load regulator and centrifugal governor without any action on the part of the operator.

THE 2420 SERIES TRANSMISSION, C-273 TORQUE CONVERTER DRIVE LINE

The 2420 Series transmission is employed by Galion in all of its T-model motor graders except the T-600 Series B. This transmission is therefore used in the T-400A, the T-500A, and the T-500L. In conjunction with this transmission, the C-273 torque converter is used. This torque converter is mounted directly to the engine and is connected by a propeller shaft to the 2420 transmission. The output from the transmission is then directed to the final drive unit by way of another propeller shaft. The combined drive line configuration enables any one component, either torque converter, transmission, or final drive, to be removed from the machine separately. This type of arrangement allows for easy repair or replacement without effecting other drive line components.

Another important component of this type of drive line is the output shaft governor coupled to the rear of the C-273 torque converter. This governor is designed to allow the operator to maintain his machine at a pre-set constant ground speed automatically. With the use of this output shaft governor, the operator will be able to perform his blade functions more precisely as well as the motivation of the machine itself.

Galion Series A hydraulic cranes also employ the 2420 Series transmission in conjunction with the C-273 torque converter. However, this drive line differs from that of the grader in a few instances. For example, the Series A hydraulic crane with the C-273 torque converter does not have an output shaft governor. In the crane application it is not desirable to maintain any constant ground speed as in the grader application. For this reason only an accelerator is provided. Also, the 2420 transmission employed in the crane has a dual output shaft for four wheel drive. The front output shaft of this transmission has a mechanical disconnect to provide the operator with the option of two or four wheel drive.

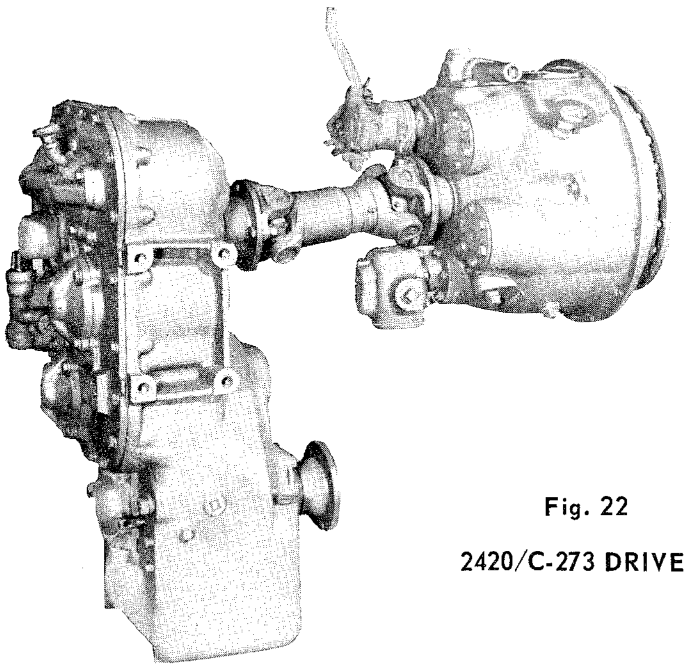


Fig. 22

2420/C-273 DRIVE LINE

C-273 TORQUE CONVERTER

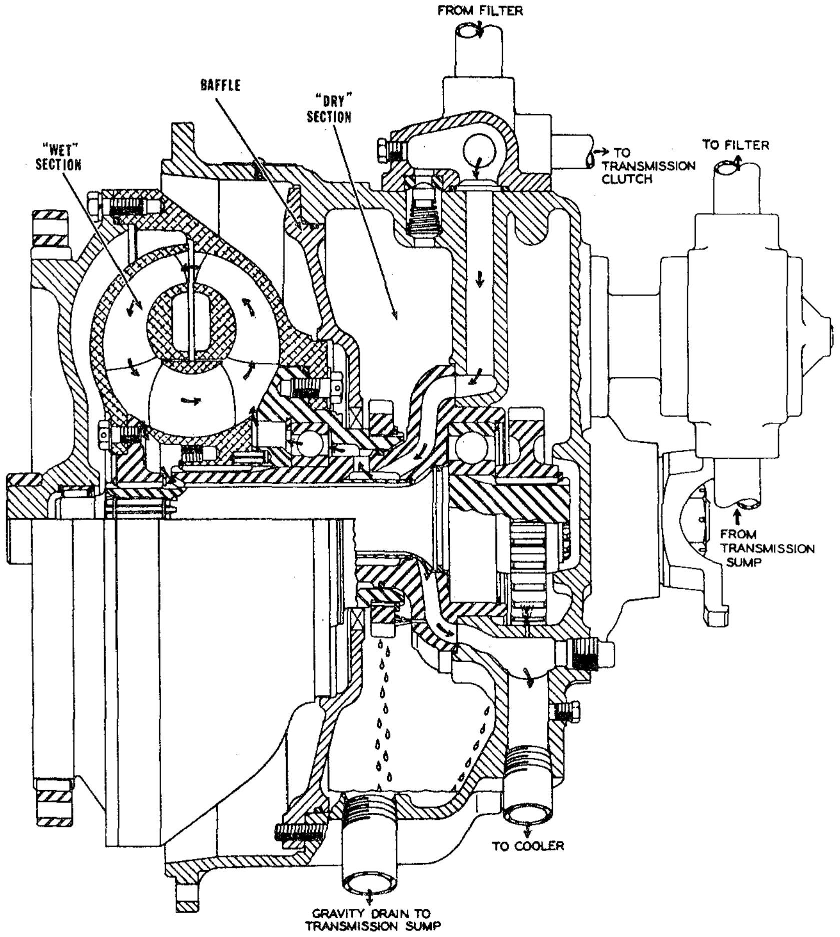


Fig. 23

The torque converter used in conjunction with the 2420 series powershift transmission functions in the same manner as the modern torque converter discussed previously. The main components of the C-273 torque converter are:

1. The impeller, which is directly connected to the engine and throws oil to the turbine.

2. The turbine, which is connected to the output shaft and receives oil from the impeller.

3. The stator, which is splined to the housing and receives oil from the turbine and redirects it to the impeller again.

Each of these components are designed to provide high torque multiplication at low output/high input speeds, and, fluid coupling effect when input and output speeds are the same. For this reason, this type of torque converter is especially suited for a grader or crane application where heavy loads must be moved.

Coupled to the impeller of this torque converter is a set of accessory gears. These gears enable installation of the hydraulic pump and torque converter charge pump to the rear of the converter. Being geared to the impeller, and the impeller directly connected to the engine, enables these pumps to always produce a flow of oil as long as the engine is turning. (The crane application has only the converter charge pump installed here. The hydraulic tandem pump is connected to the crankshaft of the engine.)

The torque converter charge pump is used (1) to hydraulically actuate the clutch packs within the 2420 transmission, (2) to provide a lubrication flow of oil to the torque converter and transmission components, and (3) to "charge" the members of the torque converter with a sufficient amount of oil to allow proper operation of the unit. The charge pump is a simple gear type pump and produces a flow rate of 8 gpm per 1000 rpm.

Coupled to the turbine and output shaft of the torque converter is another set of accessory gears. In the application of the grader, an output shaft governor is installed here. The governor can then act as a load sensing device since it is directly geared to the output shaft. In the crane application, the output shaft governor is not needed since regulation of constant ground speed is not needed. For this reason, there is no idler gear installed. Also, since the crane tandem hydraulic pump is mounted on the crankshaft, the idler gear for a hydraulic pump is not needed and is therefore eliminated.

Many times the interior of this torque converter is named by the "wet" section and the "dry" section. The "wet" section is referred to as the portion of the torque converter containing the impeller, turbine, and stator since it contains a large amount of fluid for transmission of rotation.

The "dry" section of the torque converter is the area of the interior containing the accessory drive gears for both impeller and turbine. Although this area is not dry in the true sense of the word, we call it dry in relation to the other section containing considerably more fluid. The oil within the dry section is used only for lubrication of gears, shafts, and bearings. The "wet" and "dry" sections are completely separated by the baffle as shown in figure 23.

Mounted at the top of the C-273 torque converter, when in conjunction with the 2420 series transmission, is a device called the regulating valve. This valve is used to maintain pressure for clutch pack activation as well as provide a safety for excessive flow from the charge pump. The particular function and operation of the regulating valve will be discussed in depth at a later time in this manual.

THE 2420 SERIES TRANSMISSION

The 2420 Series transmission is a constant mesh power shifted forward, reverse, high and low with a mechanical range shift between travel and working speeds. This provides four speeds in either forward or reverse.

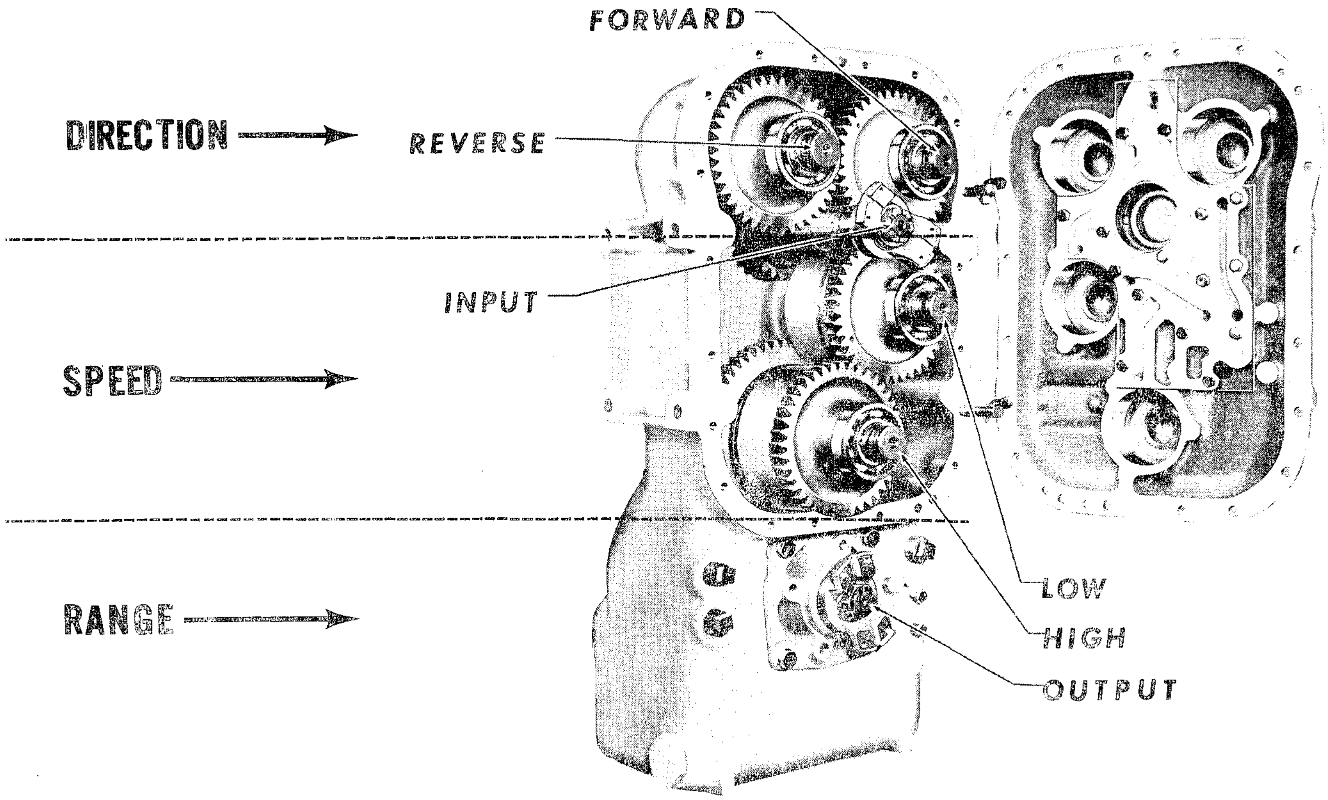


Fig. 24

Actually one can think of this transmission having three separate shifting sections. The first section provides selection of the direction of travel -- either forward or reverse. Two clutch packs within the upper case enable this function. To obtain reverse direction, the "reverse" clutch pack is pressurized and is engaged while the "forward" is not pressurized and is disengaged. On the other hand, forward direction of travel is obtained by pressurizing and engaging the "forward" clutch pack while the reverse is disengaged. Actuation of these clutch packs and the corresponding direction of travel is controlled in the operator's compartment by one forward/ reverse control lever. Movement of this lever to the forward position engages the transmission in the forward direction. Movement of this lever to the reverse position engages the transmission in the reverse direction. When this lever is centered, a "neutral" condition exists within the transmission and no power flow is going through either forward or reverse clutch pack. A "neutral start" safety switch is provided on this control for starting the machine.

The second section of the transmission contains two more clutch packs for selection of low or high speed. We will designate these clutch packs as "low" or "first" clutch pack or "high" or "second" clutch pack. In the operator's compartment another single control lever is used to actuate these two clutch packs. For instance, when the control lever is moved to the "low" position, the "low" clutch pack is pressurized and engaged while the "high" is not pressurized and is disengaged. When the control lever is moved to the "high" position, the "high" clutch pack is pressurized and engaged while the "low" is not pressurized and is disengaged. As with the forward/reverse clutch, a neutral position is provided where neither clutch pack is engaged.

These two clutch packs can be engaged and disengaged while a machine is moving. This provides for powershifting "on-the-go" from "low" to "high" or "high" to "low" speeds.

Each of the four clutch packs discussed above have basically the same components in each. In fact, the forward, reverse, and low clutch packs are identical in every respect. However, the high clutch pack differs from these three only in a different hub arrangement. All of these clutch packs can be serviced or removed from the case with the transmission installed in the machine. It is only necessary to remove the large case cover plate for access to these clutch packs.

The third section of the 2420 transmission located at the bottom of the case, contains a mechanical range shift. This range shift is accomplished through a shift collar and is not power shifted with clutch packs. To change ranges, the machine must be stopped and the forward/reverse or low/high control lever put into neutral position. Although "on-the-go" shifting is not provided between the mechanical ranges, the "low" and "high" clutch packs enable powershifting in either the working range (low range) or the traveling range (high range).

A lever is provided in the operator's compartment for this range change. Movement of this lever corresponds with the range. A neutral position is also obtained with this lever centered between high and low.

It is important to note that there is one control lever for each "section" of the 2420 transmission. Each lever must be engaged in a direction, speed, or range to cause motivation of the machine. If any one lever is in neutral the entire transmission is in neutral. Also, machines with this transmission can only be started when the forward/reverse control is in the neutral position due to the safety start switch incorporated.

The engagement within the transmission and the positions of the shifting control levers is shown in figure 25 for each gear ratio. Note that each drawing shows a dual output shaft and disconnect. This disconnect is only applicable to the hydraulic crane where four wheel drive (and two wheel when disconnected) is desirable. This disconnect is controlled by a lever in the operator's compartment. Changing from two wheel drive to four wheel drive (or vice versa) must be done with the machine stopped. Consult the machine's operator's manual for specific instructions.

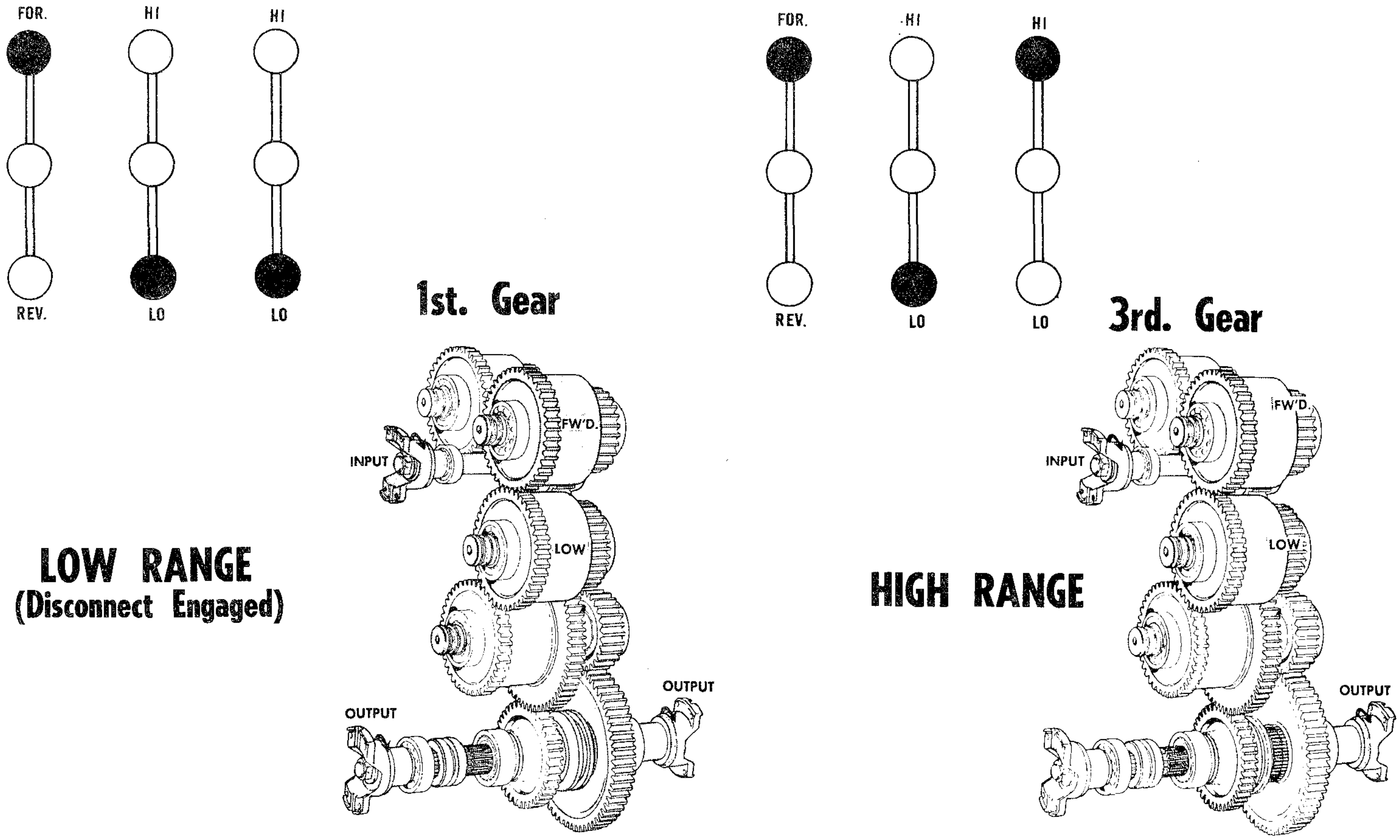
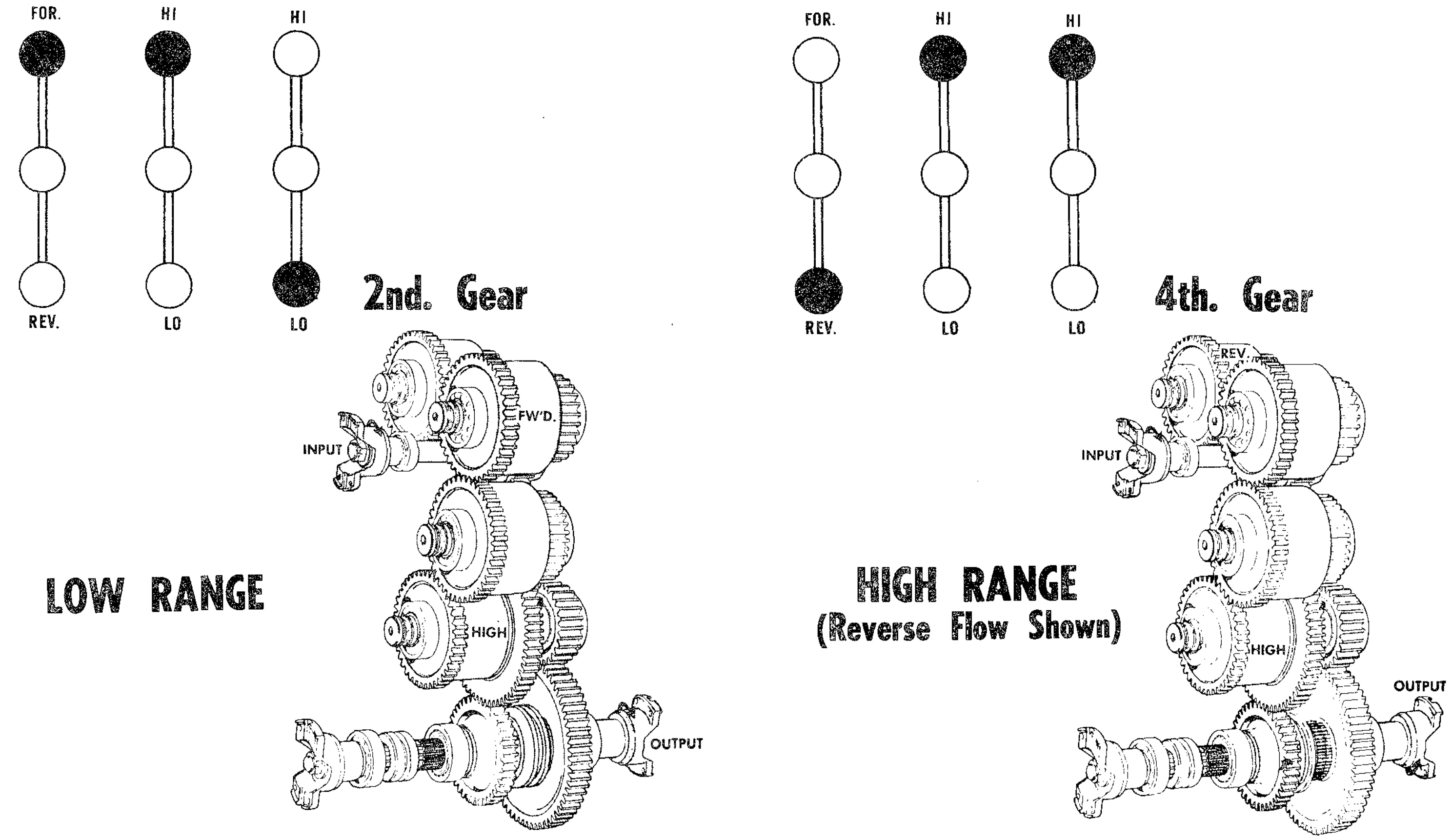


Fig. 25
2420 CLUTCH PACK ENGAGEMENT



Another important component of the 2420 Series transmission is the control valve assembly mounted on the cover plate of the transmission. A drawing of this control valve is shown below.

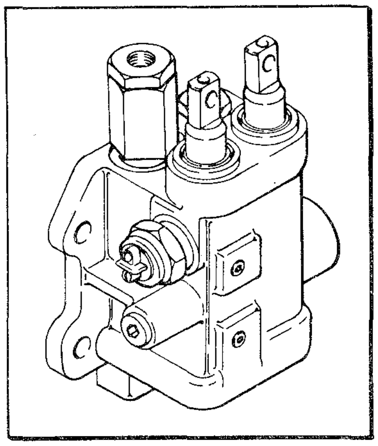


Fig. 26

2420 CONTROL VALVE ASSEMBLY

This valve contains three spools which direct oil to the various hydraulic functions within the transmission case. One spool directs oil to either the forward or reverse clutch pack according to its position within the body. This spool is "detented" by a neutral start switch which prevents accidental starting in gear.

Another valve spool is installed in this valve body directly down stream from the forward/reverse spool. This is called the brake disconnect or "declutch" spool. This spool is activated hydraulically by the brake system of the graders only. When a motor grader operator has his brake disconnect valve open and applies his brakes, brake system hydraulic pressure activates this spool. When this spool is activated, hydraulic pressure within either forward or reverse clutch pack is lost, and, the transmission is put in a neutral position. Releasing the brake allows the oil to pressurize the proper clutch pack again, and the transmission will be engaged as previously.

On the other hand, if the motor grader operator has his brake disconnect valve closed and he applies his brakes, the transmission will not be put into neutral position since brake system hydraulic pressure cannot activate the "declutch" spool. In the event this valve is closed (or open), it is always proper operation to decelerate the machine prior to applying the brake. (The output shaft governor will cause the engine to drive against the brakes if not decelerated).

On Series A hydraulic cranes, this valve is not used. The spool is incorporated in the control valve body, but there is no hydraulic brake line connected to it. Therefore, applying the brakes on a crane does not "neutralize" the transmission. The installation of a brake disconnect valve is not necessary for a crane application because of the absence of an output shaft governor.

The third valve spool within the control valve is used to direct oil to the low or high speed clutch packs. This spool is "detented" by a ball and spring to provide three positions -- low clutch pack engaged, neutral, high clutch pack engaged.

The cover plate of the 2420 Series transmission is used not only to support the internal clutch packs, but, is also used to direct a pressure lubrication flow of oil to the clutch pack bearings and clutch plates. It is also used to direct a "pressurized" flow to activate all the clutch packs. Various ports and galley-ways are machined into this cover plate to accomplish these flows.

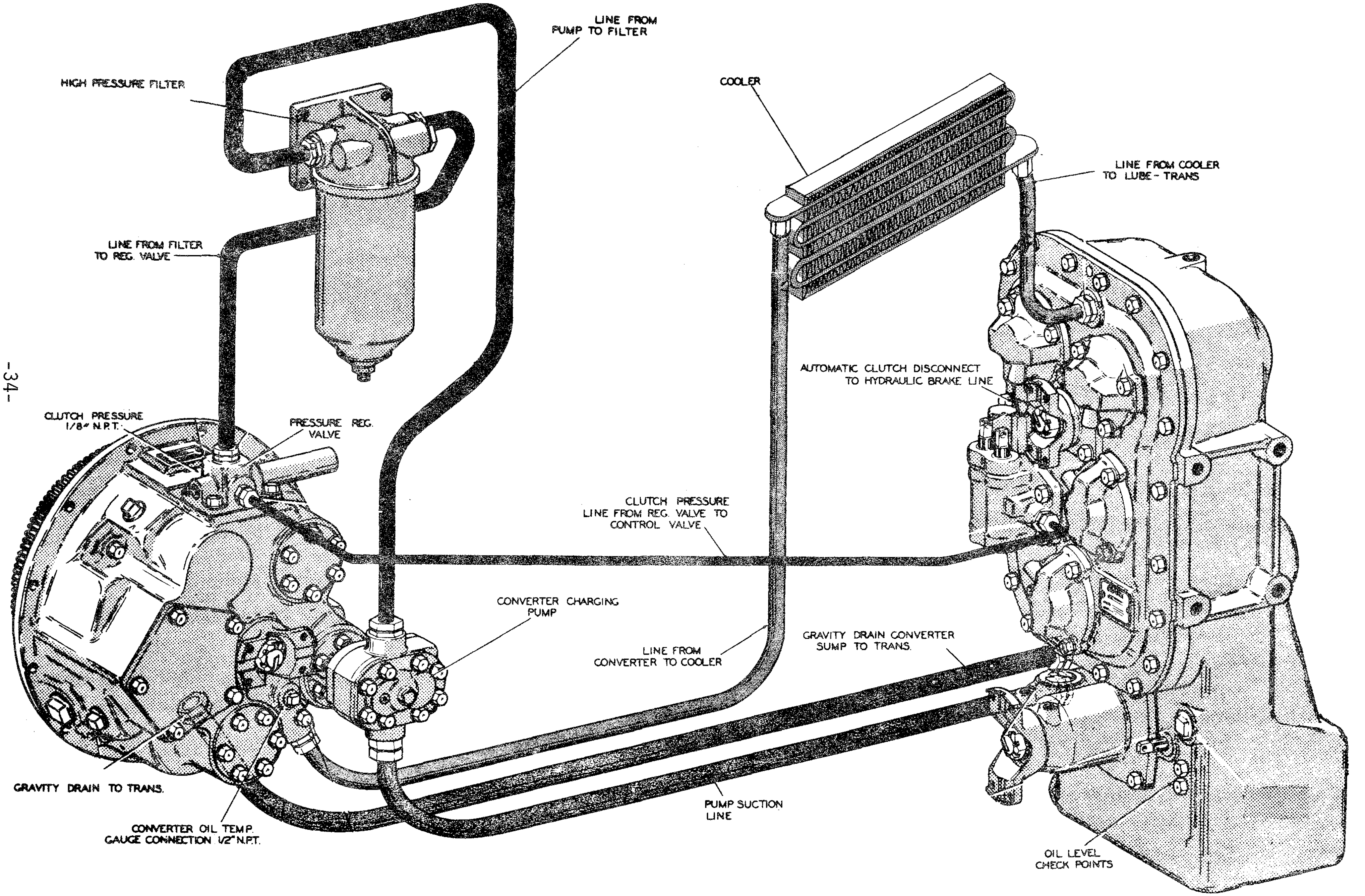
The 2420 Series transmission has a breather employed to allow atmospheric pressure to enter the interior of the case. Presently on the crane transmission, this breather is installed at the top of the case cover in the forward clutch pack distributor bearing cap. Some past graders have had the breather installed here also. Present graders have a breather installed in the control valve assembly instead of the forward clutch pack bearing cap.

OUTPUT SHAFT GOVERNOR
USED WITH THE 2420 SERIES DRIVE LINE

The output shaft governor employed with the 2420 Series transmission and the C-273 torque converter is of the centrifugal weights type as discussed in depth previously. This governor is mounted at the rear of the torque converter and is geared to the output shaft from the turbine accessory gears (See page 28). It should be noted that the output shaft governor is eliminated from the crane since a constant output shaft speed is not needed.

Fig. 27

2420/C-273 DRIVE LINE HYDRAULIC CIRCUIT



HYDRAULIC SYSTEM OF THE 2420 SERIES DRIVE LINE

The circuit drawing on page 34 may appear rather complicated. However, explanation of the oil flows of the entire system can be made easier by examining each component in detail and then taking an overall view.

SUMP

The lower section of the 2420 series transmission not only contains a mechanical range shift, but doubles as a reservoir for the hydraulic oil of the system. This reservoir is usually referred to as a sump.

Oil returning from throughout the system is collected in the sump. At the lower portion of the sump, a line is installed leading to the inlet side of the charge pump. A screen is provided within the sump to prevent foreign material entering the pump. The magnetic drain plug for the sump also collects foreign ferrous material.

CHARGE PUMP

The charge pump, driven off the impeller accessory gears of the torque converter, produces a flow of oil to perform the various hydraulic and lubricating functions of the converter/transmission circuit. This is a simple gear type pump producing a flow rate of 8 gpm per 1000 rpm.

The differential pressure between the inlet side of the charge pump and the atmospheric pressure (entering through the transmission breather) above the surface of the oil in the sump, causes a flow of oil to the charge pump. The meshing of the pump's gear teeth causes the oil to be forced from the inlet side to the exhaust side. Oil from the pump then travels by a flexible hose to a filter.

FILTER

A 70 micron replaceable filter is installed in the line leading from the charge pump. This eliminates foreign material from circulating throughout the entire system.

The transmission/converter filter should be replaced initially after the first 250 hours of operation and again at 500 hours. Thereafter the filter should be replaced at each oil change (every 500 hours). For removal and installation of the filter element see the machine's particular operator's manual.

REGULATING VALVE ASSEMBLY

Once oil exits the filter element, it travels by way of a flexible line to the regulating valve. This valve is mounted on the top of the C-273 torque converter when employed in the 2420 drive line. It performs three specific functions which are, in order of priority:

1. to maintain a pressure of 260 psi for clutch pack activation in the transmission.

2. to supply a flow of oil to "charge" the impeller, turbine stator of the torque converter ("wet" section).

3. to provide a safety relief in the event of excess flow from the charge pump. This safety relief flow drains into the "dry" section of the torque converter.

In addition to the above, a transmission pressure gauge is installed at this valve. A flexible plastic line leads to the instrument panel and a gauge. "Safe" zone shown on the transmission pressure gauge is 240-280 psi.

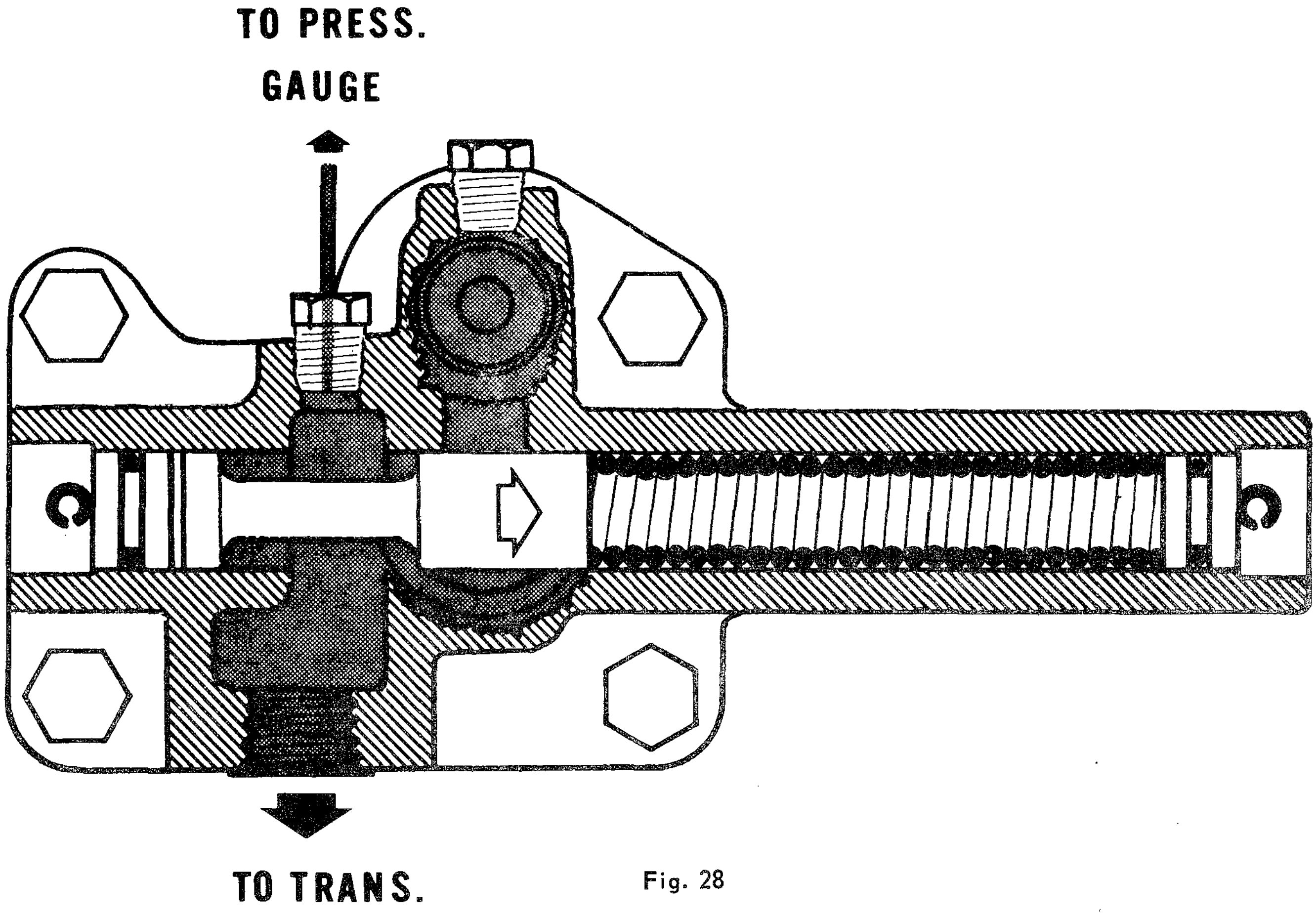


Fig. 28

REGULATING VALVE ASSEMBLY

The pressure regulating valve (figure 28) remains closed until required pressure is delivered to the transmission control valve assembly for actuating the direction and speed clutch packs (approximately 260 psi). This regulating valve consists of a hardened valve spool operating in a closely fitted bore. The valve spool is backed up by a spring to hold the valve spool against its seat until the oil pressure builds up to 260 psi operating pressure. The valve spool then moves toward the spring until a port is exposed along the side of the bore. The oil can then flow through this port into the "wet" section of the torque converter.

The above arrangement within the regulating valve provides first, sufficient pressure to activate clutch packs within the transmission, and second, a flow of oil to "charge" the "wet" section of the torque converter. By the word "charge" we mean replenishment of any lost oil from within the three members of the torque converter -- impeller, turbine, or stator. Actually there is always a constant flow of oil through the torque converter to allow for cooling.

A safety relief valve is also incorporated between the regulating valve housing and the housing of the torque converter. This valve is a simple "poppet" type which opens only in the event of a blocked passage or excessive flow from the charge pump. Should this valve open, excess flow will be discharged directly into the "dry" section (accessory gears) of the torque converter. Whenever excessive flow ceases, this valve will close again and allow the entire flow to enter the "wet" section.

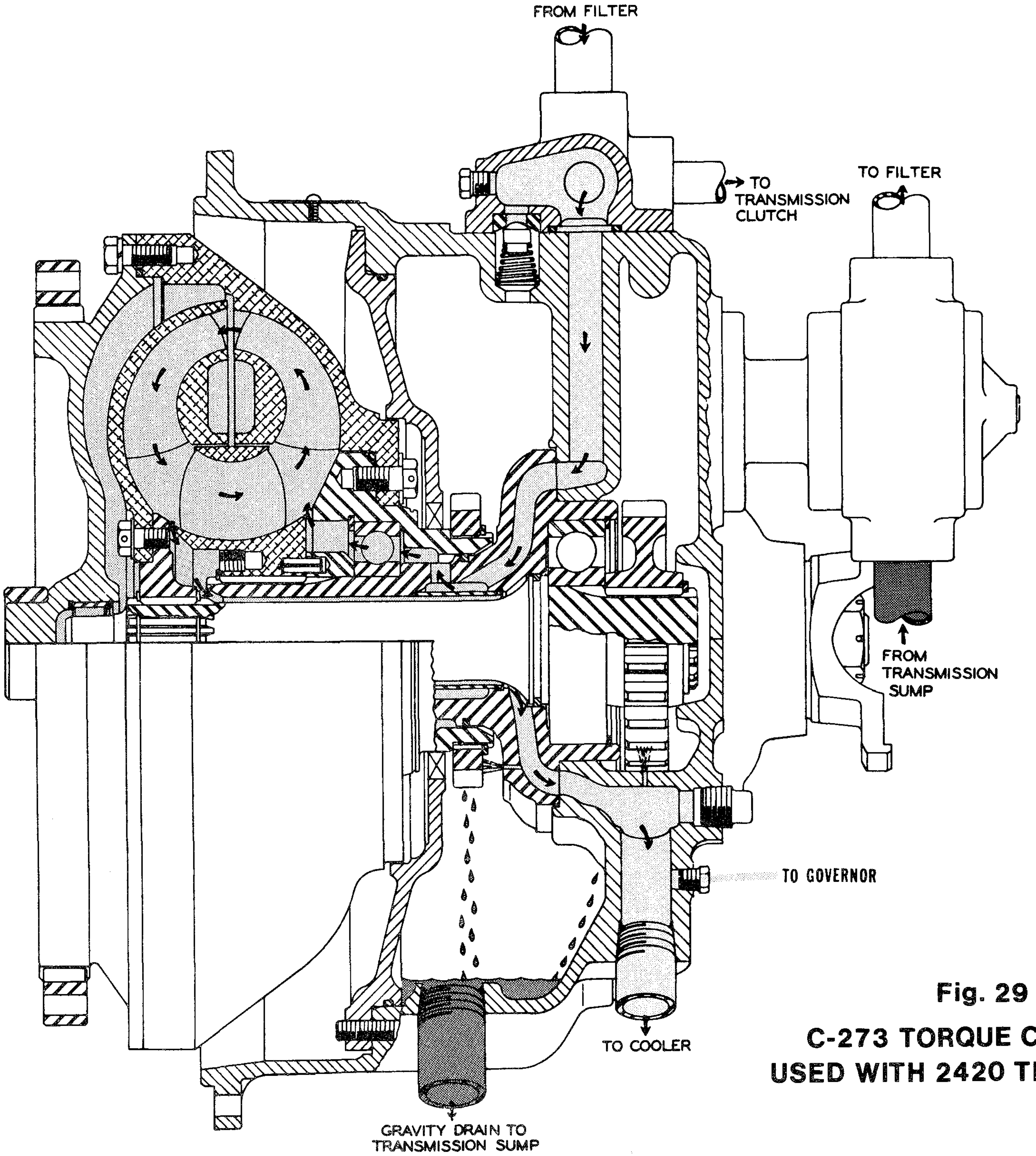
C-273 TORQUE CONVERTER

By way of a galley-way cast in the housing of the torque converter, "charge" oil travels from the regulating valve to the "wet" section of the converter (see figure 29). This oil is directed through the stator support and impeller hub bearing into the interior of the impeller. Once entering the impeller, oil travels from impeller, to turbine, to stator, and back to the impeller again. The oil traveling between the three members transmits rotation as discussed before on page 5.

As oil enters the impeller, oil is also exiting from the turbine. This oil exits between the stator support and turbine shaft. Piston ring seals allow all oil flows to be properly contained. As stated, this arrangement provides for continuous loss and replacement of oil within the "wet" section. The "lost" oil is carried away to be cooled at an air to oil heat exchanger (cooler).

Another galley-way cast in the housing of the torque converter provides a passage for the oil exiting the turbine. This oil then travels from the turbine, between the stator support and turbine shaft, through the galley-way, and finally to a port (called "converter out") leading to the cooler.

Prior to exiting the converter housing, the "converter out" oil passes (1) two 1/64 inch lubrication spray holes, (2) a temperature sending unit, and (3) a line leading to the output shaft governor for lubrication. This oil is under approximately 35 psi as it flows from the converter. Therefore, as it passes the two 1/64 inch holes, a lubrication spray is directed into the "dry" section of the converter housing. These sprays lubricate all the accessory gears (turbine and impeller) and bearings in this portion of the housing. This lubrication spray oil collects at the bottom of the "dry" section and exits the housing at the lowest point. A flexible hose provides a simple gravity drain to the transmission sump.



HIGH PRESSURE
LOW PRESSURE
DRAIN OR SUCTION

Fig. 29

C-273 TORQUE CONVERTER USED WITH 2420 TRANSMISSION

A temperature sending unit is installed in the housing of the converter to sense the temperature of the "converter out" oil. A wire leads from this sending unit to the temperature gauge in the instrument panel. Normal operating temperature ranges from 160°F to 180°F. During stall condition, this temperature may rise. However, never operate a machine above 250°F or component damage may result. (Remember: one second of stall equals one degree of heat increase.)

The line leading to the output shaft governor provides lubrication of its weights, bearings, and spider assembly. The length of this flexible plastic lube tube is 31 inches. This length provides a controlled amount of oil flow to the governor for lubrication and yet provides for proper operation. Shortening of this tube can cause an excessive amount of oil to enter the governor housing and, as a result, the governor weights would spin in a "flood" of oil. This flooding prohibits proper operation of the governor.

The use of too long a tube can prevent the proper amount of lubrication from reaching the governor. For this reason, this tube must be 31 inches long.

After oil enters the housing of the governor, it simply drains into the "dry" section of the converter. From there it exits the gravity drain port to the transmission sump.

It should be noted that oil from the safety relief valve of the regulating valve enters the "dry" section of the torque converter. This relief oil, the spray lubrication oil, and the output shaft governor lubrication oil all exit by way of the gravity drain port leading to the transmission sump.

COOLER

Oil from the converter out port of the torque converter travels directly by way of a flexible hose to an air to oil cooler. This oil is under approximately 35 psi upon leaving the converter. The heat exchanger is located adjacent to the engine radiator and functions in such a manner as to stabilize converter oil temperature. For example, excessive heat created when the converter is in stall condition is dissipated by the cooler. The horsepower introduced as mechanical input during stall is entirely transformed into heat engergy since there is no output of mechanical power. This heat is carried away by the oil to the cooler where it is dissipated. Obviously, the cooler has a limited cooling capability. For this reason, a machine cannot be held in stall for an excessive period of time (limit 30 seconds) since the cooler is limited to the amount of heat transfer.

Maintenance of the cooler entails external cleaning with compressed air and/or flushing with a water hose each 50 hours of operation. When a machine is operating in areas where lint, chaff, or vegetation are prevalent, the cooler should be inspected and cleaned more often.

TRANSMISSION PRESSURE LUBRICATION

Oil which exits the cooler travels by way of another flexible hose to a port at the top of the transmission case cover plate. This cooled oil will be used for lubrication of all bearings, shafts, and clutch plates within each clutch pack. This oil is under very low pressure. The cover plate of the transmission has a number of galley-ways and ports cast and machined within it to allow this lubrication flow to reach each clutch pack. The picture below shows the lubrication flow to each clutch pack within the cover plate.

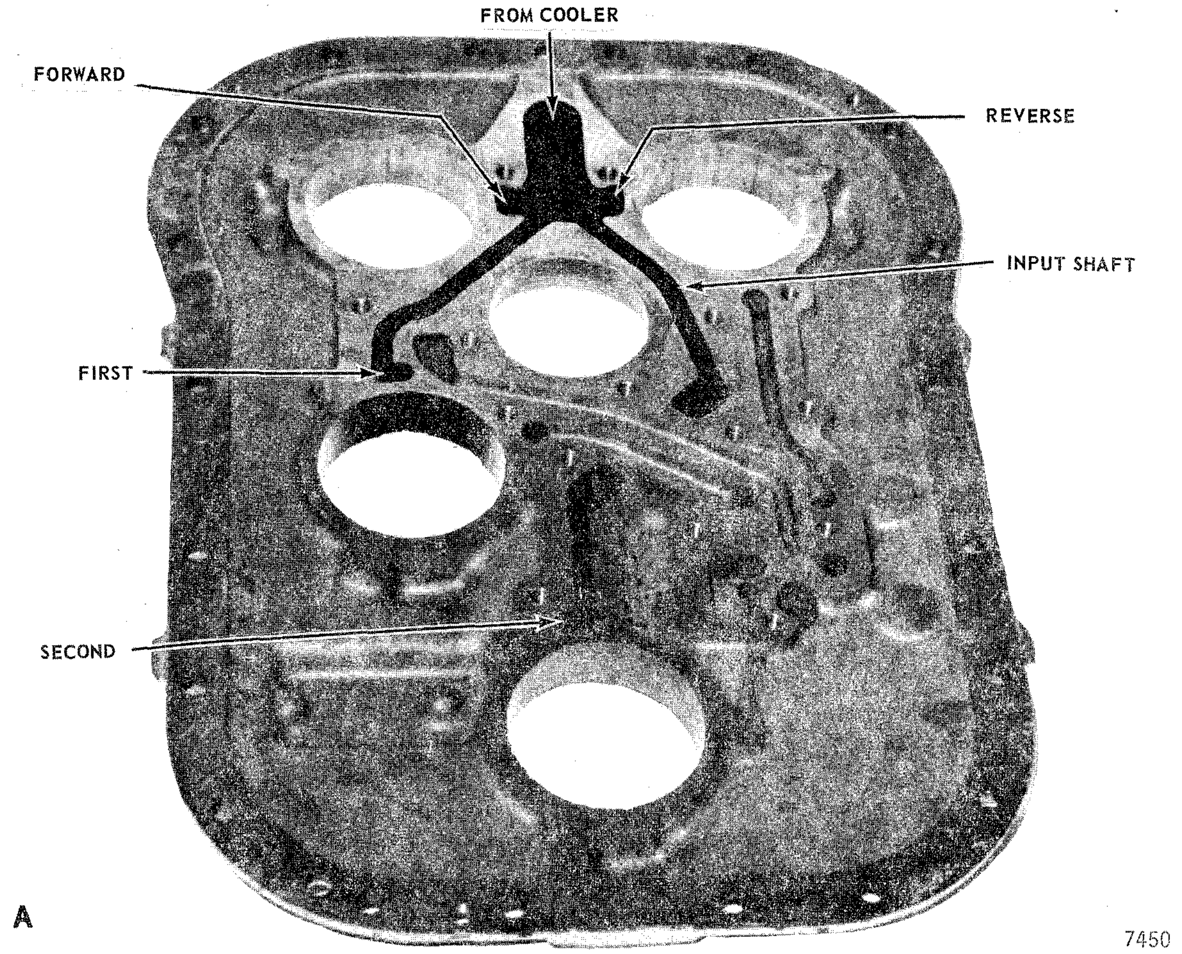


Fig. 30
2420 TRANSMISSION CASE COVER

It should be noted that to contain this flow within the cover plate, a machined flat plate is bolted to the inside of the transmission cover plate. This flat plate and the cover plate have no gasket between them due to each piece being machined flat to a fine tolerance. When bolted together, a precision fit between them exists which keeps leakage to a minimum.

From the galley-ways in the cover plate, the lubrication oil flow is directed to the end of each clutch pack shaft by way of the distributor bearing cap. This bearing cap retains each clutch pack shaft bearing. It also serves the purpose of distributing the lubrication flow to the clutch pack shaft. "Hook-ring" piston type sealing rings on the clutch pack shaft contain this flow into the center of the shaft.

A temperature sending unit is installed in the housing of the converter to sense the temperature of the "converter out" oil. A wire leads from this sending unit to the temperature gauge in the instrument panel. Normal operating temperature ranges from 160°F to 180°F. During stall condition, this temperature may rise. However, never operate a machine above 250°F or component damage may result. (Remember: one second of stall equals one degree of heat increase.)

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The use of too long a tube can prevent the proper amount of lubrication from reaching the governor. For this reason, this tube must be 31 inches long.

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COOLER

Oil from the converter out port of the torque converter travels directly by way of a flexible hose to an air to oil cooler. This oil is under approximately 35 psi upon leaving the converter. The heat exchanger is located adjacent to the engine radiator and functions in such a manner as to stabilize converter oil temperature. For example, excessive heat created when the converter is in stall condition is dissipated by the cooler. The horsepower introduced as mechanical input during stall is entirely transformed into heat engergy since there is no output of mechanical power. This heat is carried away by the oil to the cooler where it is dissipated. Obviously, the cooler has a limited cooling capability. For this reason, a machine cannot be held in stall for an excessive period of time (limit 30 seconds) since the cooler is limited to the amount of heat transfer.

Maintenance of the cooler entails external cleaning with compressed air and/or flushing with a water hose each 50 hours of operation. When a machine is operating in areas where lint, chaff, or vegetation are prevalent, the cooler should be inspected and cleaned more often.

TRANSMISSION PRESSURE LUBRICATION

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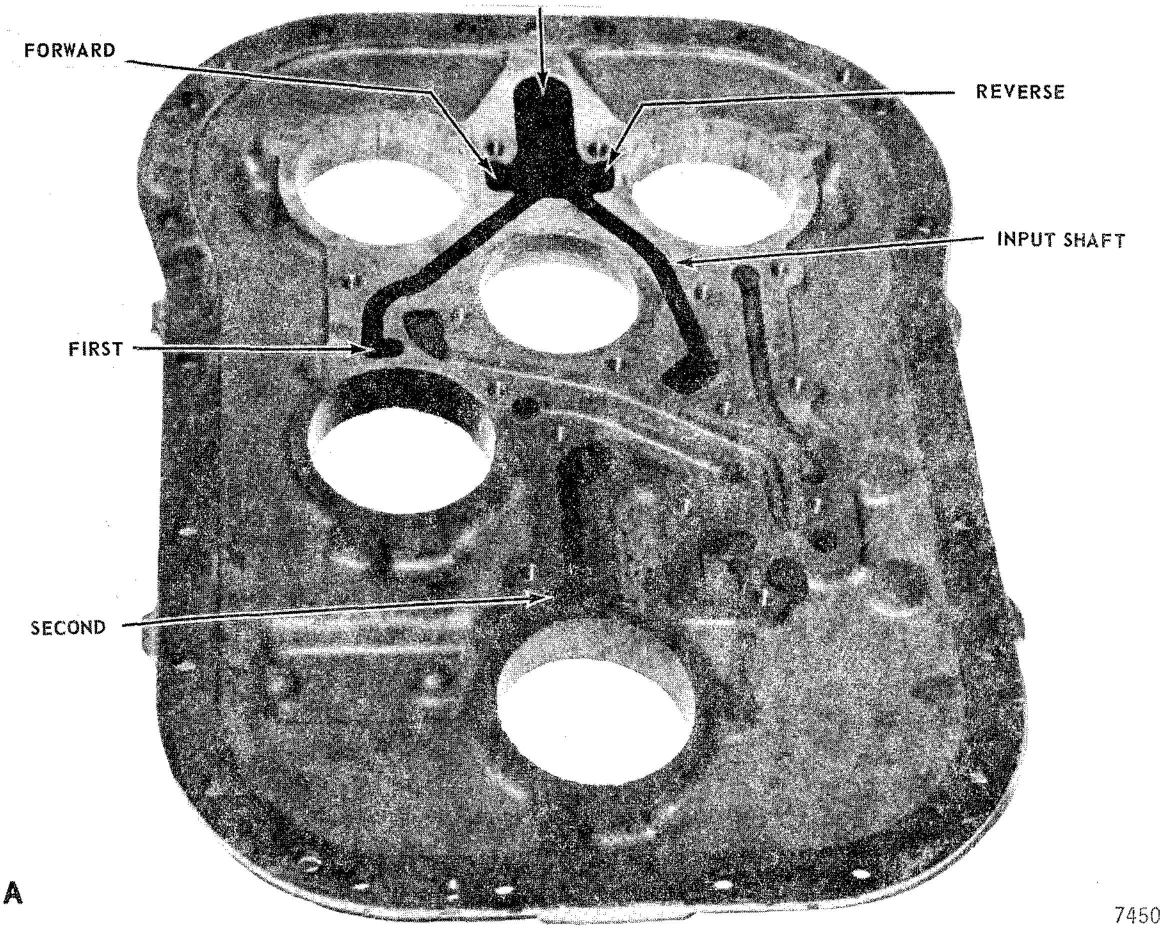

Fig. 30

2420 TRANSMISSION CASE COVER

It should be noted that to contain this flow within the cover plate, a machined flat plate is bolted to the inside of the transmission cover plate. This flat plate and the cover plate have no gasket between them due to each piece being machined flat to a fine tolerance. When bolted together, a precision fit between them exists which keeps leakage to a minimum.

From the galley-ways in the cover plate, the lubrication oil flow is directed to the end of each clutch pack shaft by way of the distributor bearing cap. This bearing cap retains each clutch pack shaft bearing. It also serves the purpose of distributing the lubrication flow to the clutch pack shaft. "Hook-ring" piston type sealing rings on the clutch pack shaft contain this flow into the center of the shaft.

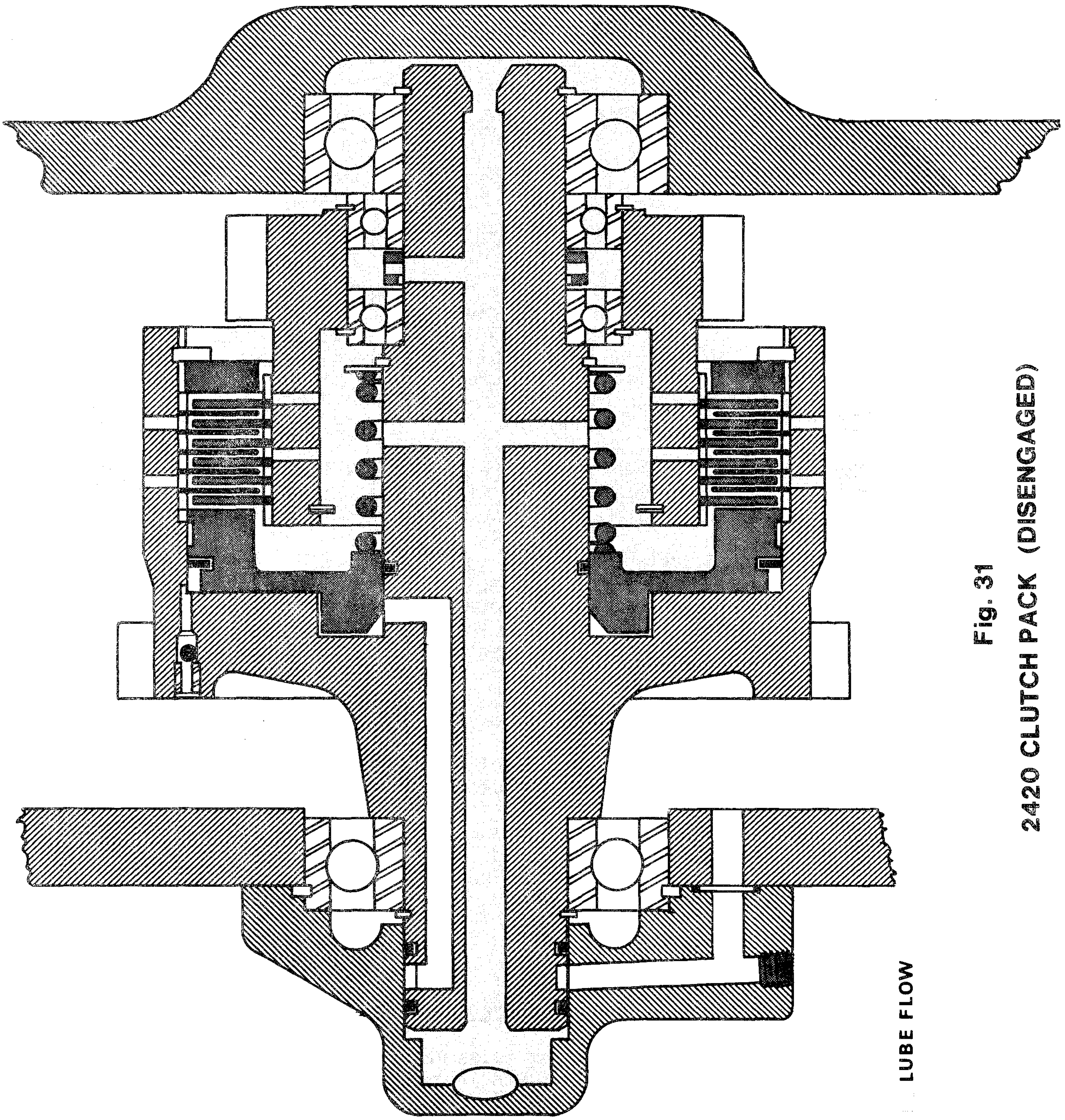

Fig. 31
2420 CLUTCH PACK (DISENGAGED)

LUBRICATION FLOW WITHIN THE CLUTCH PACKS

A cross-section drawing of a clutch pack is shown in figure 31.

Oil from the distributor bearing cap is channeled down the center of the shaft assembly. (Actually the shaft, clutch drum, and gear are all one unit.) Three holes are drilled in such a manner as to intersect this center bore. Two holes allow passage of oil to the alternated bronze and steel discs. These discs are the clutch plates of the clutch pack. A lubrication flow can then enter the cavity of the clutch plates to allow for cooling and lubrication.

The other hole which intersects the bore, allows for lubrication of the two clutch hub bearings. A bearing spacer with an oil groove properly channels the oil to lubricate these bearings.

Finally, oil which travels the entire length of the center bore lubricates the clutch shaft bearing at the opposite end. With the above arrangement all bearings and clutch plates are properly lubricated. After this lubrication has been accomplished, oil from each bearing drops into the center of the transmission case. This oil eventually returns to the transmission sump at the bottom of the case.

Lubricating oil for the clutch plates exits the hub and drum assembly by the numerous holes drilled in the drum. Whenever a clutch pack is disengaged, oil is discharging from these holes. This provides excellent cooling of the clutch plates within the clutch pack.

The oil used for lubrication within the clutch packs perform one other basic function prior to returning to the sump. This oil is thrown or "sprayed" from each clutch pack. This provides lubrication of all gears in constant mesh within the transmission. Moreover, lubrication of the mechanical section (range shift) of the transmission is attained by "splash" lubrication from the transmission sump.

PRESSURE FLOW TO TRANSMISSION

As previously stated, the regulating valve maintains pressure to the transmission control valve assembly prior to allowing a flow of oil to continue to the torque converter and then to transmission lubrication. The following information will be concerning the pressure flow to the transmission control valve assembly and clutch packs.

CONTROL VALVE ASSEMBLY

The transmission control valve assembly controls the pressure flow to the transmission clutch packs. The entire assembly consists of:

1. A sliding spool to direct pressure to either the forward or reverse clutch packs. This spool will be designated forward/reverse.
2. A neutral start switch to prevent accidental starting in gear. This is also used as a detent for the forward/reverse spool.
3. A brake disconnect or "declutch" spool used to "neutralize" the transmission when the brake pedal is applied (and brake disconnect valve open). This spool is downstream from the forward/reverse spool and functions on brake system hydraulic pressure.
4. A second sliding spool to direct pressure to either the low or high clutch packs. This spool will be designated high/low.
5. A ball and spring to be used as a detent for the high/low spool. This provides the three positions of the spool.
6. A breather to allow atmospheric pressure to enter the interior of the transmission case. This enables air pressure above the upper surface of oil within the sump. (On crane applications and some early grader applications, the breather is installed on the forward bearing cap.)
7. A housing to contain all of the above components. This housing is mounted directly to the cover plate of the transmission. All pressure flows from the control valve assembly are directed through galley-ways in the cover plate to the respective clutch packs.

The above components of the control valve assembly are represented in the schematic drawing below.

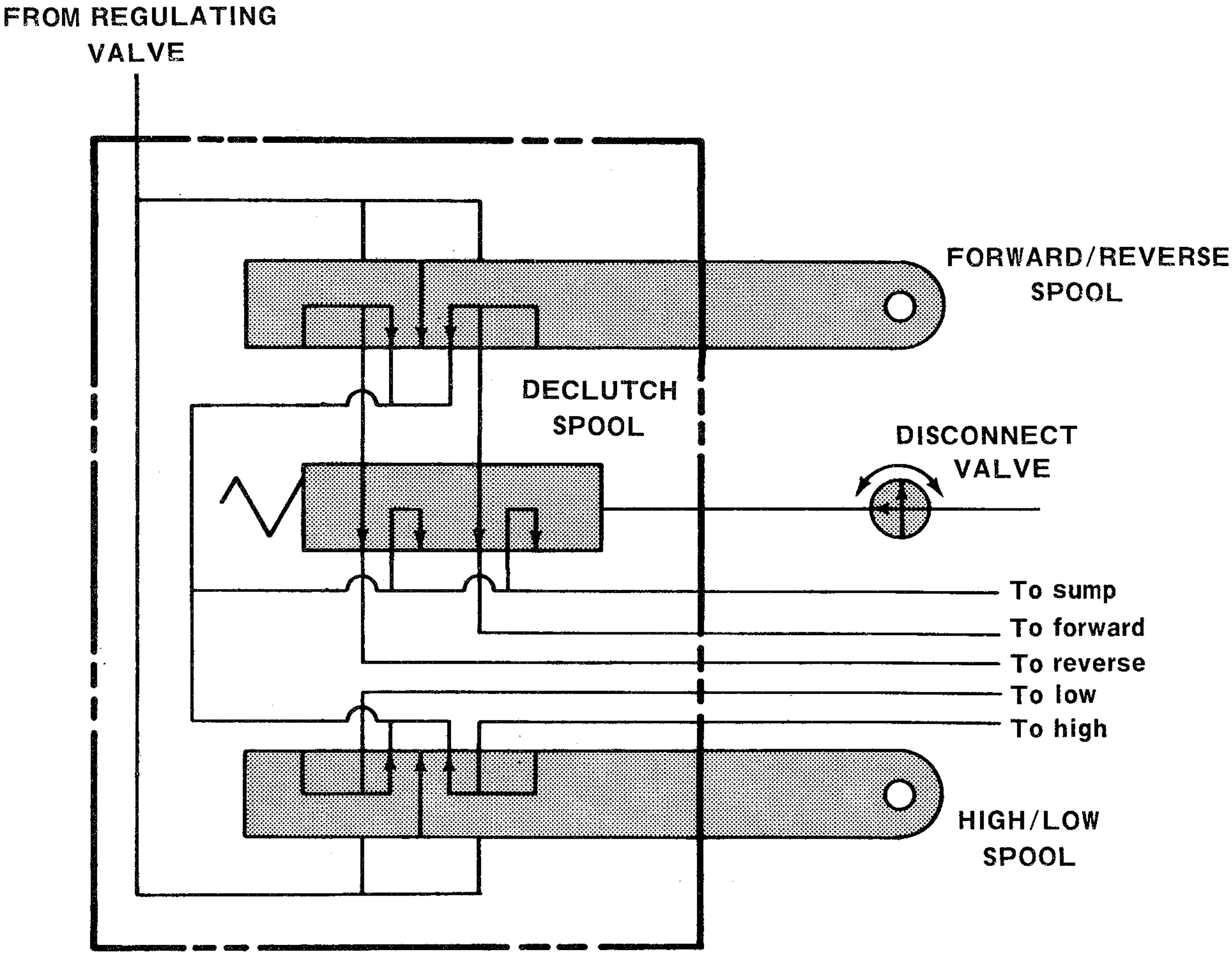

Fig. 32
2420 CONTROL VALVE ASSEMBLY

The following sequence of drawings and explanations shows the function and operation of the control valve assembly.

1. All control levers in neutral:

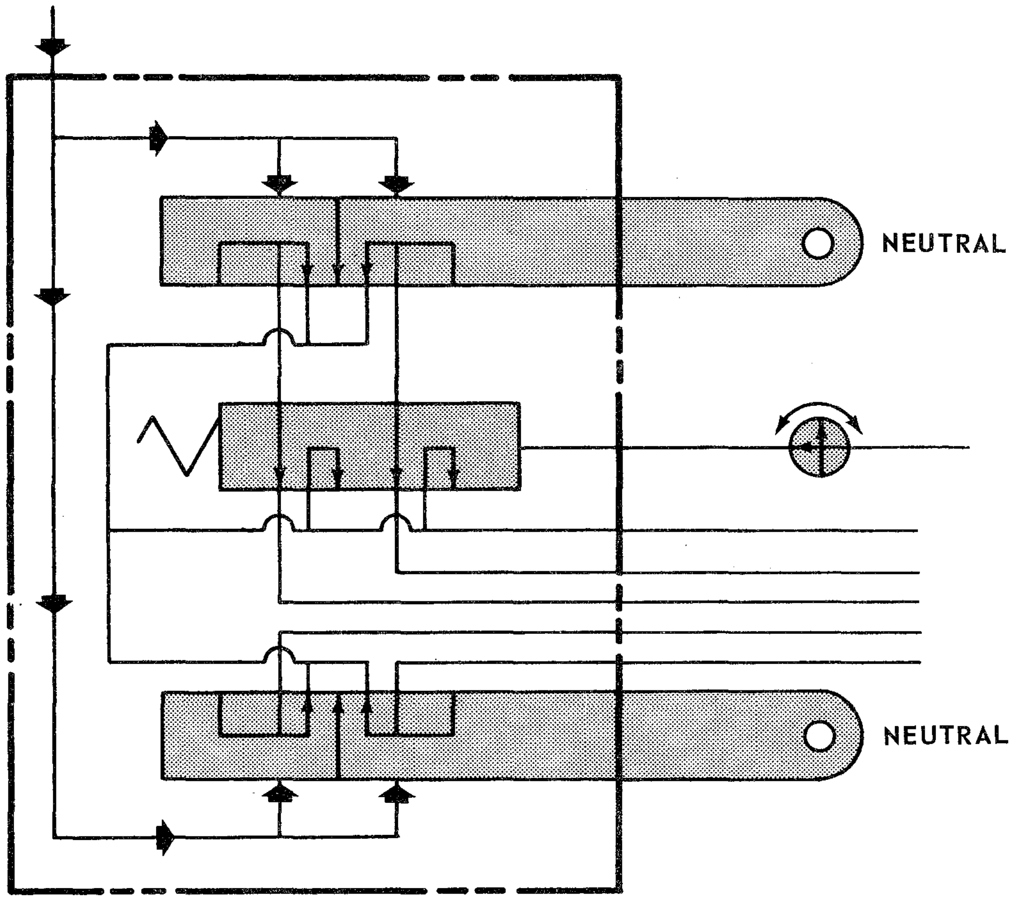

Fig. 33

With all controls in the operator's compartment in neutral, pressure from the regulating valve (approximately 260 psi) is blocked at the control valve assembly. Both forward/reverse and high/low spools prevent pressure from entering any clutch pack. In this case, since no pressure can reach any clutch pack, all clutch packs are disengaged and the transmission is in neutral. No transmission of rotation from input to output can take place.

2. Forward/reverse control lever in forward position, high/low control lever in low position.

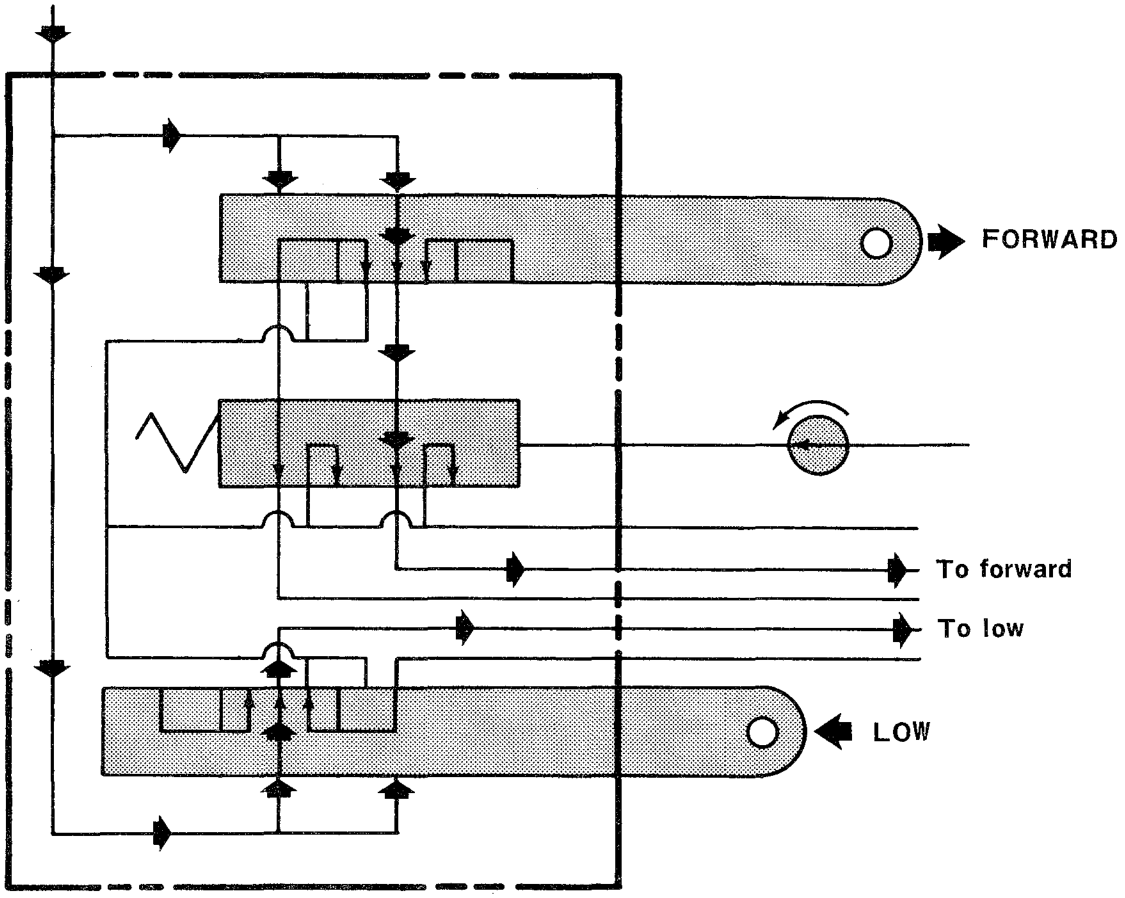

Fig. 34

When the forward position is selected with the direction control lever, the forward/reverse spool is shifted in such a manner as to direct pressure to the forward clutch pack. This engages this clutch pack and provides forward direction within the transmission. At the same time, oil pressure is not directed to the reverse clutch pack and, it is therefore disengaged.

When the low position is selected with the speed shift control lever, the high/low spool is shifted in such a manner as to direct pressure to the low clutch pack. This oil pressure then engages the low clutch pack to provide a "low" speed gear ratio. Since oil pressure is not directed to the high clutch pack, it is not engaged.

Should the mechanical range shift be in either low or high position, motivation of the machine will occur forward in either "first gear" or "third gear", respectively. Shifting of the mechanical range shift should be done prior to engagement of the forward/reverse lever or high/low speed lever. The machine also should never be moving when engaging the mechanical range shift.

3. Forward/reverse control lever in forward position, high/low control lever shifted from low to high position "on-the-go":

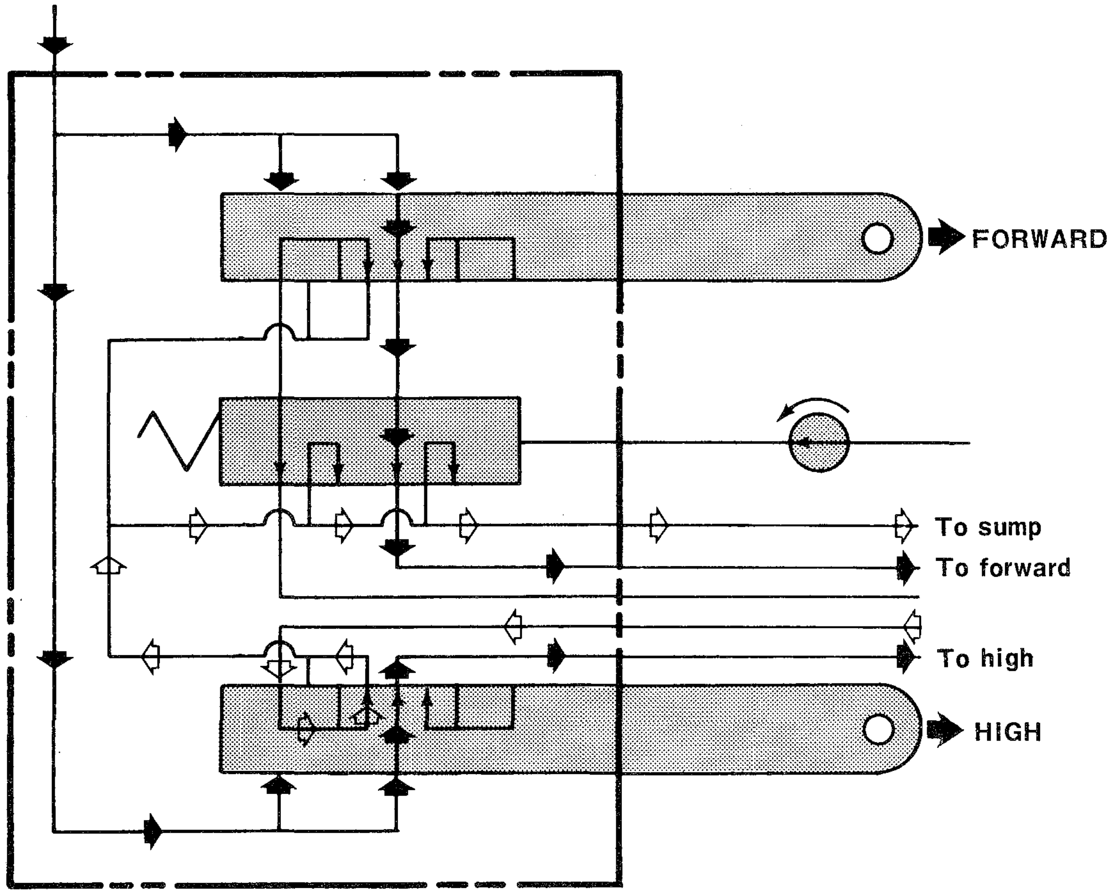

Fig. 35

In this example, the operator powershifts his high/low speed control lever from the previous position, as in example 2 above, to high speed position. Actually if his mechanical range shift is in low position, then when he powershifts he is going from first to second gear; if the mechanical range shift is in high position, he would be powershifting from third to fourth gear.

When the operator changes his lever position, the high/low spool in the control valve assembly is shifted. Oil pressure which was before directed to the low clutch pack is now directed to the high clutch pack. At the same time oil and oil pressure within the low clutch pack is quickly released through the control valve. (Bleed balls in the clutch packs also aid in releasing pressure.) This released oil is simply dumped into the transmission case for return to the sump.

This arrangement prevents both high and low clutch packs from being engaged at any one time. It also allows for quick engagement and disengagement of clutch packs which is needed for powershifting "on-the-go".

(When shifting from forward to reverse, the oil pressure is diverted and released in the same manner as above. However, shifting from forward to reverse or vice versa should only be done with the machine stopped and engine speed decelerated to idle.)

4. Machine in low speed, forward direction with the mechanical range shift in low position (first gear, forward) and the brake pedal applied:

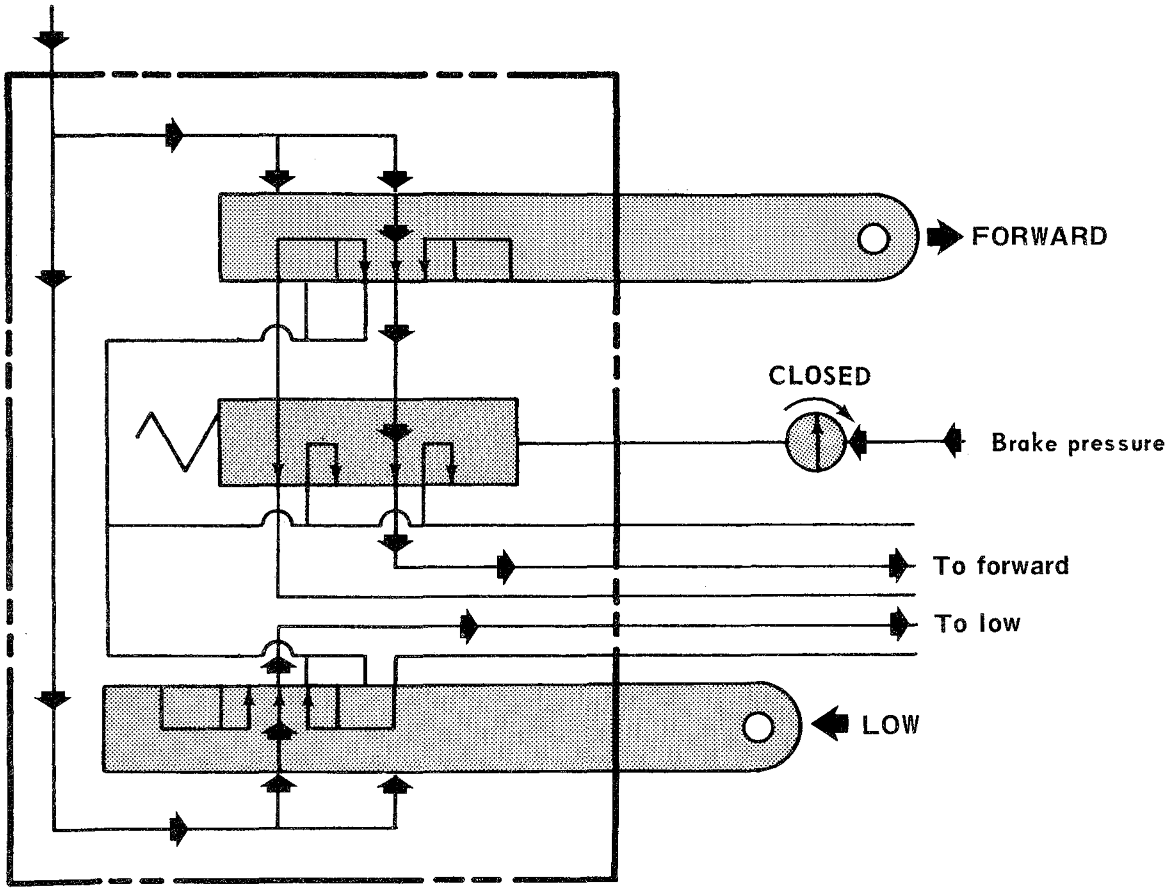

Fig. 36

DISCONNECT VALVE CLOSED, BRAKES APPLIED

A brake disconnect valve is located below the operator's seat on a side panel. A decal informs the operator of its function. Should this valve be closed (clockwise), and the operator applies his brakes, the transmission will remain in gear. As shown above, the brake disconnect valve in the closed position prevents brake system hydraulic pressure from reaching the "declutch" spool in the control valve assembly. (He must decelerate prior to braking in this event in order to stop the machine.)

However, should the operator open (counter-clockwise) his brake disconnect valve in the operator's compartment, his transmission will be put into neutral whenever his brake pedal is applied. The following schematic drawing is applicable to this situation.

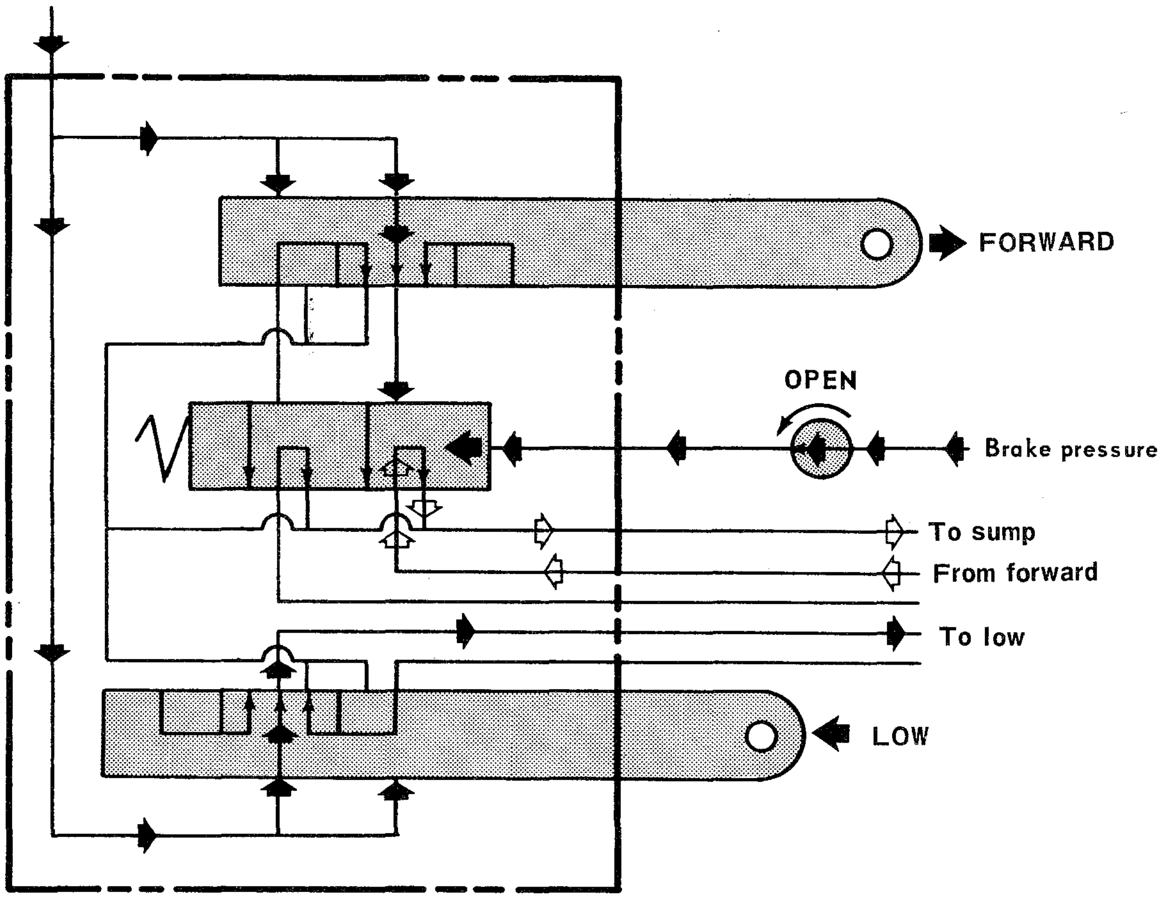

Fig. 37
DISCONNECT VALVE OPEN, BRAKES APPLIED

With the brake disconnect valve open, brake system hydraulic pressure shifts the "declutch" (or brake disconnect) spool against its spring. This action in turn blocks the pressure passing through the forward/reverse spool to the forward clutch pack. At the same time, pressure within the forward clutch pack is released, and, is therefore disengaged. Since the activation of this declutch spool has caused neither forward or reverse clutch pack to be engaged, the entire transmission is in neutral.

Thus, whenever the brake disconnect valve in the operator's compartment is open and the brake pedal is applied, the transmission will be put into neutral. If this valve is closed and the brake pedal is applied, the transmission will not be put into neutral. Prior to braking, it is always proper operation to decelerate the engine.

Disengagement of the transmission whenever the brake pedal is applied must be an option for the operator. For instance, when a motor grader is descending a long mountain road, it would not be advantageous to "neutralize" the transmission when the brake pedal is applied. If his brake disconnect valve is open, then every time the brake is applied, the transmission is put in neutral and the engine does not slow the machine.

For this reason, in the above example it would be advantageous to close the brake disconnect valve. In this case the transmission will remain engaged at all times. When descending the mountain road, the operator needs only to decelerate and apply his brakes. Here both brakes and engine will slow the machine.

Another example where this valve would be handy is when operating a grader in close quarters. Let's assume a grader is operating near a hillside. If the operator wishes to grade forward to the edge and then instantly reverse, he should have his valve closed. He should control his speed with his decelerator pedal ("inching") and upon approaching the edge of the hill depress the decelerator completely, apply his brakes, and stop. Then he should reverse the direction control lever.

With his brake disconnect valve closed, the engagement of his transmission from forward to reverse will be quite rapid. And when he releases his brake pedal and decelerator, the machine will immediately travel in reverse direction away from the edge of the hillside.

If the operator tries to do the same above example with his brake disconnect valve open, then when he arrives at the edge and applies his brake pedal, the transmission will be put into neutral. He would reverse his direction lever and release his brake pedal. However, in this case, the brake system hydraulic pressure takes a few seconds of time to drop after the brake pedal is released. During this time lag, the transmission is still in neutral and the brakes are released. When the brake system pressure "bleeds" off completely, the transmission clutch pack will engage in gear again. However, the time lag could be enough for the machine to roll forward an undesired amount since the brake pedal is released and the transmission, during this time period, is in neutral.

For this reason, in close quarters operation, the brake disconnect valve should be closed and the decelerator used for "inching". If the brake pedal is applied, the decelerator should be completely depressed.

5. Brake disconnect valve open, brake pedal depressed, brake disconnect valve closed, and then brake pedal released, in that order.

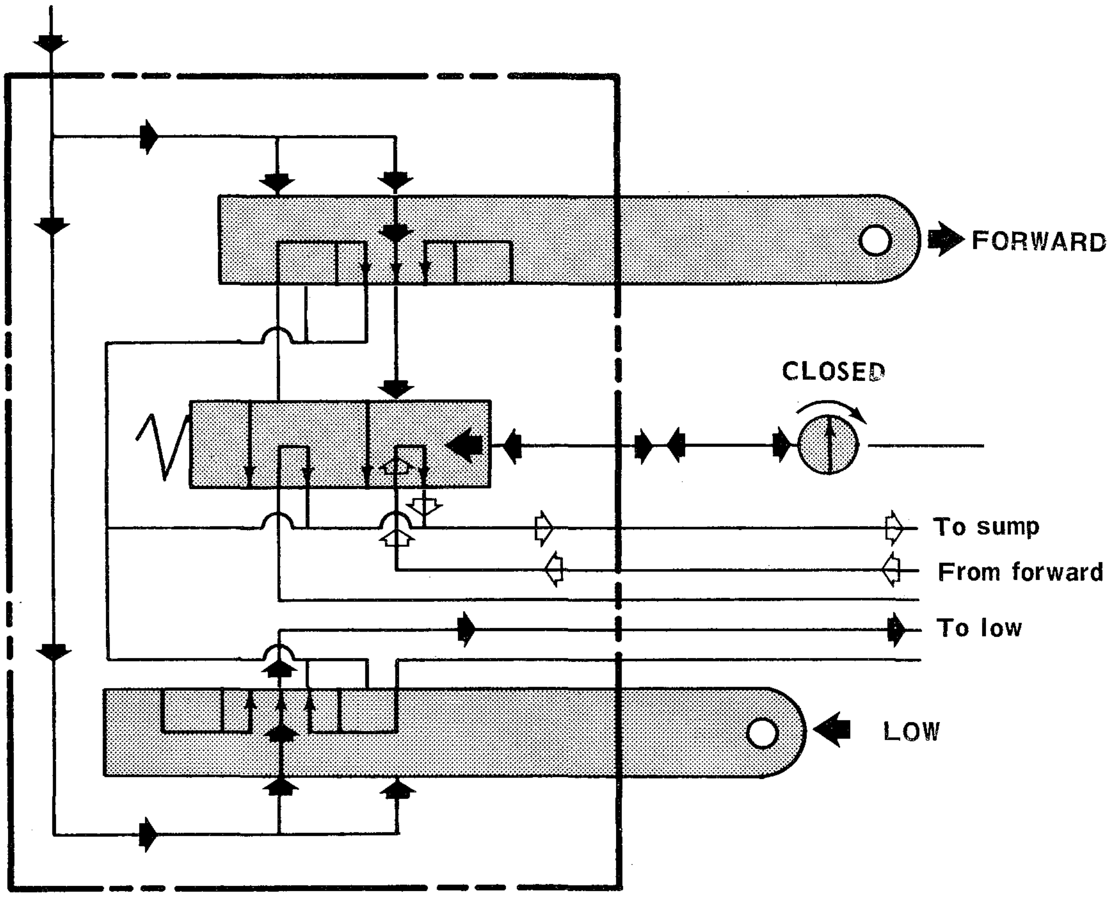

Fig. 38

This sequence of events produces a "locked-in-neutral" condition within the transmission. When the operator has his brake disconnect valve open and he depresses the brake pedal, brake system hydraulic pressure activates the "declutch" spool. This in turn disengages both forward and reverse clutch packs to produce a neutral condition.

Now, if the operator maintains the brake pedal in the depressed position and closes completely the brake disconnect valve, then his transmission will be "locked" in a neutral position even after he releases the brake pedal. The operator can choose any gear ratio and direction and motivation of the machine is impossible. As soon as the brake disconnect valve is opened again, the transmission returns to normal and any gear ratio in either forward or reverse can be obtained.

Actually when the brake disconnect valve is opened again, brake system hydraulic pressure "bleeds" off and the "declutch" spool in the control valve assembly shifts to allow either the forward or reverse clutch pack to engage again.

Do not use this "locking-in-neutral" technique for a safety device while working on, around, or under a machine.

Another important point is that this brake disconnect valve should always be either open or closed fully. Never operate a machine with this valve partially open or closed.

This brake disconnect valve and the line to the declutch spool within the control valve assembly are eliminated on all Galion cranes employing the 2420 transmission. This means that the transmission will remain engaged when the brake pedal is applied on a Series A crane.

PRESSURE FLOW WITHIN THE CASE COVER PLATE

As stated previously, the cover plate on the 2420 transmission conducts a lubrication flow of oil from the cooler to each clutch pack shaft. This cover plate also conducts the pressure from the control valve assembly to the respective clutch packs. The picture below shows the various galley-ways where the pressure is directed.

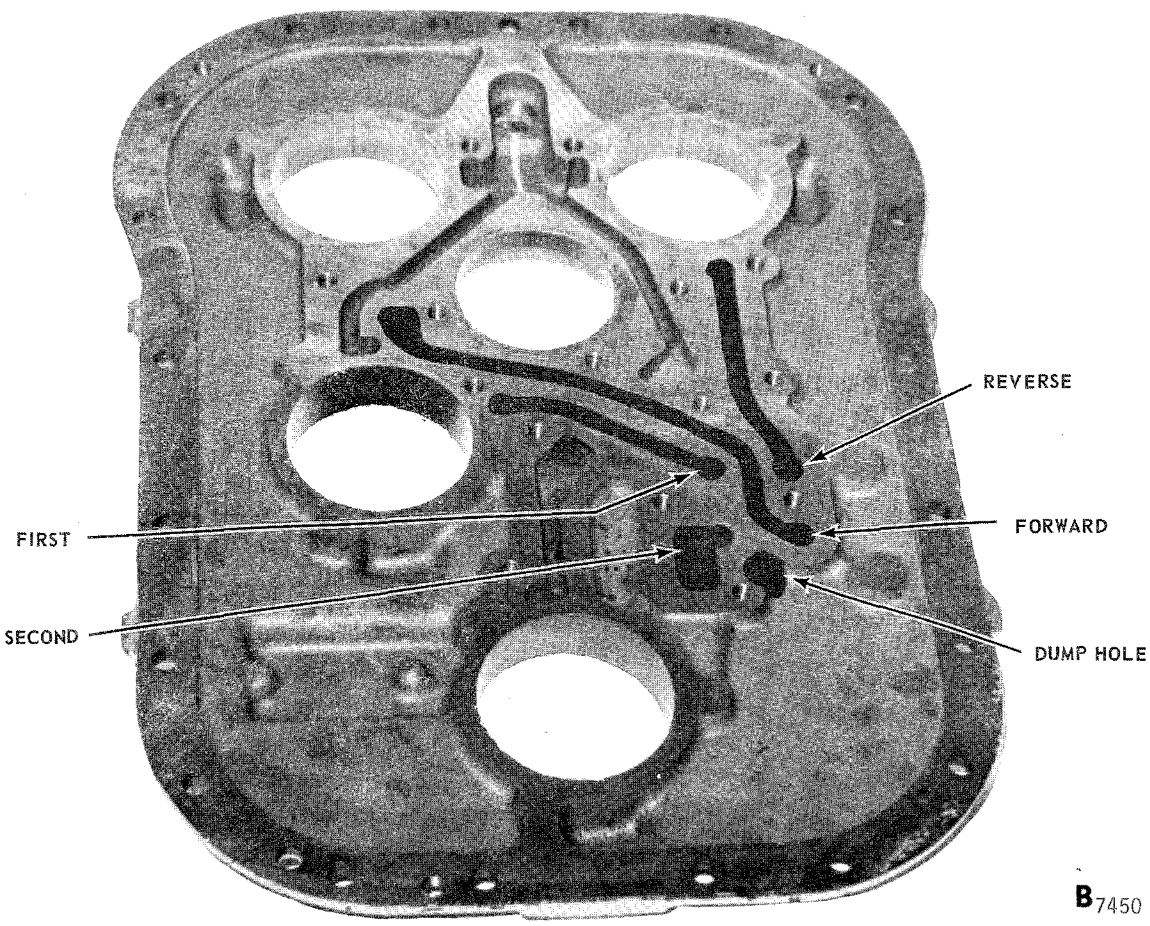

Fig. 39

2420 TRANSMISSION CASE COVER

A machined flat plate covers these galley-ways on the interior of the case cover plate. This seals the passages for pressure to be conducted. It should be noted that a hole is not covered by the flat plate. This hole allows oil from within the clutch packs to return to the sump whenever a clutch pack is released (disengaged).

Oil pressure is directed from the cover plate galley-ways to the clutch pack shafts by way of the distributor bearing caps. "Hook-ring" piston sealing rings separate the lubrication flow from the pressure flow upon entering the clutch pack through the shaft.

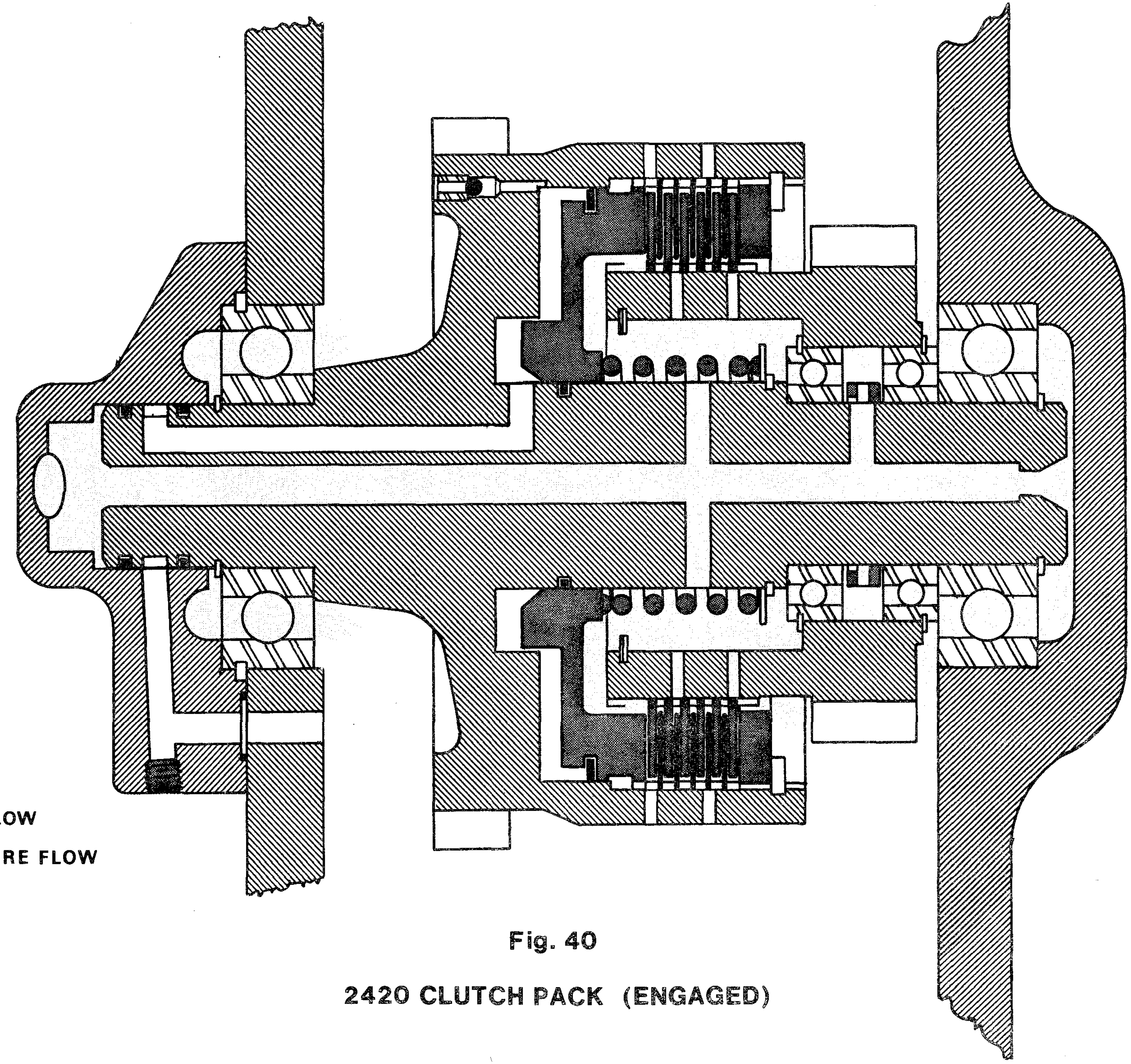

Fig. 40

2420 CLUTCH PACK (ENGAGED)

PRESSURE FLOW WITHIN THE CLUTCH PACKS

The cross-section drawing in figure 40 designates the pressure flow within the clutch pack when engaged (pressurized).

When a clutch pack is engaged, oil pressure is directed from the control valve assembly through the cover plate and distributor bearing cap to the clutch pack shaft. "Hook-ring" seals on the end of this shaft channel this pressure down a bore in the center.

Once into the shaft, oil is directed through a drilled hole into the rear side of the piston bore. Pressure of the oil forces the piston and discs over against the heavy back-up plate. The discs, with teeth on the outer diameter (steel), clamping against discs, with teeth on the inner diameter (bronze), enables the hub and the clutch shaft to be locked together and allows them to turn as a unit.

When the control valve spool is shifted in such a manner as to release pressure and disengage the clutch pack, the piston return spring forces out any oil from behind the piston. This oil exits at the control valve spool and is merely dumped into the center of the transmission case. It will eventually drain into the sump.

"Bleed balls" in the clutch drum also allow quick escape for oil when the pressure is released. The oil passing through here exits into the center of the case also.

MAINTENANCE OF THE 2420, C-273 DRIVE LINE

The following information should be beneficial when maintaining graders or cranes employing the 2420/C-273 drive line.

OIL SPECIFICATIONS

Present Galion grader or crane 2420 Series transmissions use either automatic transmission fluid, ATF, type A, suffix A identification, or "DEXRON". Both lubricants are approved for use by Galion. Both Type A, ATF and DEXRON are completely compatible. Type A, ATF can be "topped" or added to with DEXRON, and, DEXRON can be "topped" with Type A, ATF. Both DEXRON and Type A, ATF can be mixed in any amount and still be compatible.

For futher specific information concerning lubricants, consult the machine's particular operator's manual.

OIL LEVEL CHECK PROCEDURE

Two oil level check plugs are installed in the lower front side of the 2420 transmission. With the engine at idle, parking brake set, moldboard on the ground, all shift levers in neutral, and oil at operating temperature (minimum 160°F), the oil level must be between the height of the two plugs.

Fill plug for the system is located at the top of the torque converter. Fill as required with the engine shut down.

For step-by-step procedure of checking the oil level or adding oil, consult the machine's particular operator's manual.

FILTER AND OIL REPLACEMENT

Transmission and converter oil should be changed each 500 hours of operation.

The filter element should be changed after the first 250 hours of operation and at 500 hours of operation. Thereafter, the filter should be changed at each oil change --- every 500 hours.

THE 3420 SERIES TRANSMISSION, C-273 TORQUE CONVERTER DRIVE LINE

The 3420 Series transmission is employed by Galion in the T-600B motor grader. In conjunction with this transmission, the C-273 torque converter is used. This torque converter is mounted directly to the engine and is connected by a propeller shaft to the 3420 transmission. The output from the transmission is then directed to the final drive unit by way of another propeller shaft. The combined drive line configuration enables any one component, either torque converter, transmission, or final drive, to be removed from the machine separately. This type of arrangement allows for easy repair or replacement without effecting other drive line components.

Another important component of this type of drive line is the output shaft governor coupled to the rear of the torque converter. This governor is designed to allow the operator to maintain his machine at a pre-set constant ground speed automatically. With the use of this output shaft governor, the operator will be able to perform his blade functions more precisely as well as the motivation of the machine itself.

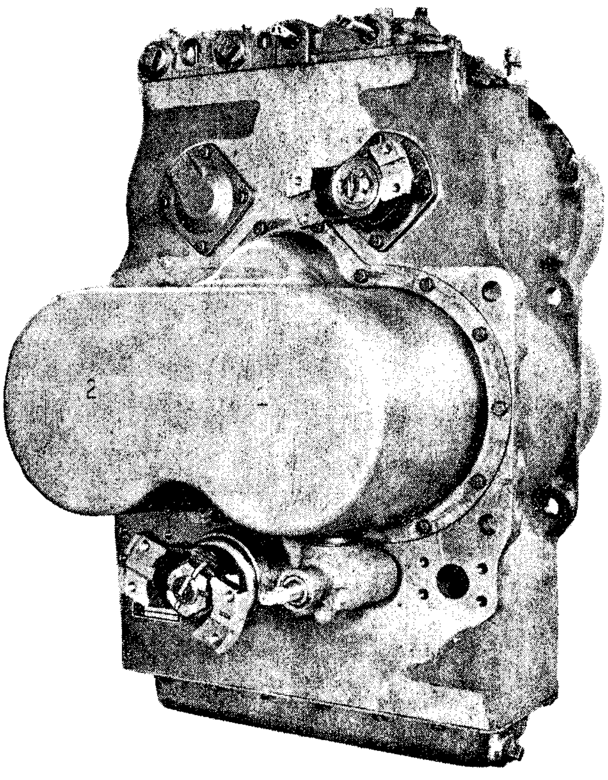

Fig. 41

3420 TRANSMISSION

C-273 TORQUE CONVERTER

All torque converters employed with the 3420 transmission are identical with that employed with the 2420 transmission except T-600B motor graders with Detroit Diesel 6-71 power. C-273.5 torque converters are used with the 6-71 thus denoting a 13.5 inch impeller; C-273 torque converters contain 13 inch impellers. All components within the C-273 used with both 2420 and 3420 series transmissions are the same in every respect.

The cross-section drawing below shows the C-273 as used with the 3420 series transmission.

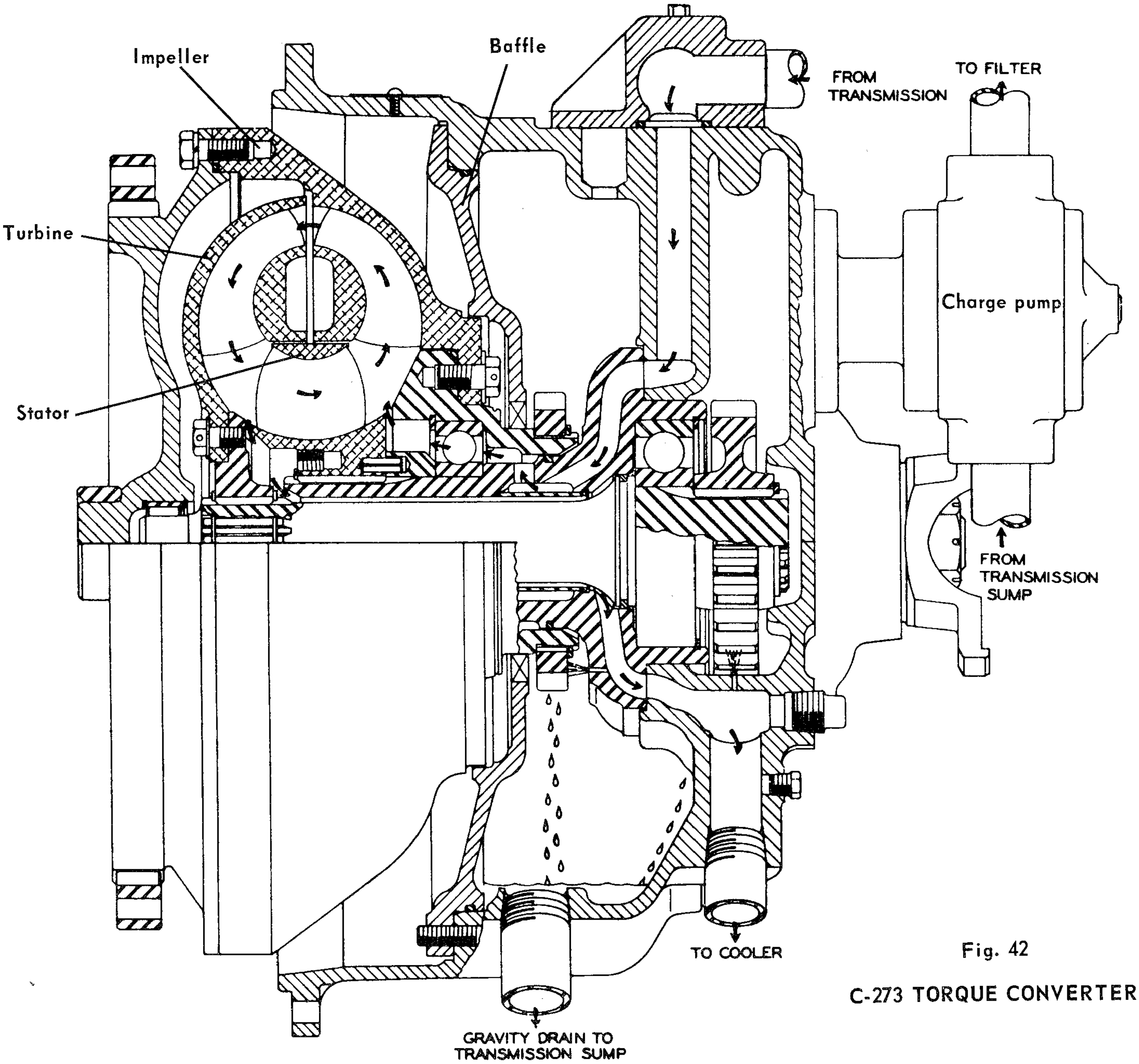

Fig. 42

C-273 TORQUE CONVERTER

Notice that the C-273 torque converter above does not have a regulating valve mounted at the top of the housing. Instead, with this type of drive line, the regulating valve is part of the control valve assembly mounted on the top of the 3420 transmission. A casting with a gasket covers the area of the torque converter housing where the regulating valve was installed before as with the 2420 system. This casting merely covers the exposed safety relief valve port and also acts as a fitting for charge oil coming from the regulating valve on the top of the 3420 transmission. Also a safety relief valve is incorporated at the combined regulating/control valve assembly rather than as before at the torque converter.

As with the 2420 system, a torque converter charge pump is installed off of the impeller accessory gears of the "dry" section. It is used (1) to hydraulically actuate the clutch packs within the 3420 transmission, (2) to provide a lubrication flow of oil to the torque converter and transmission components, and (3) to "charge" or replenish the three members of the torque converter with a sufficient amount of oil to allow proper operation of the unit. This pump is a simple gear type pump which produces a flow rate of 8 gpm per 1000 rpm.

The output shaft governor of this drive line is mounted on the torque converter and is gear driven within the "dry" section. The operation and components of this output shaft governor are identical to that used with the 2420 drive line. (However, governor components differ slightly between Detroit Diesel and IHC/Cummins engine applications.) For further information concerning the function of this type of output shaft governor, see page 10 of this manual.

THE 3420 SERIES TRANSMISSION

The 3420 Series transmission is a constant mesh power shifted forward and reverse with a full power shift in the first, second, third, and fourth speeds. This provides four speeds in either forward or reverse with shifting "on-the-go" capabilities between all speeds.

Actually one can think of this transmission having two separate shifting "sections". One "section" provides selection of the direction of travel -- either forward or reverse. Two clutch packs within the transmission enable this function. To obtain reverse direction, the "reverse" clutch pack is pressurized and is engaged while the "forward" is not pressurized and is disengaged. On the other hand, forward direction of travel is obtained by pressurizing and engaging the "forward" clutch pack while the reverse is disengaged. Actuation of these clutch packs and the corresponding direction of travel is controlled in the operator's compartment by one forward/reverse control lever. Movement of this lever to the forward position engages the transmission in the forward direction. Movement of this lever to the reverse position engages the transmission in the reverse direction. When this lever is centered, a "neutral" condition exists within the transmission and no power flow is going through either forward or reverse clutch pack. A "neutral start" safety switch is provided on this control for starting the machine.

The other "section" of the 3420 transmission provides selection of the speed --- either first, second, third, or fourth. A clutch pack is provided for each corresponding speed. A single control lever in the operator's compartment provides selection of any of the four speeds. For example, if first gear is chosen, then the "first" clutch pack is pressurized and engaged while the other three speed clutch packs are not pressurized and are therefore disengaged. Actually, selection of any particular speed pressurizes and engages that clutch pack while the others are not pressurized and are disengaged. The control lever in the operator's compartment is "detented" in such a manner as to provide positive selection of any of the four speeds. It should be noted that there is no "neutral" position for the speed shift control lever. Therefore, "neutral" condition within the transmission can only be obtained by centering the forward/reverse control lever.

Each of the four speed clutch packs can be engaged and disengaged while a machine is moving. This provides for powershifting up or down in speed ratio "on-the-go".

Another important component of the 3420 Series transmission is the control cover assembly mounted on the top of the transmission. A drawing of this control cover assembly is shown below.

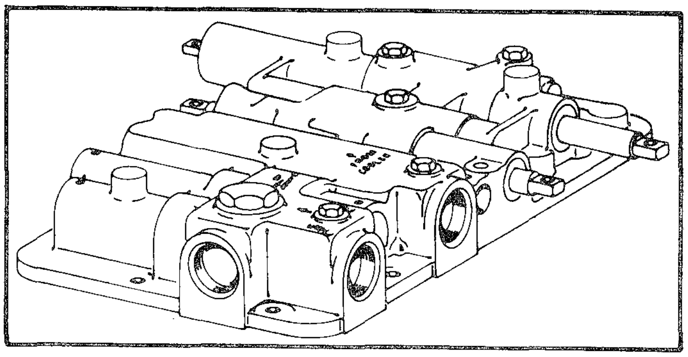

Fig. 43

CONTROL COVER ASSEMBLY

The above entire assembly consists of two basic "sections". The one "section" of the assembly contains a regulating valve assembly which functions in the same manner as the regulating valve of the 2420 system mounted on the top of the C-273 torque converter. This valve is used to maintain pressure for clutch pack activation. Also, part of this section contains a safety valve which opens to by-pass oil should excessive pressure build within the "charge" line leading to the converter.

The other "section" of the control cover assembly contains (1) a declutch spool, (2) a forward/reverse spool, and (3) a speed selector spool. Together these components function to control pressure and thus transmission engagement and disengagement. This section operates similarly to the control valve assembly of the 2420 Series transmission.

It should be noted that the control cover assembly of the 3420 transmission also contains a lube manifold which channels oil from the cooler to the various lubrication tubes within the transmission case.

Within the 3420 transmission case are a number of tubes to direct both lubrication and pressure oil. Lubrication oil from the lube manifold of the control cover assembly is carried by these tubes to each clutch pack. This oil then lubricates all bearings and clutch plates within each clutch pack. Pressure oil is then carried by another set of these tubes to engage clutch packs.

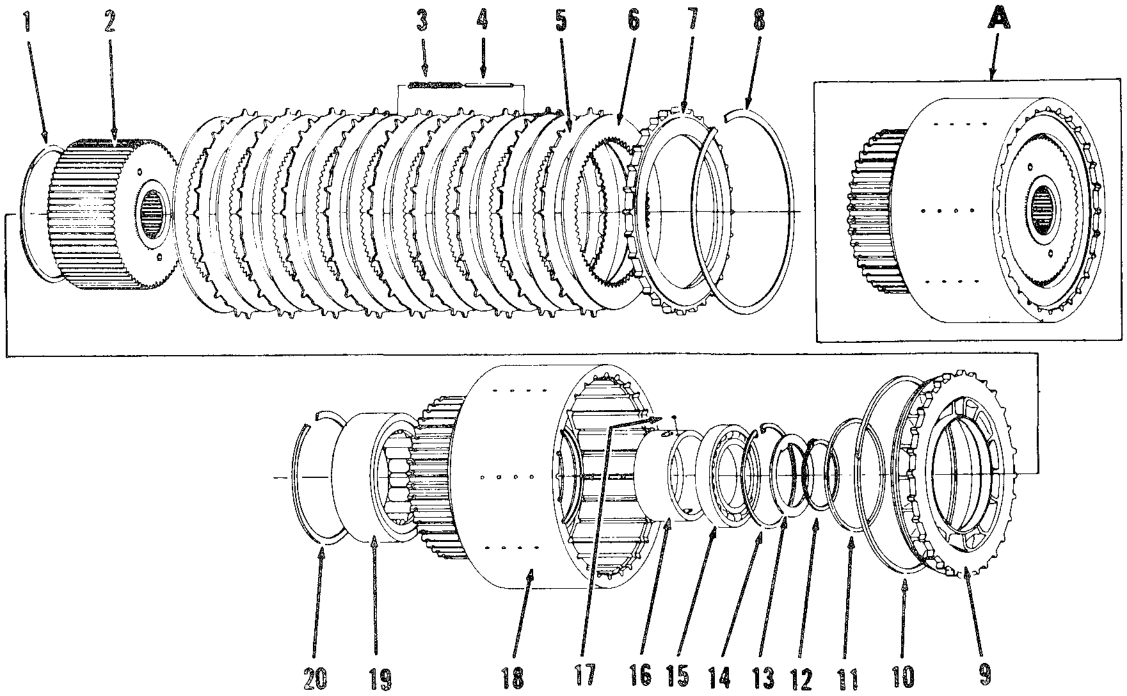

Fig. 44

3420 CLUTCH PACK

The direction and speed clutch packs each consist of a drum (18) with internal gear teeth and a bore to receive a hydraulically actuated piston. A piston (9) is inserted into the bore of the drum. The piston is oil tight by the use of sealing rings (10 & 11). A bronze disc (6) with internal teeth is inserted into the drum and rests against the piston. Next, a steel disc (5) with splines at the outer diameter is inserted. Discs are alternated until the required total is achieved. After inserting the last disc, a series of springs and pins (3 & 4) are assembled in such a manner that these springs rest on teeth of the piston. A heavy back-up plate (7) is then inserted and secured by a snap ring (8). A hub (2) with I.D. and O.D. splines is inserted into the splines of discs with teeth on the inner diameter and a splined shaft extending through the clutch support. This hub is retained by a snap ring (1). The discs and inner shaft are free to increase in speed or rotate in the opposite direction as long as no pressure is present in the direction or speed clutch pack.

A breather is also installed in both converter and transmission housings. These breathers should be kept clean to allow free passage of air.

OUTPUT SHAFT GOVERNOR
USED WITH THE 3420 SERIES DRIVE LINE

The output shaft governor employed with the 3420 Series transmission and the C-273 torque converter (or C-273.5 and DD 6-71 engine) is of the centrifugal weights type as discussed in depth previously. This governor is mounted at the rear of the torque converter and is geared to the output shaft from the turbine accessory gears.

HYDRAULIC SYSTEM OF THE 3420 SERIES DRIVE LINE

The circuit drawing below should be referred to for an overall view of the entire 3420 hydraulic system.

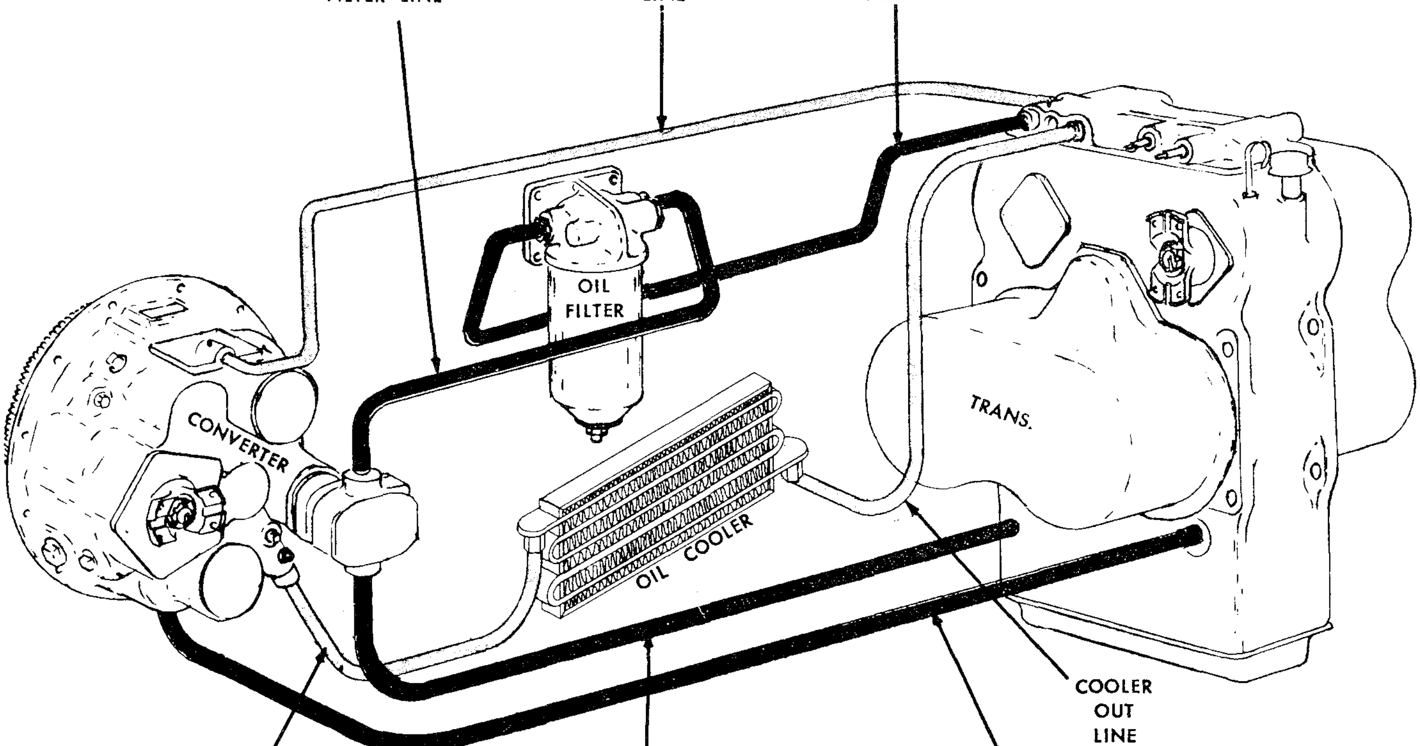

Fig. 45

3420/C-273 DRIVE LINE HYDRAULIC CIRCUIT

SUMP

The lower section of the 3420 series transmission case serves as a reservoir for the hydraulic oil of the system. This will be referred to as a sump.

Oil returning from throughout the system is collected in the sump. A screen mounted in a frame in the sump is provided to remove any foreign material from this returning oil. This above screen is covered by the sump pan which contains a magnet to catch any metallic particles. Another screen is installed in the port leading to the charge pump. Clean oil then travels by way of a flexible hose to the inlet side of the charge pump.

CHARGE PUMP

The charge pump, driven off the impeller accessory gears of the torque converter, produces a flow of oil to perform the various hydraulic and lubricating functions of the converter/transmission circuit. This is a simple gear type pump producing a flow rate of 8 gpm per 1000 rpm. Exhausting oil from the charge pump then travels by a flexible hose to a filter.

FILTER

A 70 micron replaceable filter element is installed in the line leading from the charge pump. This eliminates foreign material from circulating throughout the entire system.

The transmission/converter filter should be replaced initially after the first 250 hours of operation and again at 500 hours. Thereafter the filter should be replaced at each oil change (every 500 hours). For removal and installation of the filter element see the machines particular operator's manual.

REGULATING VALVE ASSEMBLY

Once oil exits the filter element, it travels by way of a flexible line to the regulating valve which is within the control cover assembly. The control cover assembly is mounted on the top of the 3420 transmission. The regulating valve performs three specific functions which are, in order of priority:

1. to maintain a pressure of approximately 200 psi for clutch pack activation in the transmission.

2. to supply a flow of oil to "charge" the impeller, turbine, stator of the torque converter ("wet" section).

3. to provide a safety relief in the event of excess flow from the charge pump or a blocked passage within the converter. This safety relief flow is ported into the transmission and eventually drains to the sump.

In addition to the above, a transmission pressure gauge is installed at this valve. A flexible plastic line leads to the instrument panel and a gauge. "Safe" zone shown on the transmission pressure gauge is 180 to 220 psi.

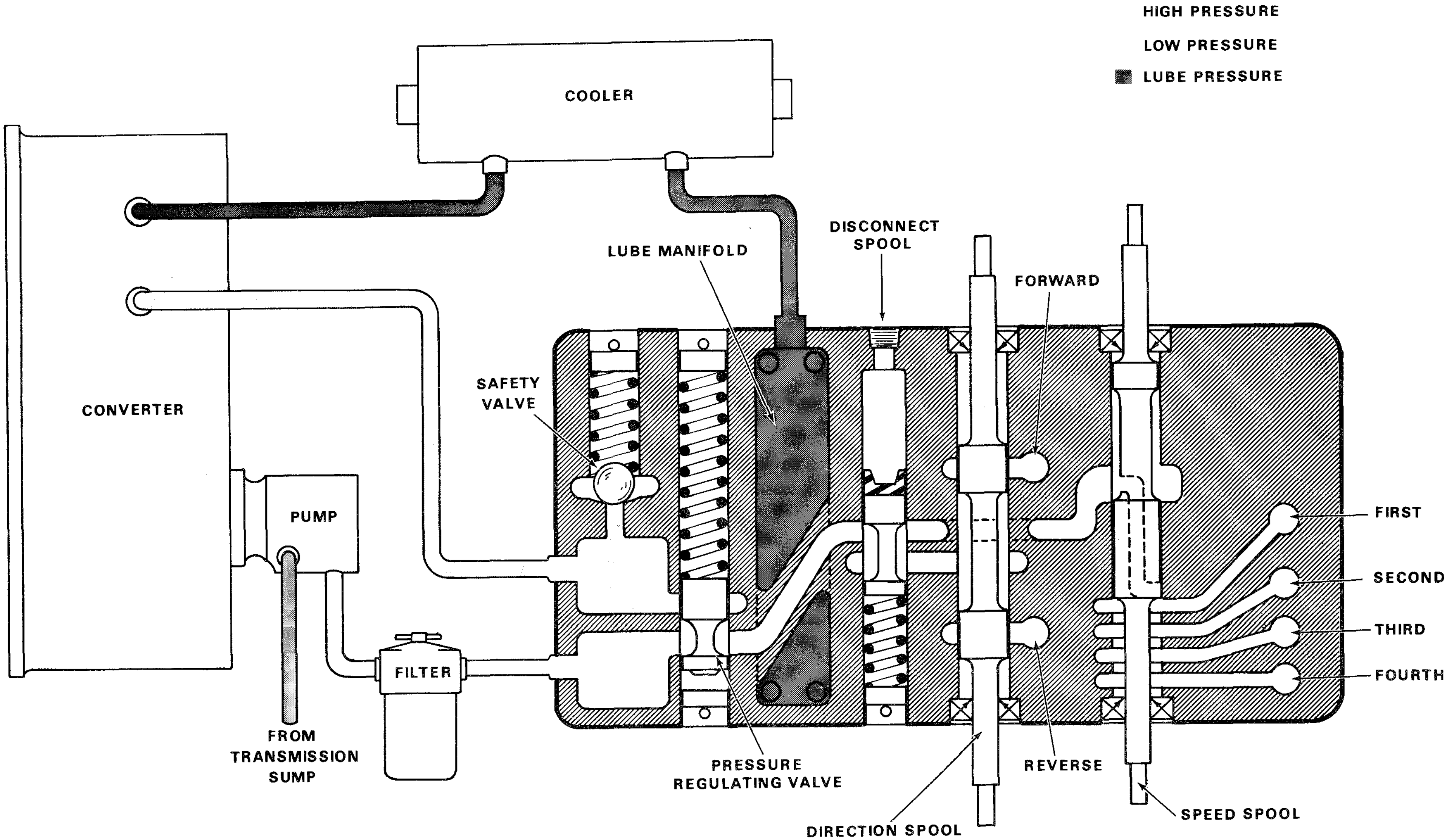

Fig. 46

CONTROL COVER ASSEMBLY

The pressure regulating valve mounted on the top of the transmission (fig. 46) remains closed until required pressure is delivered to the transmission for actuating the direction and speed clutch packs. This valve consists of a hardened valve spool operating in a closely fitted bore. The valve spool is backed up by a spring to hold the valve spool against its seat until the oil pressure builds up to the specified pressure (approximately 200 psi). The valve spool then moves toward the spring until a port is exposed along the side of the bore. The oil can then flow through this port to the "wet" section of the torque converter by way of a flexible line.

The above arrangement within the regulating valve provides first, sufficient pressure to activate clutch packs within the transmission, and second, a flow of oil to "charge" the "wet" section of the torque converter. By the word "charge" we mean replenishment of any lost oil from within the three members of the converter --- impeller, turbine, or stator. Actually there is always a flow of oil through the torque converter to allow for cooling.

C-273 TORQUE CONVERTER

The torque converter employed with the 3420 series transmission is identical with that used with the 2420 series transmission. However, there is no regulating valve assembly mounted on the converter as with the 2420 system. Instead, an adaptor cover takes its place. More over, safety relief oil from the regulating valve is discharged to the transmission case rather than the "dry" section of the converter.

After entering the converter, the oil is directed through the stator support to the converter cavity and exits between the turbine shaft and converter support.

The three members of the torque converter are composed of a series of blades. The blades are curved in such a manner as to force the oil to circulate from the impeller to the turbine, through the stator again into the impeller. This circulation causes the turbine to turn in the same direction as the impeller. Oil enters the inner side of the impeller and exits from the outer side into the outer side of the turbine. It then exits from the inner side of the turbine and after passing through the stator, again enters the inner side of the impeller.

Converter "stall" is achieved whenever the turbine and output shaft are stationary and the engine and impeller is operating at full power or wide open throttle. CAUTION: Do not maintain "stall" for more than 30 seconds at a time. Excessive heat will be generated and may cause converter or transmission seal damage.

Oil which exits the converter cavity travels by way of a galley-way to a port called converter out which leads to the cooler. Prior to exiting the converter, the oil flow passes two (2) 1/64 inch lubrication spray holes. These sprays lubricate the "dry" section of the converter. Also, this oil is made available to flexible plastic lube tube (approximately 31 inches in length) for output shaft governor lubrication. This oil eventually is vented to the "dry" section again from the governor housing. Finally, this oil passes a temperature sending unit. This senses the temperature of the "converter out" oil.

COOLER

As with the C-273 converter employed with the 2420 drive line, converter out oil travels to an air to oil heat exchanger (cooler). The cooler, located adjacent to the engine radiator, functions to stabilize the converter oil temperature.

Maintenance of the cooler entails external cleaning with compressed air and/or flushing with a water hose each 50 hours of operation. When a machine is operating in areas where lint, chaff, or vegetation are prevalent, the cooler should be inspected and cleaned more often.

TRANSMISSION PRESSURE LUBRICATION

Oil which exits the cooler travels by way of another flexible hose to a lube manifold within the control cover assembly. The cooled oil is then directed to all clutch packs through a series of tubes within the transmission case. Lubrication of all bearings, shafts, and clutch plates with each clutch pack then takes place. After lubrication of the clutch packs occurs, the oil drains to the sump again.

The drawing below points out the lube tubes for each clutch pack within the 3420 series transmission.

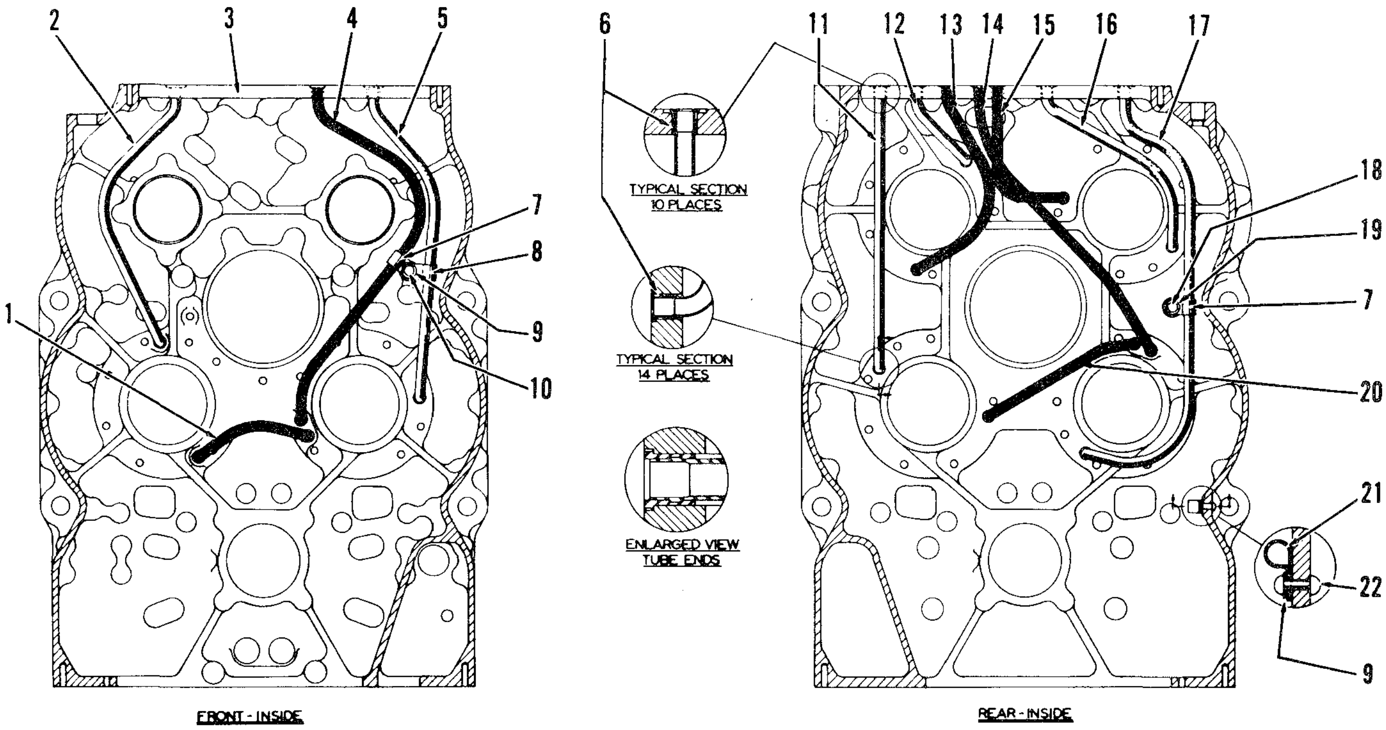

Fig. 47

3420 TRANSMISSION LUBE TUBES

PRESSURE FLOW TO TRANSMISSION

As previously stated, the regulating valve of the control cover assembly maintains pressure to the transmission control valve assembly prior to allowing a flow of oil to continue to the torque converter. This control valve assembly is actually part of the control cover assembly as shown in figure 46.

The control valve assembly on the transmission consists of a valve body with selector valve spools connected to the shifting console by exterior linkage. A detent ball and spring in the selector spool provides four positions, one position for each speed range. A detent ball and spring in the direction spool provides three positions, one each for forward, neutral, and reverse.

This control valve assembly also contains a declutch or disconnect valve spool operated by a hydraulic cylinder adapted to the control cover assembly. This valve is connected to the brake system by a line. When the wheel brakes are applied, hydraulic fluid enters the valve and overcomes a spring force. This forces the spool to shift over and block pressure from entering the directional clutches. In this manner a "neutral" is established without moving the control levers in the operator's compartment.

A brake disconnect valve located in the operator's compartment provides the operator with the option of allowing (valve open) or not allowing (valve closed) the brake hydraulic pressure to "neutralize" his transmission. For further information concerning this brake disconnect valve and its uses, see page 47 of this manual.

Engagement within the transmission is thus controlled by only two control levers (and valve spools). With the engine running and the directional (forward/reverse) control lever in neutral position, oil pressure is blocked at the control valve, and the transmission is in neutral. Movement of the forward/reverse lever and spool will direct oil, under pressure to either the forward or reverse clutch pack as desired, while the opposite one is open to relieve pressure. Engagement and disengagement of the four speed clutch packs occurs in the same manner.

PRESSURE FLOW WITHIN THE 3420 TRANSMISSION CASE

Through a series of tubes within the 3420 transmission case, oil and oil pressure is conducted to the respective clutch pack for activation. The drawing below shows these pressure tubes to each clutch pack.

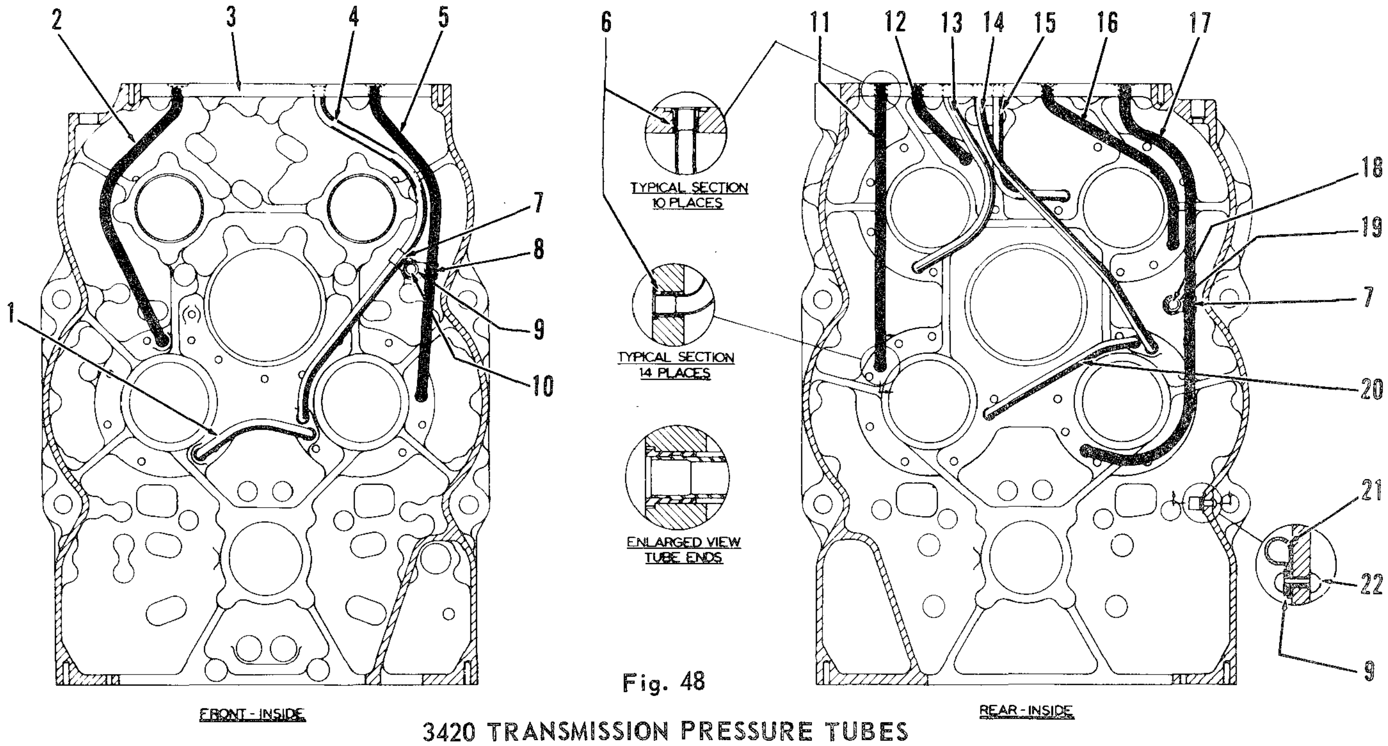

Fig. 48

3420 TRANSMISSION PRESSURE TUBES

PRESSURE FLOW WITHIN THE CLUTCH PACKS

To engage a clutch pack, as previously stated, the control valve is placed in the desired position. This allows oil under pressure to flow from the control cover valve, through a tube in the transmission case, to a chosen clutch pack. Once into the drum of the clutch pack, oil is directed through a drilled hole into the rear side of the piston bore. Pressure of the oil forces the piston and discs over against the heavy back-up plate. The discs, with teeth on the outer diameter, clamping against discs, with teeth on the inner diameter, enables the clutch pack drum and drive shaft to be locked together. This allows these two components of the clutch pack to rotate as one unit.

To disengage the clutch pack, the valve spool within the control cover assembly is shifted in such a manner as to release pressure from the respective clutch pack. The series of piston return springs within the clutch pack can then force the oil from behind the piston back to the control cover assembly, the oil is released to the transmission case where it eventually returns to the sump.

Also there are bleed balls in the clutch drums which allow quick escape for oil when the pressure to the piston is released. These bleed balls insure positive disengagement of the clutch plates whenever pressure is released to the clutch pack.

With the above arrangement, quick engagement and disengagement of clutch packs is available for power shifting "on-the-go".

MAINTENANCE OF THE 3420, C-273 DRIVE LINE

The following information should be beneficial when maintaining graders employing the 3420/C-273 drive line.

OIL SPECIFICATIONS

Present Galion grader 3420 Series transmissions use either automatic transmission fluid, ATF, Type A, suffix A identification, or "DEXRON". Both lubricants are approved for use by Galion. Both Type A, ATF and DEXRON are completely compatible. Type A, ATF can be "topped" or added to with DEXRON, and, DEXRON can be "topped" with Type A, ATF. Both DEXRON and Type A, ATF can be mixed in any amount and still be compatible.

For further information concerning lubricants, consult the machine's particular operator's manual.

OIL LEVEL CHECK PROCEDURE

Check transmission oil level with engine at idle, all controls in neutral, parking brake set, moldboard on the ground, and oil at operating temperature (at least 160° F). Remove operator's seat and cover, withdraw dipstick to check level.

Add oil to "full" mark through fill cap adjacent to dipstick. DO NOT OVERFILL.

(There is also a fill plug at the torque converter.)

For step-by-step procedure of checking the oil level or adding oil, consult the machine's particular operator's manual.

FILTER AND OIL REPLACEMENT

Transmission and converter oil should be changed each 500 hours of operation.

The filter element should be changed after the first 250 hours of operation and at 500 hours of operation. Thereafter, the filter should be changed at each oil change --- every 500 hours.

ENGINE SPEED SETTINGS FOR POWERSHIFT GRADERS & AND CRANES

Adjustment of governor and/or throttle linkages can be obtained from five (5) different engine speed setting checks. The following explanation of engine speeds will be helpful when performing these checks.

DECELERATED IDLE

This engine speed is obtained by depressing the decelerator pedal in the operator's compartment. Decelerated idle can only be obtained when an output shaft governor is employed.

LIMITED LOW IDLE

This engine speed is obtained by setting the ground speed control lever to the lowest speed position. The decelerator pedal must be released and all shift control levers must be in neutral.

LIMITED HIGH IDLE

This engine speed is obtained by moving the ground speed control lever to the highest speed position. All shift control levers must be in neutral and the decelerator pedal must be released.

STALL

This is the maximum speed of the engine with the drive line "locked" and not rotating. This speed setting is obtained by:

1. Parking brake set.
2. Moldboard placed on the ground.
3. Brake disconnect valve (for graders only) closed.
4. Service brakes applied.
5. Ground speed control lever at approximately 1/3 to 1/2 speed position.
6. Transmission placed in 4th speed, forward direction.

CAUTION: Do not maintain "stall" for more than 30 seconds at a time. Excessive heat will be generated within the converter and may cause converter or transmission seal damage. Proper governor adjustment should show same stall speed regardless of ground speed control lever position.

ENGINE HIGH IDLE

This is the maximum speed of the engine under no load. This speed is limited only by the engine's throttle governor. To obtain this speed setting, the output shaft governor linkage to the engine fuel pump must be disconnected. Then engine fuel pump must be manually operated to the "full" fuel position. All controls should be in neutral with the moldboard on the ground and the parking brake set.

The following chart provides the recommended engine speeds for Galion powershift graders and cranes, effective January 1, 1971.

GRADER ENGINE SPEEDS WITH POWERSHIFT TRANSMISSIONS

GRADER MODEL	ENGINE MAKE & MODEL	HIGH IDLE		LOW IDLE		FULL LOAD RPM	STALL RPM
		RPM	LIMITED BY HAND THROTTLE	DECEL-ERATOR SETTING	LIMITED BY HAND THROTTLE		
T400A	IHC D-407	2750	2250	700	900	2500	2480
T400A	DD 4-53	2750	2250	700	900	2500	2480
T500A	DD 4-71	2450	2150	700	900	2300	2360
T500A	CUM C464-C160	2500	2150	700	900	2300	2340
T500A	IHC DT 407	2500	2000	700	900	2300	2360
T500QP4	CUM C464-C160	2500	2150	700	900	2300	2340
T500QP4	DD 4-71	2450	2150	700	900	2300	2360
T500L	DD 4-71	2450	2150	700	900	2300	2360
T500L	IHC DT 407	2500	2000	700	900	2300	2360
T500L	CUM CT464-C175	2700	2300	700	900	2500	2510
T500QP5	CUM CT464-C175	2700	2300	700	900	2500	2510
T600B	CUM CT464-C175	2700	2300	700	900	2500	2510
T600B	DD 6-71	2450	2250	700	900	2300	2140
T600B	IHC DT 407	2500	2000	700	900	2300	2360

CRANE ENGINE SPEEDS

CRANE MODEL	ENGINE MAKE & MODEL	LOW IDLE ±50 RPM	HIGH IDLE ±50 RPM	STALL SPEED ±50 RPM
90A	IHC UV-345	750	2900	2400
90A	DD 4-53	750	2900	2400
100A	IHC UV-345	750	2900	2400
100A	DD 4-53	750	2900	2400
110A	IHC UV-345	750	2900	2400
110A	DD 4-53	750	2900	2400
125A	IHC UV-345	750	2900	2400
125A	DD 4-53	750	2900	2400
150A	IHC UV-345	750	2900	2400
150A	DD 4-53	750	2900	2400
150A	CUMMINS V-352-C	750	2900	2400

2420 TRANSMISSION & C-273 CONVERTER HYDRAULIC PRESSURES

A. CLUTCH PRESSURES

If clutch pressure does not read 260± 20 psi on the instrument panel, install a reliable 300-350 psi gauge in place of the flexible plastic pressure line at the regulating valve. The drawing on page 36 of this manual shows this pressure check point.

Record pressures at engine High idle and Low idle with the moldboard in the ground and the parking brake set. Check all four clutches by the following procedure:

(1) To check forward clutch -- engage in forward with high/low clutches in neutral.

(2) To check reverse clutch -- engage in reverse with high/low clutches in neutral.

(3) To check low clutch -- engage in low with forward/reverse clutches in neutral.

(4) To check high clutch -- engage in high with forward/reverse clutches in neutral.

All pressures should be 260± 20 psi. (Clutch pressures may be taken from 1/8" N.P.T. fittings located on each bearing cap.)

B. CONVERTER OUT PRESSURE

Install a reliable 100 psi gauge in place of the output shaft governor lube tube on the torque converter. Operate the engine at High idle with the transmission in neutral and the converter temperature 180° F. Converter out pressure should be 35± 10 psi.

3420 TRANSMISSION & C-273 CONVERTER HYDRAULIC PRESSURES

A. CLUTCH PRESSURES

If clutch pressure does not read 200± 20 psi on the instrument panel, install a reliable 300-350 psi gauge in place of the flexible plastic pressure line at the regulating valve. (The regulating valve is part of the control cover assembly mounted at the top of the transmission.)

Record pressures at engine High idle and Low idle with the moldboard in the ground and the parking brake set. Check all six clutches by the following procedure:

(1) To check forward clutch -- engage in forward with 4th clutch engaged.

(2) To check reverse clutch -- engage in reverse with 4th clutch engaged.

(3) To check 1st clutch -- engage in 1st with forward/reverse in neutral.

(4) To check 2nd clutch -- engage in 2nd with forward/reverse in neutral.

(5) To check 3rd clutch -- engage in 3rd with forward/reverse in neutral.

(6) To check 4th clutch -- engage in 4th with forward/reverse in neutral.

All pressures should be 200± 20 psi.

B. CONVERTER OUT PRESSURE

Install a reliable 100 psi gauge in place of the output shaft governor lube tube on the torque converter. Operate the engine at High idle with the transmission in neutral and the converter temperature 180° F. Converter out pressure should be 35± 10 psi.

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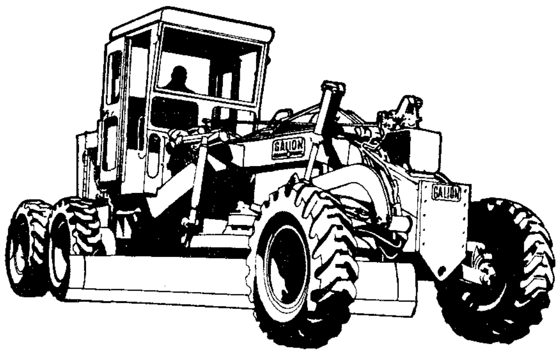
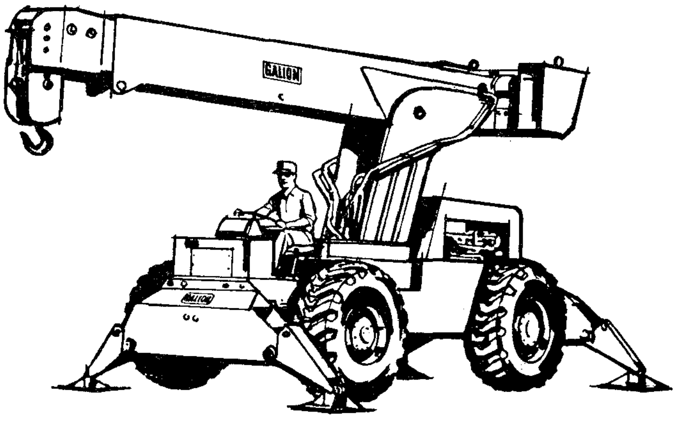


GRADER & CRANE POWERSHIFT TRANSMISSIONS



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