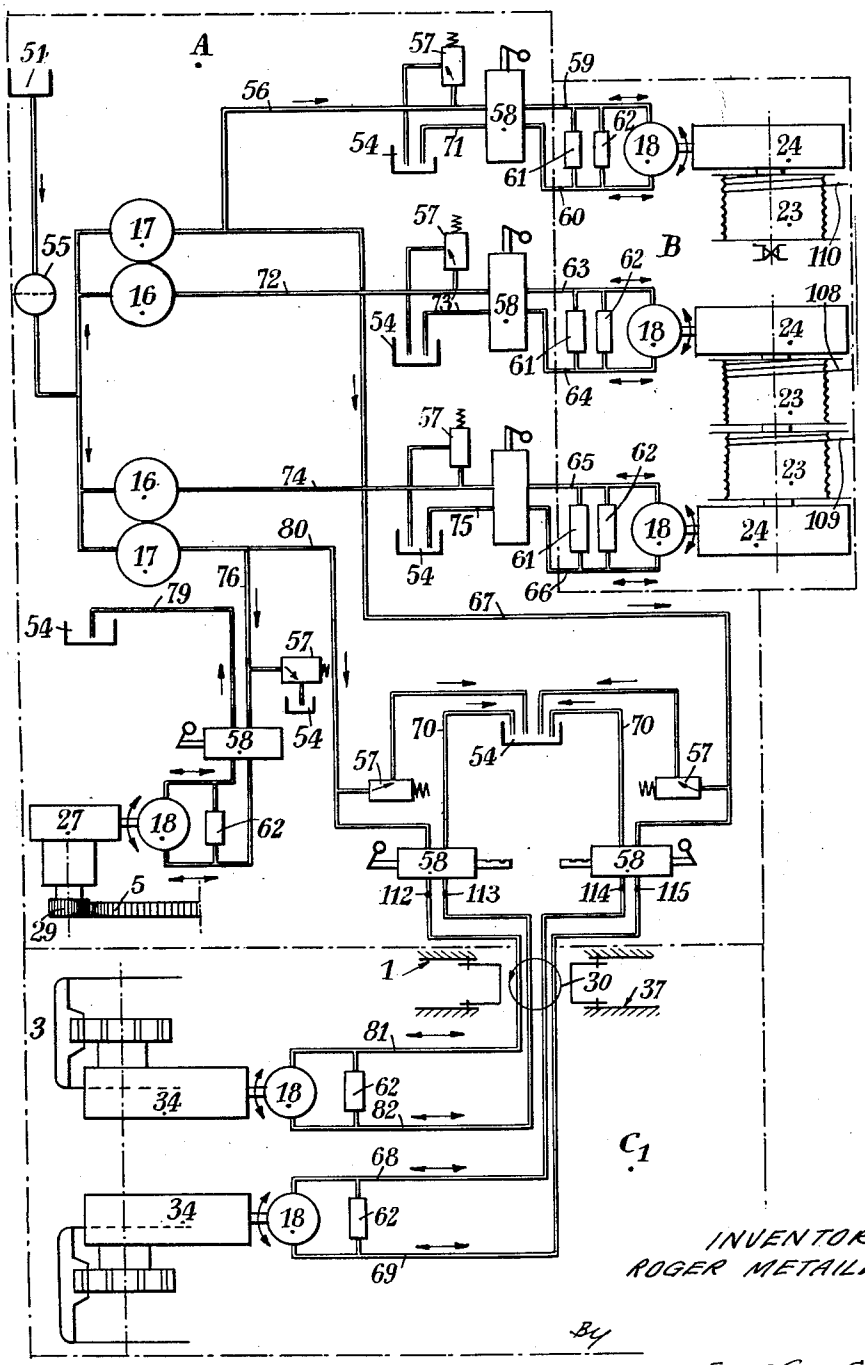
March 9, 1965 R. METAILLER 3,172,552

HYDRAULIC CONTROL SYSTEM FOR SELF-PROPELLED EXCAVATOR

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Fig. 1



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Fig. 2

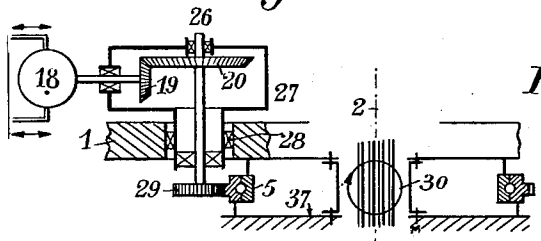


Fig. 3

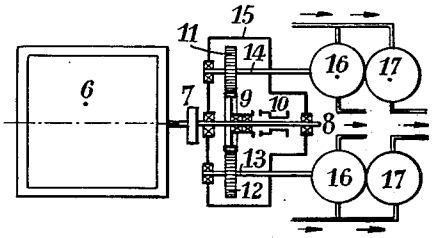


Fig. 5

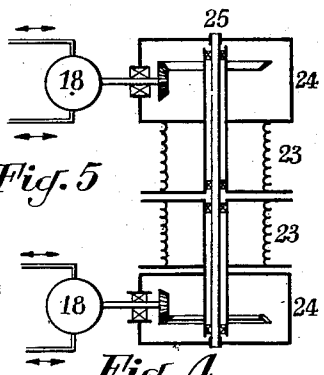


Fig. 4

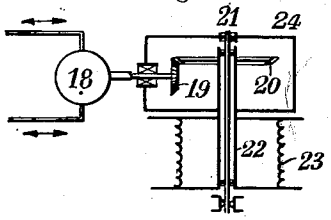


Fig. 7

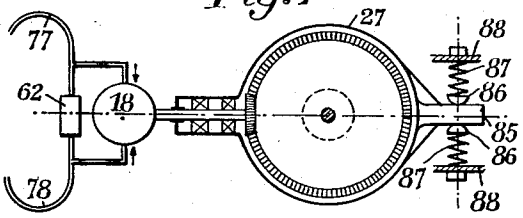


Fig. 6

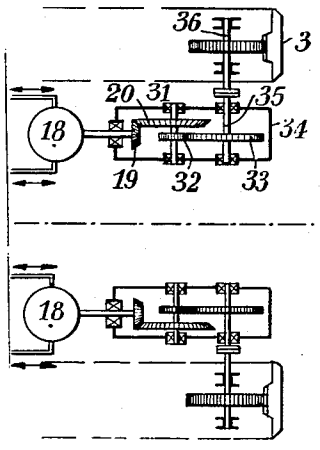


Fig. 8

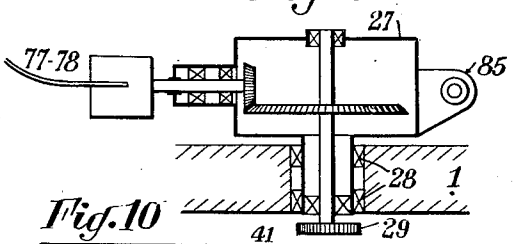
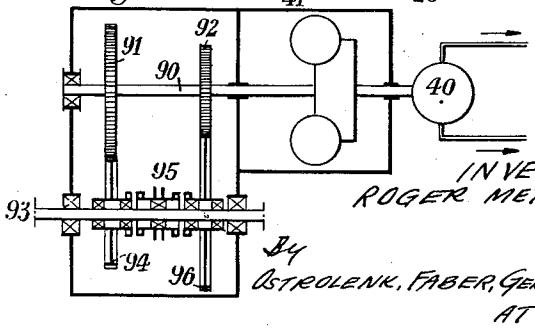


Fig. 10



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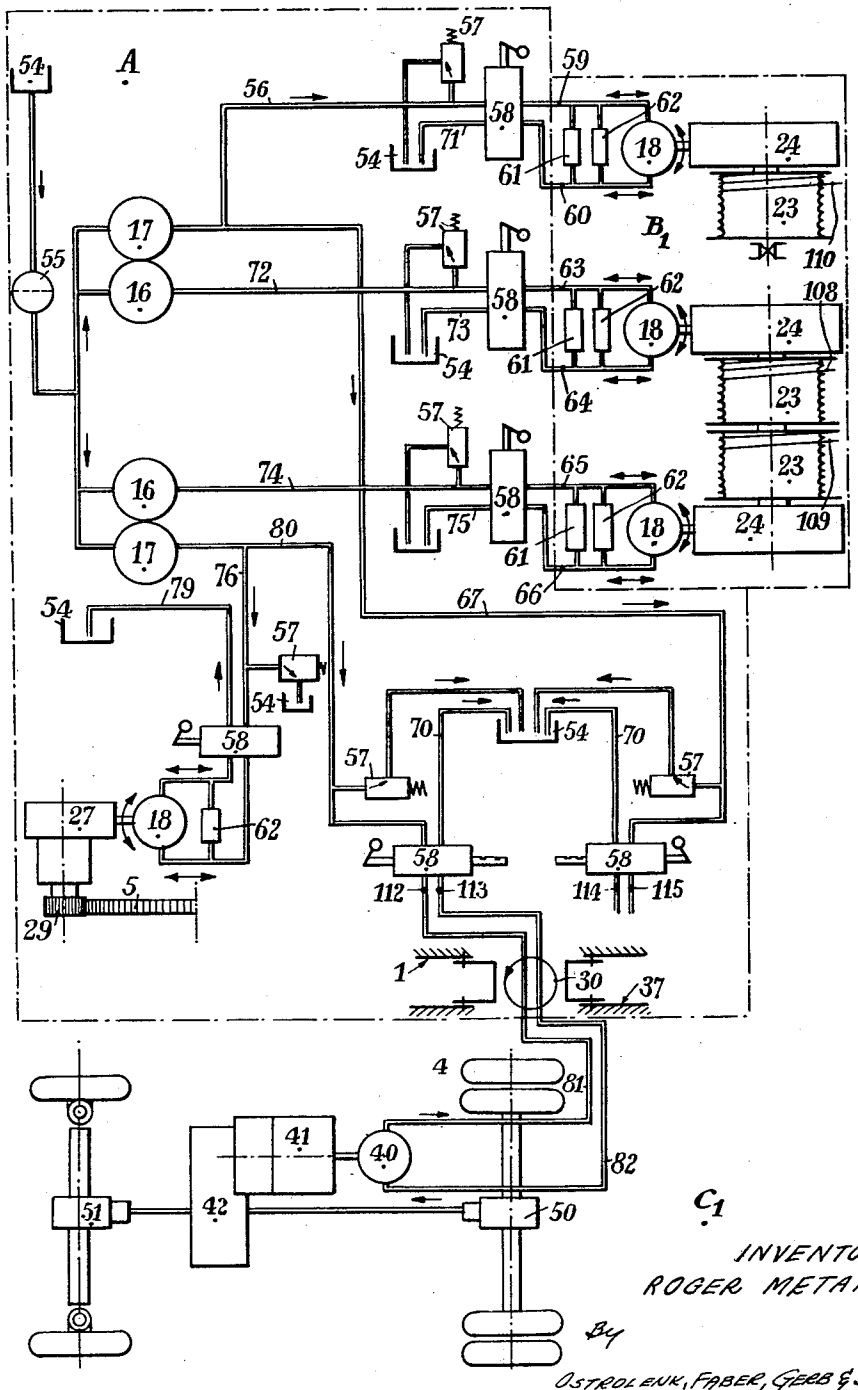
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Fig. 9



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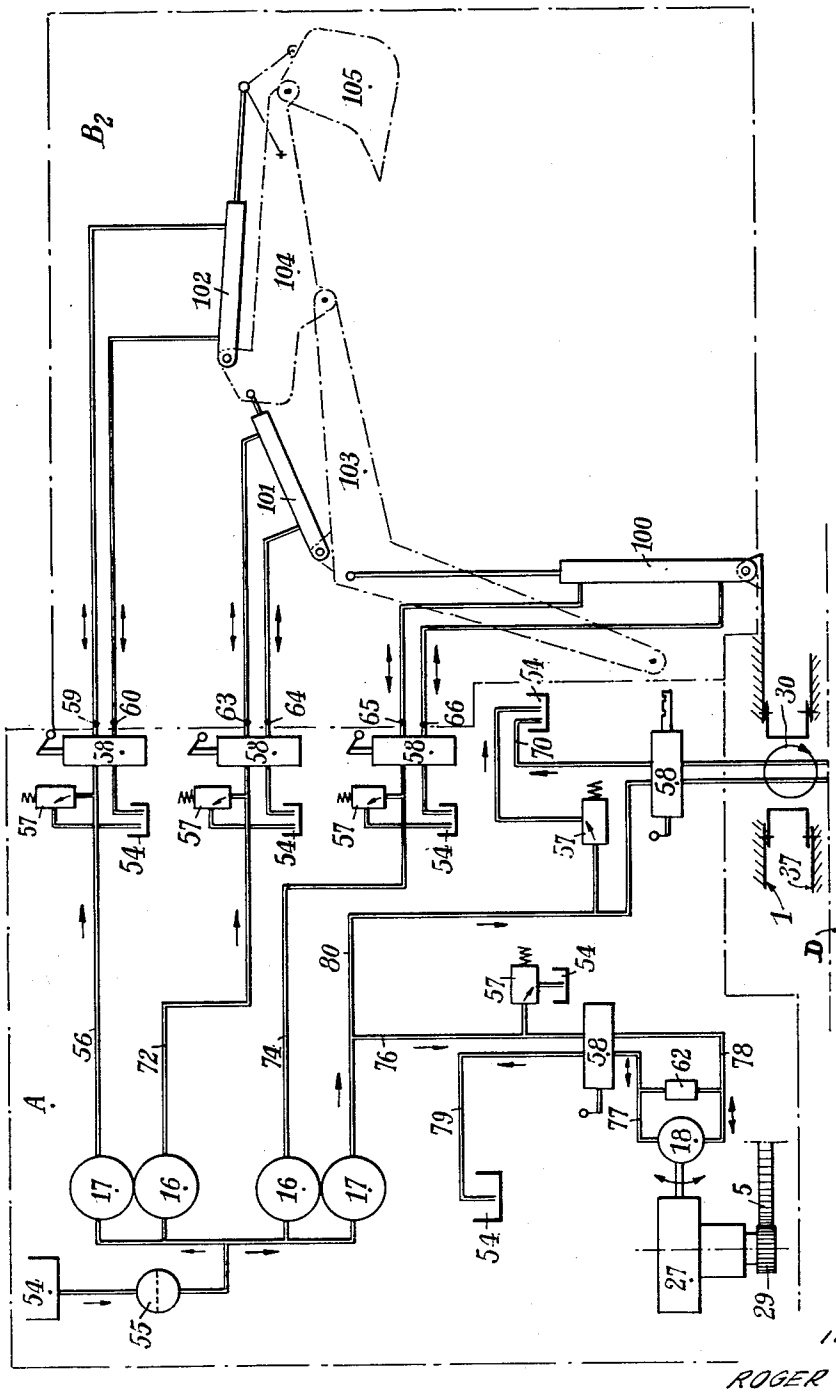


Fig. 11

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HYDRAULIC CONTROL SYSTEM FOR SELF-PROPELLED EXCAVATOR

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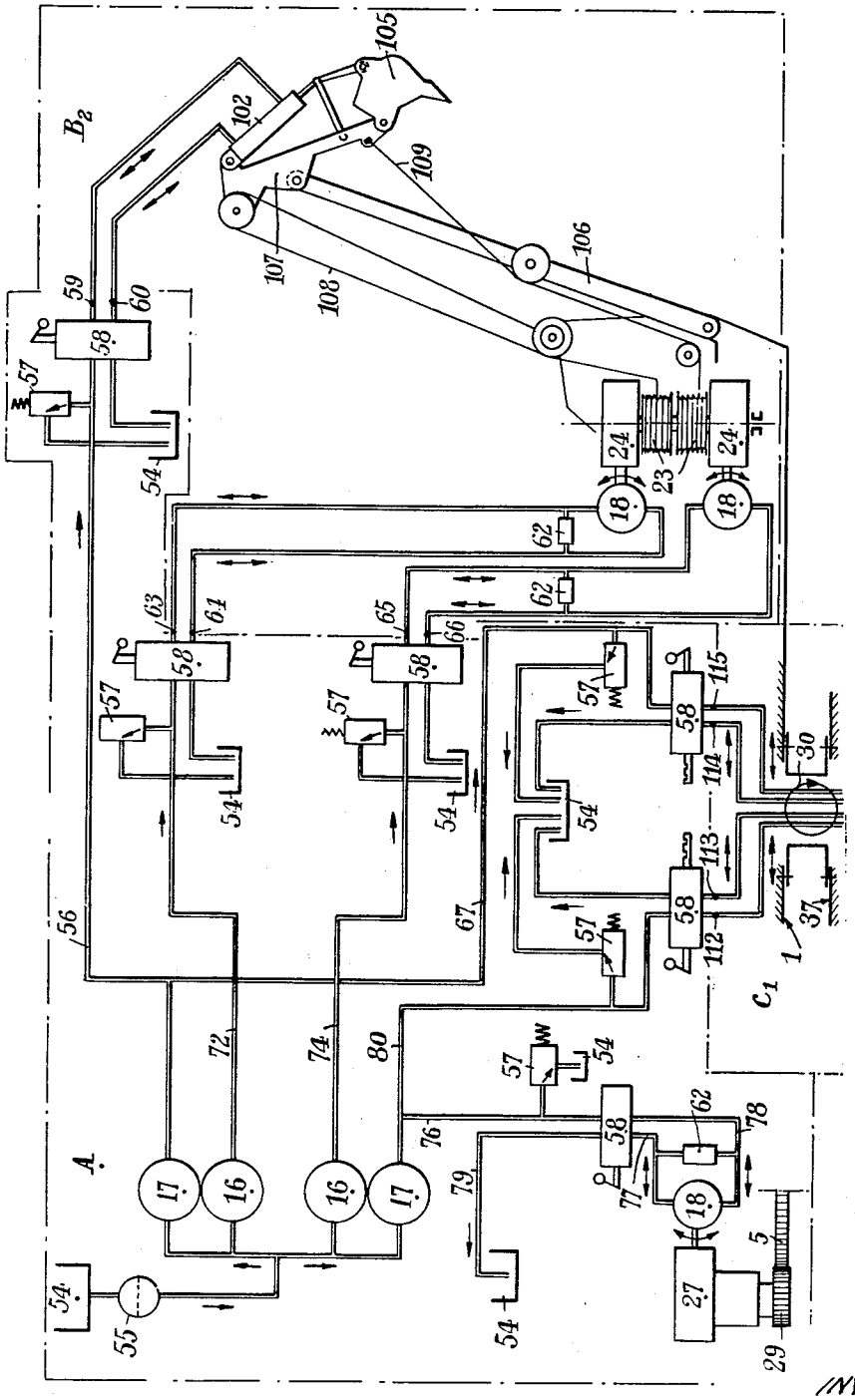


Fig. 12

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United States Patent Office

3,172,552

Patented Mar. 9, 1965

3,172,552

HYDRAULIC CONTROL SYSTEM FOR SELF-PROPELLED EXCAVATOR

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Filed Apr. 9, 1963, Ser. No. 271,741

4 Claims. (Cl. 214—138)

This invention relates in general to excavators and has specific reference to a hydraulic control system for a self-propelled excavator comprising a slewing platform, one or a plurality of working equipments pivotally mounted on said slewing platform, for example a boom or jib pivotally mounted on said platform, a bucket arm or dipper handle pivoted on the outer end of said boom and a bucket or dipper pivoted in turn on the outer end of said dipper arm or handle, and mechanical means arranged under the aforesaid platform for propelling the machine.

In public work or earth-moving machines of the type broadly defined hereinabove hydraulic control systems or gears are frequently provided, but in hitherto known hydraulic control systems or gears certain pumps feed a plurality of members adapted to operate simultaneously, and therefore the movements impressed to these members are obviously attended by a certain irregularity.

It is the chief object of this invention to provide a hydraulic control system for an excavator of the type broadly set forth hereinabove, wherein each pump actuates either a single one of the mechanical members to be operated or two mechanical members of which the simultaneous operation must be strictly avoided under any circumstances.

This hydraulic control system comprises a control unit incorporating five pairs of junction-points permitting, by properly connecting receiving units to these pairs of junction-points, adapting of the system to the equipment of an excavator having its pivoting or oscillating elements operated by means of drums or double-acting cylinders and its frame mounted either on crawler tracks or on heavy tyres, and this control unit comprising four hydraulic pumps connected in parallel to a fluid reservoir and driven from the power unit (for instance the diesel or like thermal engine) of the machine is characterized in that two of said hydraulic pumps are adapted to feed hydraulic fluid under pressure each to one pair of junction-points feeding respectively hydraulic motors controlling two of said pivoting elements, another pump delivering in parallel hydraulic fluid to a pair of junction-points for feeding in turn the motor associated with another pivoting element, and another pair of junction-points leading to a rotary joint in said slewing platform, the last pump delivering in parallel hydraulic fluid under pressure to a hydraulic motor for slewing the platform and to another pair of junction-points leading to said rotary joint under said platform which is provided for feeding the hydraulic motors driving mechanican means mounted under said platform for propelling the excavator forwards or backwards.

It will be seen that in this arrangement the first and second pumps each actuate a single element, that is, one of the elements pivotally mounted on the slewing platform. The third pump feeds the motor driving the third pivoting element and also one of the motors driving the mechanical means mounted under the platform for propelling the excavator. These two last-named motors are never operated simultaneously. The same applies to the two motors operable from the fourth pump since these two motors produce the one the slewing movements of the platform relative to the undercarriage, and the other the forward or backward translation of this undercarriage.

With the foregoing and other objects in view, the invention resides in the novel arrangement and combination of parts and in the details of construction hereinafter described and claimed, it being understood that changes in the precise embodiment of the invention herein disclosed may be made within the scope of what is claimed without departing from the spirit of the invention.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a general diagram showing the control system of this invention as applied to a crawler-mounted machine wherein the pivoting working elements are actuated by means of drums and ropes;

FIGURES 2 to 8 illustrate various details of the assembly shown in FIG. 1;

FIG. 9 is an assembly diagram showing the complete arrangement as applied to a machine wherein, as in the example of FIG. 1, three pivoting working elements are actuated by means of drums and ropes, the machine being mounted on pneumatic tyres;

FIGURE 10 illustrates on a larger scale one portion of the diagram of FIG. 9 to show a detail of that portion of the system which drives the tyre-mounted wheels of the machine undercarriage;

FIGURE 11 is the assembly diagram of the control system as applied to a machine wherein three pivoting working elements are operated by means of double-acting hydraulic cylinders; and

FIGURE 12 is another assembly diagram of the control system as applied to a machine wherein two pivoting working elements are operated by means of drum-and-rope units, the third element being operated by means of a hydraulic cylinder.

The platform **1** of FIG. 1 adapted to be slewed about the axis **2** as shown in FIG. 2 is connected to the central portion **37** of the undercarriage through a race **5**. This platform **1**, as shown in FIG. 3, comprises:

A thermal engine **6** drivingly connected through a coupling **7** to a transfer gearing **15** which, through the shaft **8** on which a pinion **9** mounted for free rotation may be rendered solid with this shaft **8** through a sliding hub **10**, is in meshing engagement with pinions **11**, **12** solid with shafts **14**, **13**, respectively, drives the hydraulic pumps **16**, **17** mounted in parallel. A boom-luffing drum **23** shown in FIG. 4 is driven from a hydraulic motor **18** through bevel gears **19**, **20** and a sleeve **22** rigid with the rope drum **23**. The sleeve **22** is mounted for free rotation on shaft **21** rigid with a gear case **24**. A set of two drums **23** for hoisting the load or the two-rope grab bucket, or a drag line bucket (or any other desired equipment) illustrated in FIG. 5 comprises the elements corresponding to those of FIG. 4 and shown as being mounted on a stationary shaft rigid with gear cases **24**. A rotary-motion or slewing mechanism produces the slewing motion of the platform **1** from a hydraulic motor **18** through bevel gears **19**, **20** rigid with a vertical shaft **26** mounted for loose rotation in a gear case **27**. To this end a toothed wheel **29** rigid with shaft **26** is in constant meshing engagement with the circular rack of a guide race **5**, this rack being secured on the central portion **37** of the frame or undercarriage of the machine. The gear case **27** is mounted for free rotation with respect to the platform **1** through the medium of bushings or bearings **28**. A rotary joint **30** mounted between the platform **1** and the central portion **37** of the undercarriage permits, as shown in FIG. 2, the circulation of fluid under pressure from the slewing platform to the undercarriage irrespective of the relative positions of the platform and undercarriage. The undercarriage is mounted on a pair of lateral crawler tracks **3** each provided, as shown in FIG.

6, with a separate driving unit comprising a hydraulic motor **18** and a mechanical transmission consisting of pinions **19**, **20**, **32**, **33** and shafts **31**, **35** enclosed in the gear case **34**. This mechanism is adapted to drive a sprocket **36** driving in turn the crawler tracks **3**.

The pumps **16** and **17** driven from motor **6** as shown in FIG. 3 have their suction port connected to the reservoir **54** and draw oil therefrom through a filter **55**.

A boom luffing rope **110** is wound on the luffing drum **23** from the mechanism contained in the gear case **24** and the hydraulic motor **18**. This motor is fed from a pump **17** delivering the fluid under pressure through a pipe line **56**. The fluid pressure is controlled by a pressure limiter **57** adapted to discharge the excess oil into the reservoir **54** if necessary. A distributor **58** comprises a neutral position wherein the motor is not fed with oil or like fluid under pressure, the latter returning in this case to the reservoir through the line **71**; in this position the fluid under pressure circulates in the pipe line on the junction side **59**, so that the motor is driven in the load-hoisting direction and the fluid returned through the pipe line on the other junction side **60**, and an opposite position wherein the fluid flows through junction side **60**, the motor in this case being driven in the load lowering direction and the fluid returned through the pipe line on junction side **59**. A pressure equalizer **62** is adapted to by-pass the feed and return lines of hydraulic motor **18**, should the pressure within the motor exceed that of pump **17**. A monitored valve **61** opens the circuit through the junction side **59** when the pressure is delivered through the other junction side **60** for lowering the load. The opening of junction side **59** and therefore the load lowering speed are controlled by a calibration of valve **61**. Therefore, this calibration makes it necessary to operate the engine **6** for lowering the load. To permit the control of the free fall of the load a mechanical clutch or a hydraulic motor **18** with a zero output position may be provided between the output shaft of motor **18** and pinion **19**.

Ropes **108** and **109** are controlled by units similar to those described hereinabove and fed with fluid from pumps **16**.

The slewing wheel **29** is driven from the mechanism contained in the gear case **27** and the hydraulic motor **18** is fed with fluid under pressure from pump **17** through the pressure limiter **57** and distributor **58**. The pressure equalizer **62** is adapted to by-pass the feed and return lines of motor **18** should the pressure within this motor exceed that of the fluid delivered by pump **17** and controlled by limiter **57**.

The forward and backward motion of the crawler-mounted undercarriage is obtained by means of two units each comprising a mechanism (contained in a gear case **34**) and hydraulic motor **18**. Each motor **18** is fed through one of the two pumps **17** through a pipe line **80** leading to a distributor **58** associated with a pressure limiter **57**. The fluid under pressure flows through the rotary joint **30** mounted between the slewing platform **1** and the central portion of undercarriage **37**. The combination of the positions of distributor **58** permits of driving the two crawler tracks either simultaneously in the same direction (either forwards or backwards) for operating the machine along a straight course, or in opposite directions for turning the machine, another alternative consisting in driving only one crawler, the other remaining stationary, for long-radius turns. A pressure equalizer **62** is adapted to by-pass each motor **18** in case of overpressure resulting from an abnormal resistance to the driving effort.

The platform slewing mechanism comprises a damping device as shown in FIGS. 7 and 8. To this end the case **27** carries a lug **85** engaged by rods having a part-spherical head **86** urged against the lug **85** by compression springs **87** reacting against the platform **1** by means of stop members **88**. When the slewing motion is stopped abruptly

and during the opening of the equalizing valve **62**, the inertia of the mass constituted by the platform **1** is transmitted to the gear case **27** rotating freely with respect to this platform **1**, and absorbed according to the direction of rotation by one or the other spring **87**. To permit the rotation of case **27** in relation to platform **1**, flexible pipe sections **77**, **78** are inserted in the pipe lines leading to the motor **18** driving the pinion **29**.

The above-described component elements have no mechanical connection whatsoever with one another, so that their mounting on platform **1** is greatly facilitated. The hydraulic pipe lines comprise five pairs of junction-points **59–60**, **63–64**, **65–66**, **112–113** and **114–115** for connecting or disconnecting the machine elements fed through the pairs of junction points respectively.

It will be noted that the arrangement shown in FIG. 1 and described hereinabove comprises a control unit A feeding the pairs of hydraulic junction points **59–60**, **61–63**, **65–66**, **112–113** and **114–115** and two controlled units, that is unit B_1 connected to the first three pairs of hydraulic junction-points for actuating the three oscillating motions of the machine, for example the luffing motion of the boom on the platform, the motion of the dipper arm and the motion of the bucket or dipper proper on said arm, and unit C_1 connected on the last two pairs of hydraulic junction-points for controlling the movements of the machine.

In the diagram of FIG. 9 showing the adaptation of the hydraulic control system to a tyre-mounted machine having its three pivoting elements controlled by drums and ropes, the control unit A and the receiving unit B are also provided, exactly as in the preceding embodiment, but another unit C_2 is substituted for unit C_1. This unit C_2 is connected to the pair of hydraulic junction-points **112–113**, the pair of junction-points **114–115** being inoperative in this case. The undercarriage or chassis **4** of the machine carries in this example a propelling control unit consisting of a hydraulic motor **40** driving a torque converter **41**. The hydraulic motor **40** is fed from a pump **17** of unit A through the medium of pipe line **80**, pressure limiter **57** of distributor **58** and pipe lines **81**, **82** connected to the pair of junction-points **112–113**, the fluid being circulated under the frame to the aforesaid unit C_2 through a rotary joint **30**.

In this case, the pair of junction-points **114–115** remains inoperative.

FIGURE 10 shows the torque converter **41** driven from the hydraulic motor **40**. In order to widen the range of speeds of the excavator, the gearbox **42** mounted on the output shaft of the torque converted is a two-speed change gear having pinions **91**, **92** rotatably solid with the output shaft **90** of torque converter **41**. These pinions are in meshing engagement with toothed wheels **94**, **96** revolving freely on shaft **93** and adapted to be rendered separately solid with shaft **93** by means of a sliding hub **95**. If desired, the gear case **42** may be mounted directly on the torque converter **41**.

In the diagram of FIG. 11 showing the application of the control system to a machine having its three pivoting elements actuated by three double-acting cylinders there is also shown, as in all the combinations according to this invention, the control unit A of FIGS. 1 and 7, but in this case a unit B_2 is substituted for the receiving unit B_1 of these two figures. This unit B_2 comprises a boom **103** the vertical movements of which are controlled by a hydraulic cylinder **100** fed with fluid under pressure through pipe lines connected to the pair of junction-points **65–66**, an arm **104** the pivotal movements of which on the outer end of the boom are controlled through a cylinder **101** fed through pipe lines connected to the pair of junction-points **63–64**, and a bucket **105** pivoted in turn on the outer end of the arm by means of a cylinder **102** fed through pipe lines connected to the pair of junction-points **59–60**.

In the diagram of FIG. 12 showing the manner in which

the control system is adaptable to an earth moving machine having two pivoting elements actuated through drums and ropes, with a third pivoting element actuated through a double-acting hydraulic cylinder, the unit B_2 of the control system illustrated in FIG. 10 is replaced by a unit B_3 comprising a boom **106** and a dipper arm **107** pivoted on the outer end of this boom. The vertical movements and the boom and dipper arm are controlled through ropes **108** and **109** connected to drum **23**. The dipper arm **107** carries a bucket **105** pivoted by means of a double-acting cylinder **102** fed through pipe lines connected to the pair of junction-points **59–60**. Two motors **18** for driving the drums **23** are connected to the two pairs of junction-points **63–64** and **65–66**, and pressure equalizing means **62** are interposed therebetween.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

What I claim is:

1. A hydraulic control system for an excavator having a frame, a platform mounted for slewing motion on said frame, a thermal engine mounted on said platform, three swinging working members consisting of a boom mounted for luffing motion about a horizontal axis on said platform, of a bucket arm pivotally mounted on the outer end of said boom, and of a bucket pivotally mounted on the outer end of said bucket arm, of a mechanism mounted on said frame under said platform for imparting a movement of translation to the excavator and comprising a pair of drive shafts and a pair of crawler tracks driven from said drive shafts, respectively, and of another mechanism for controlling the slewing motion of said platform on said frame, said system comprising four pumps rotatably driven at the same speed from said engine, a first hydraulic motor mounted on said platform and driving on the one hand the first one of said swinging members and a first distributor for said hydraulic motor, a second hydraulic motor mounted under said platform and driving one of said drive shafts, a rotary seal axially mounted through said platform, a second distributor mounted on said platform and connected through said rotary seal to said second hydraulic motor, said first and second distirbutors being connected in parallel to the first one of said four pumps, a third and a fourth hydraulic motors mounted on said platform and adapted to control respectively said second and third swinging working members, a third and a fourth distributors controlling respectively said third and fourth hydraulic motors and fed respectively from said second and third pumps, a fifth hydraulic motor mounted on said platform for actuating the mechanism controlling the slewing movements of said platform on said frame, and a fifth distributor for said fifth motor, a sixth hydraulic motor mounted under said platform for driving said other drive shaft, a sixth distributor mounted on said platform and connected through said rotary seal to said sixth motor, said fifth and sixth distributors being connected in parallel to said four pump.

2. A hydraulic control system as set forth in claim 1 for an excavator wherein the mechanism for controlling the slewing movements of the platform relative to said frame comprises a toothed annulus fastened on said frame, a gear case rotatably mounted on said frame, an axial shaft rotatably mounted in said case, a pinion keyed on the end of said axial shaft and meshing with said toothed annulus, a lug rigid with said case, resilient means mounted on said platform for resiliently urging said case for rotation towards a mean position in relation to said platform, and a drive shaft extending radially from said case and rotatably connected to said axial shaft in said case, said fifth hydraulic motor coupled to said drive shaft extending radially from said case and flexibly mounted on said platform being fed through flexible hydraulic pipe lines whereby said fifth motor may follow the low-amplitude pivotal movements of said case in relation to said platform against the resistance of said resilient means.

3. A hydraulic control system as set forth in claim 1, for an excavator having its mechanism mounted on the frame under said platform for imparting the movements of translation to the excavator consists of a tire-mounted power-driven set of wheels, of a differential and of a single drive shaft driving said differential, wherein said drive shaft is coupled to said second hydraulic motor, said sixth distributor being kept in its closed position.

4. A hydraulic control system as set forth in claim 3, comprising in addition a torque converter and a change-speed mechanism interposed between said second hydraulic motor and the drive shaft driving said differential.

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