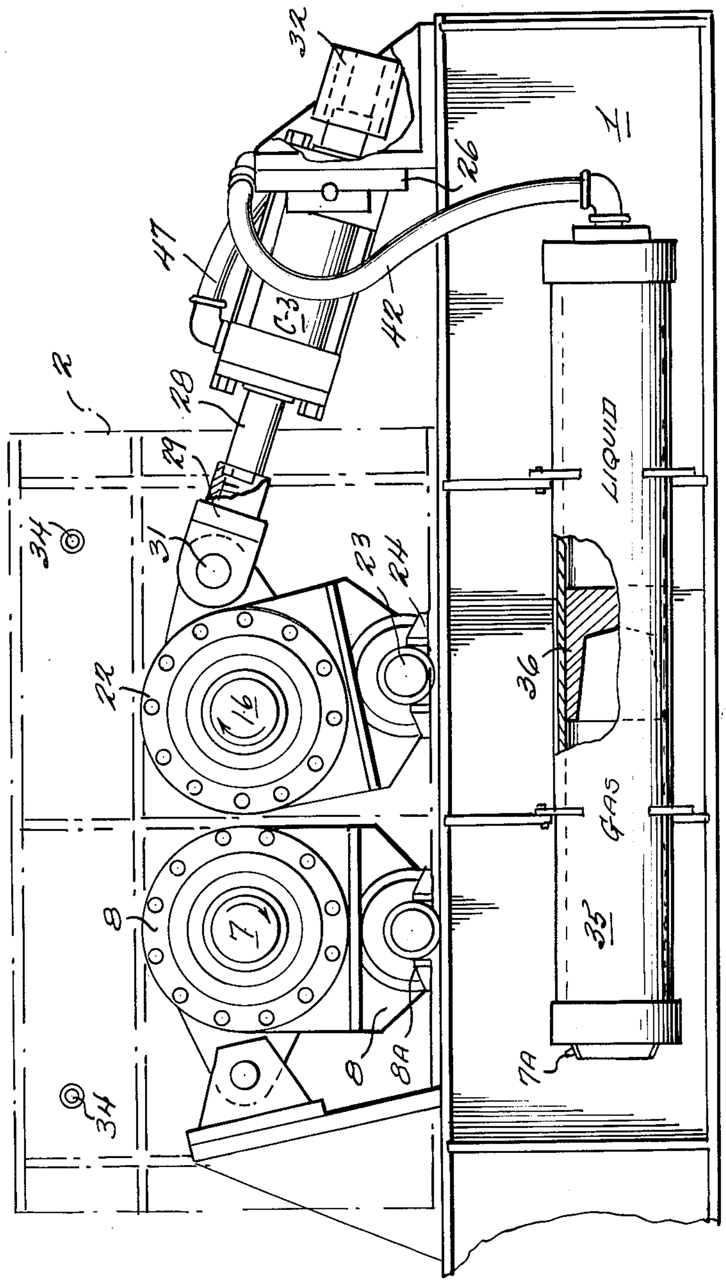
July 30, 1963 H. P. KAUTZ 3,099,406

ORE CRUSHER

Filed May 2, 1961 5 Sheets-Sheet 1



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ORE CRUSHER

Filed May 2, 1961 5 Sheets-Sheet 2

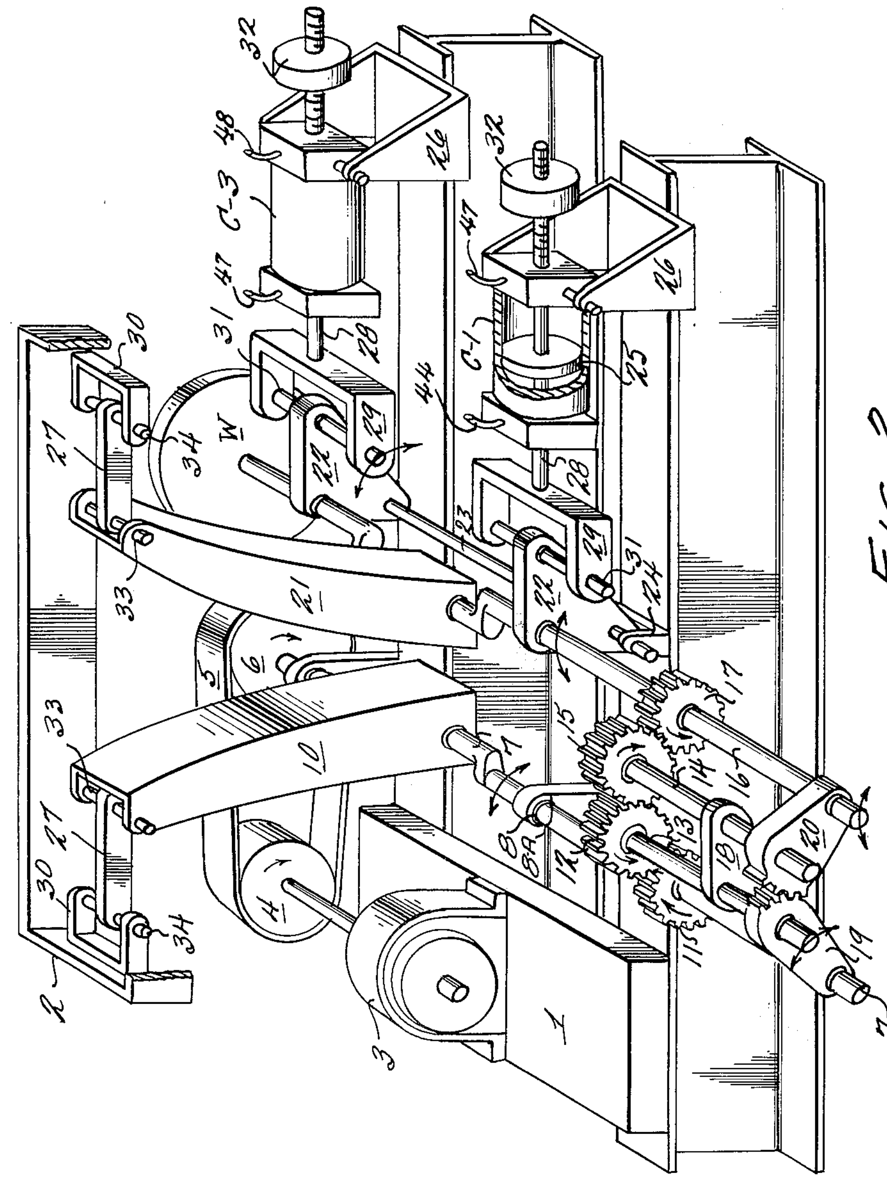

FIG. 2

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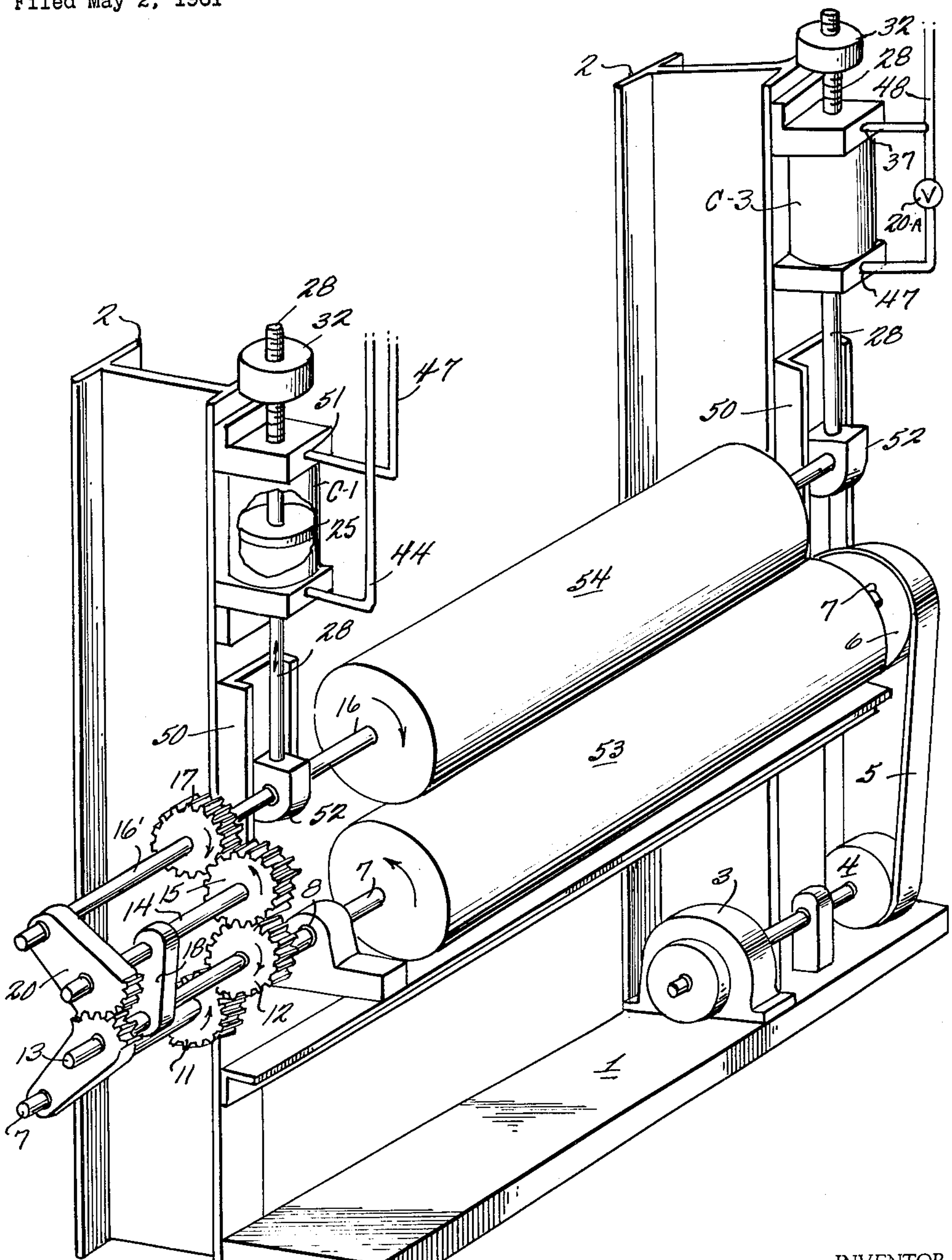

FIG. 3

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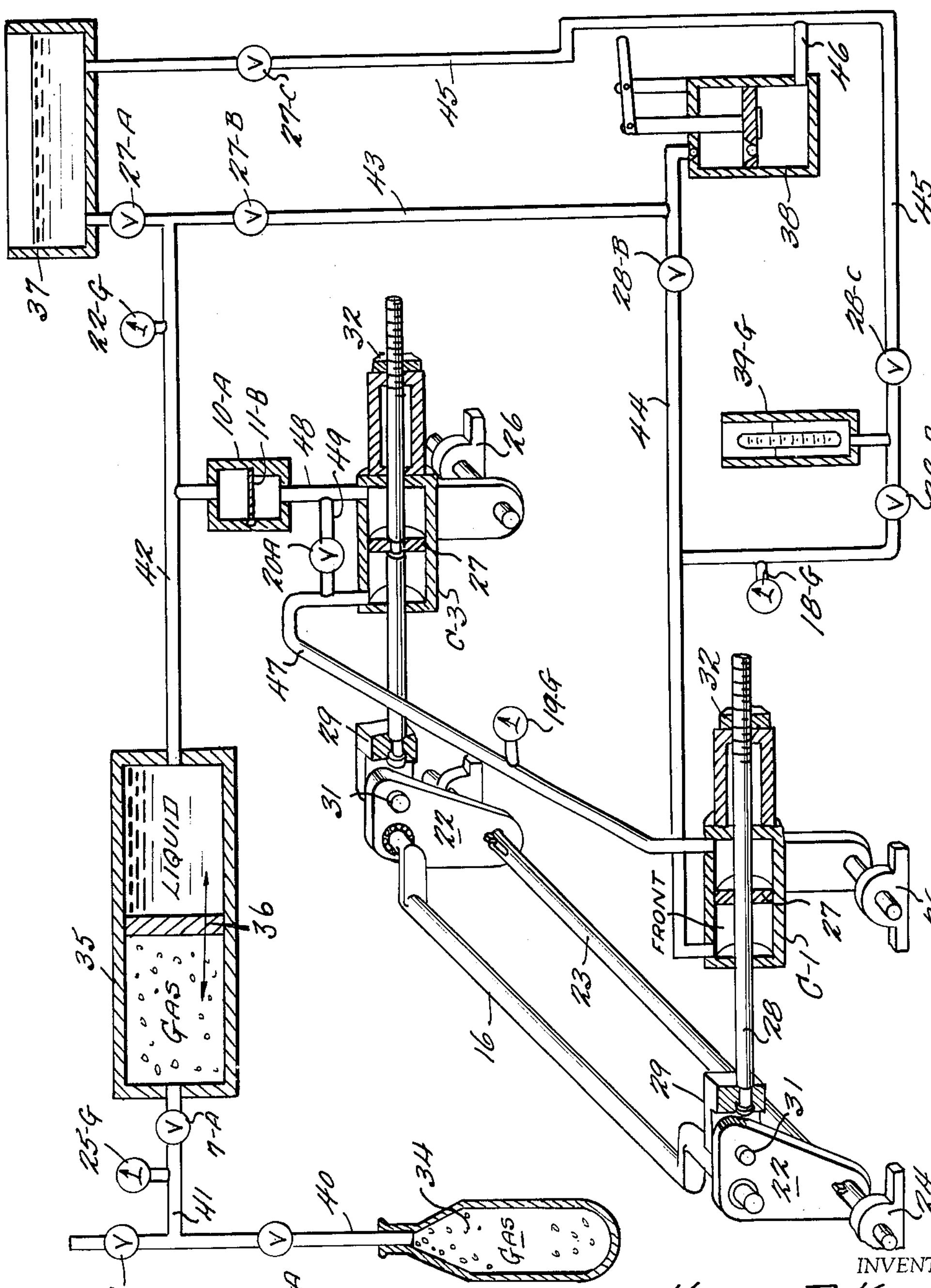

FIG. A

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TABLE OF NORMAL OPERATING & CONTROL PRCEDURES													
CONDITION	CRUSHER DRIVE MOTOR	CRUSHER FEED	POSITION OF VALVES X-CLOSED — O-OPEN										HYDRO. OIL PUMP
			6 A	7 A	9 A	20 A	27 A	27 B	27 C	28 A	28 B	28 C	
NORMAL (OPERATE	START/ON	START/ON	X	X	X	X	X	X	X	X	X	X	OFF
CLOSE JAWS	ON/OFF	ON/OFF	X	X	X	X	X	X	X	O	X	X	"
OPEN JAWS	"	"	X	X	X	X	X	X	X	X	O	O	RUN
DECREASE OIL PRESS.	"	"	X	X	X	X	O	X	X	X	X	X	OFF
INCREASE OIL PRESS.	"	"	X	X	X	X	X	O	O	X	X	X	RUN
EQUALIZE BRG. LOADS	"	OFF	X	X	X	O	X	X	X	X	X	X	OFF
DECREASE GAS PRESS.	"	ON/OFF	X	O	O	X	X	X	X	X	X	X	"
INCREASE GAS PRESS.	"	"	O	O	X	X	X	X	X	X	X	X	"
BLEED ENTRAPPED AIR	"	OFF	X	X	X	O	O	X	X	X	O	X	"

FIG. 6

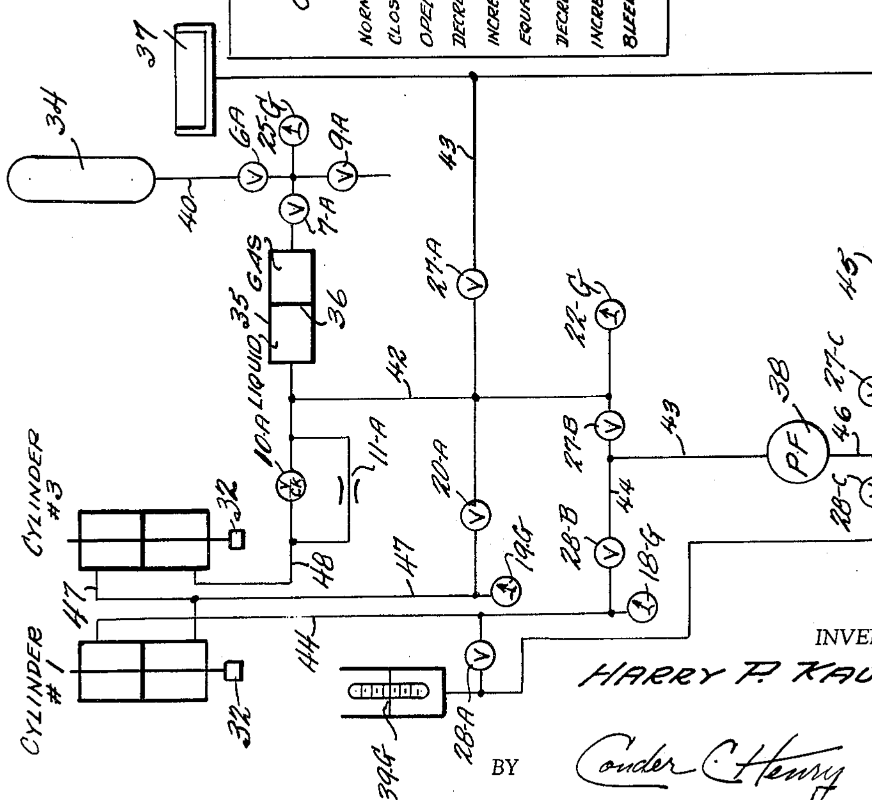

FIG. 5

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United States Patent Office

3,099,406

Patented July 30, 1963

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3,099,406
ORE CRUSHER

Harry Paul Kautz, Broomfield, Colo., assignor to Mine and Smelter Supply Co., Denver, Colo., a corporation of Colorado

Filed May 2, 1961, Ser. No. 114,587
11 Claims. (Cl. 241—32)

My invention relates to improvements in an ore crusher and more particularly to improvements in ore crushers provided with overload release devices. For purposes of description and illustration I have disclosed my invention as applied to crushers of the type revealed in the patent to Nutting, No. 2,865,570, granted December 23, 1958, and to a metal rolling mill, but it will be understood that the same can be applied to other kinds of force applying machines. For the most part I will describe my invention as applied to a double acting jaw crusher.

In heavy duty ore and stone crushers of the jaw type it is important if not necessary to incorporate therein some sort of safety mechanism to protect the machines from excessive loads which may occur during their normal operation and thereby damage or destroy them. Many expedients have heretofore been proposed, and some adopted, for accomplishing this purpose, but none of them, insofar as I am aware or have been advised, was designed to function as does my creation.

The general object of my invention is to modify the drive gearing of the jaw or jaws of an ore crusher of any kind, or the drive gearing of the force applying parts of other types of force applying machines, and to connect thereto for mutual functional cooperation therewith and as forming a part thereof a novel and relatively simple, practical and efficient release mechanism for permitting a crusher jaw or other force applying member to yield or release when it is subjected to a predetermined stress. More particularly, the principal object of my invention is to include as a part of the gearing of a jaw crusher an automatically operable overload release or safety mechanism which, without any interruption of the cycle of operation of the crusher, i.e., without requiring an interruption of feed and/or input power, and without dephasing the mechanism, will function as follows:

(1) Protect the drive shaft and other crusher parts and assemblies which are expensive to replace from being broken because of damaging loads, stresses and strains which may occur during normal operation of the machine;

(2) Prevent the machine from being choked in case an excessive amount of ore is fed thereto;

(3) Provide for the automatic and dampened recovery and return of the crusher machine elements to their previously adjusted operating positions and conditions after movement thereof during overload release;

(4) Provide for the selective adjustment to a permissible load which, when exceeded, will automatically actuate a movement of the crusher machine elements to avoid damaging stresses;

(5) Indicate the amount of load required to cause automatic overload release of the crusher jaws;

(6) Provide for the selective adjustment of the set, i.e., the space normally required between machine elements, and

(7) Indicate the set.

Another object of my invention is to provide novel adjustments for various parts of the machine.

Still another object of my invention is to provide a power gear mounted on a shaft for driving one member of a force applying machine and a driven gear mounted on another shaft parallel to and synchronized with the first gear for driving another member of said machine, and means interconnecting said gears whereby the cen-

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ter line distance between said shafts may vary without allowing or causing any appreciable change in the gear synchronism.

These and other objects of my invention will become apparent from the following specification and drawings in which:

FIG. 1 is a side elevational view of a crusher embodying my invention with the gear housing removed and showing the pressurized accumulator partly in section;

FIG. 2 is a perspective view showing the interrelationship of the mechanical elements of my invention as applied to a double acting jaw crusher;

FIG. 3 is a perspective view of my invention as applied to a metal rolling mill;

FIG. 4 is an exploded view showing the components and association of parts of my overload release mechanism as applied to the machines illustrated by FIGS. 1 and 3;

FIG. 5 is a schematic diagram of the same; and

FIG. 6 is a table outlining the normal operating and control procedures of the overload release mechanism illustrated by FIG. 4.

Referring in detail to such drawings and particularly to FIGS. 1 and 2, the numerals **1** and **2** designates lower and upper crusher frames, respectively. Bolted to the lower frame is an electric motor **3** having a motor shaft to the end of which is keyed a pulley **4** for driving another pulley **6** by means of a belt **5**. The driven pulley is keyed to one end of the primary crankshaft **7** of the crusher, which crankshaft may be supported in any suitable manner. As illustrated by FIG. 2, the primary crankshaft is journaled in main shaft bearings **8**, which bearings are pinned to stanchions **8*a*** rigidly secured to the lower crusher frame, and a crusher jaw **10** is journaled on the throw or eccentric portion of such crankshaft.

Adjacent the outer end of the primary crankshaft opposite the end on which the pulley **6** is mounted, is keyed a primary spur or helical gear **11** which meshes with an idler spur or helical gear **12** rotatably mounted on a primary idler shaft **13**. A second idler shaft **14**, on which is rotatably mounted a secondary idler spur or helical gear **15**, is positioned parallel to shafts **7** and **13**. A secondary crankshaft **16** is disposed parallel to the primary crankshaft. On one end of the secondary crankshaft is keyed a flywheel W and on its opposite end is keyed a driven spur or helical gear **17** having the same number of teeth as gear **11** and meshing with gear **15**.

The primary and secondary idler shafts **13** and **14** are mounted in the ends of idler gear link or links **18** which maintains the center line distance between them, while the center line distance between the primary crankshaft **7** and the primary idler shaft **13** is maintained by a primary gear link or links **19** in the ends of which shafts **7** and **13** are journaled. Similarly, the center line distance between the secondary idler gear shaft **14** and the secondary crankshaft **16** is maintained by a secondary gear link or links **20** in the ends of which said shafts are journaled. Gear links **19** and **20** have meshed gear teeth on their upper ends.

Secondary crankshaft **16** is similar in design to the primary crankshaft but it and the parts carried by it are supported differently.

A crusher jaw **21** is journaled for movement on the crank throw or eccentric portion of the secondary crankshaft opposite to and laterally spaced from jaw **10**, and the lower portion of jaw **21** as well as the secondary crankshaft on which it is mounted is capable of limited movement as a unit in an arcuate path because of the nature of the assembly supporting them.

As will appear from FIG. 2, the secondary crankshaft is journaled in the upper corners of a pair of spaced inverted triangular shaped bearing blocks **22** keyed at their apices on a rotatable torsion bare 23 which is journaled in bearings carried by a support 24 secured to the lower crusher frame.

Both crusher jaws are stabilized and guided at their upper ends by horizontally disposed toggle assemblies comprising links 27 having their ends connected to pins 33 journaled in the upper ends of the jaws and their opposite ends connected to pins 34 journaled in clevises 30 which are rigidly secured to the upper frame. The two oppositely swinging crusher jaws, therefore, are guided by appropriate horizontal guides at their upper portions and are driven at their lower portions by coupled eccentrics running synchronously in mirror image of each other.

An overload release mechanism is provided and operatively connected to the bearing blocks. Such mechanism comprises two hydraulic cylinders C1 and C3 which are hinged near the ends thereof in trunnion bearing bases 26 secured to the lower crusher frame. Each cylinder contains a double acting piston 25 mounted on a piston rod 28 which projects from both ends of the cylinder. The forward portions or ends of such rods are secured in clevises 29, and the clevises are pivoted by clevis pins 31 to the upper corners of the bearing blocks opposite the corners where the secondary crankshaft passes therethrough.

The opposite ends of the piston rods are screw threaded. Nuts 32 are screwed onto the screw threaded ends of the piston rods and bear against the trunnion supported ends of the cylinders for mechanically adjusting the set.

Each of the cylinders has two compartments. As shown by FIG. 4, the left hand ends of cylinders C1 and C3, or the compartments in such ends, will be called the forward or front compartments, and the right hand ends of such cylinders, or the compartments in such ends, will be called the rear compartments.

In addition to the cylinders and pistons, the components utilized in precharging, bleeding, adjusting and operating the overload release mechanism comprise a gas holder or container 34; a pressurized accumulator for holding gas and oil 35 which has a floating divider or piston head 36 therein; a main hydraulic reservoir 37; a set oil reservoir 39G; a pump 38; and a flow control combination or restrictor valve. Such valve can be a check valve 10A in combination with a bypass needle valve 11A (see FIG. 5) which provides a variable orifice or restriction, or in combination with a fixed orifice bypass, or a check valve in which the check valve gate is perforated with a fixed orifice 11B (see FIG. 4).

The gas holder is provided with a vent pipe 40 which is connected through another pipe 41 to the front (gas) end of the accumulator. The other end of the accumulator is connected by a pipe 42 to another pipe 43 which in turn is connected to the bottom of the main reservoir. The other end of pipe 43 is joined to a pipe 44 which interconnects the top or discharge chamber of the pump with the forward chamber of a first cylinder C1. Also extending downwardly from the main reservoir is another pipe 45 which terminates in a pipe connection with pipe 44 and has a branch connection 46 with the lower or suction chamber of the pump.

The rear chamber of cylinder C1 is connected by a pipe 47 to the forward compartment of a second cylinder C3, and the rear chamber of cylinder C3 is connected to pipe 42 by a pipe 48 through the restrictor valve 10A. Below said valve, pipes 47 and 48 are interconnected by a pipe 49.

Cut-off valves are included in the system as follows:

Two valves 6A and 7A in the pipe lines 40 and 41 between the gas holder and the accumulator, and one valve 9A in the vent portion of pipe 40; three valves 27C, 28A and 28C in line 45; two valves 27A and 27B in line 43; one valve disposed above and the other below the connection of pipe 42 with pipe 43, and one valve 20A in line 49.

Included in line 45 between valves 28A and 28C is a set oil reservoir 39G which is provided with an oil level gauge having appropriate markings, such as "Current Set," "Zero Set," "Zero Close Set," "New Jaw Plates," and "Replace Jaw Plates." Pressure gauges are included in the system as follows: Gauge 25G between valves 6A and 7A; gauge 22G in line 42; gauge 18G between valve 28A and cylinder C1, and gauge 19G in line 47.

The operation of the machine and the procedures for precharging, bleeding and adjusting the overload release mechanism as applied to the crusher will now be described.

Referring first to FIG. 2, the motor 3 drives the primary crankshaft 7 through pulleys 4, 6 and belt 5. Since the primary crankshaft rotates within the jaw 10 and the latter is mounted on the throw or eccentric portion of such shaft, jaw 10 follows only the motion of the crank center. Such jaw is further stabilized and guided by the toggle assembly 27, 30, 33 and 34. This assembly guides the jaw at the center line of the toggle pin 33 in oscillatory-rotary (reciprocating) motion about the center line of toggle pin 34.

Rotary power in a reverse direction is transmitted from the motor driven primary crankshaft to the secondary crankshaft 16 through the train of four intermeshed spur or helical gears 11, 12, 15 and 17. Due to the fact that the teeth of all of said gears are engaged and the eccentric (crank) centers of the two crankshafts opposed, such shafts are synchronized, and because the number of teeth on the primary and secondary crankshaft gears 11 and 17 are equal, the crankshafts counter-rotate at the same speed.

The primary and secondary gear links 19, 20 maintain center line distances for proper engagement of gear teeth and at the same time position and stabilize the idler gear shafts 13, 14 through their cogged engagement with each other.

In case uncrushable material is introduced between the jaws or the machine becomes overloaded for any reason, the lower portion of jaw 21 mounted on the secondary crankshaft will yield laterally and thereby relieve the excessive stresses and strains because the assembly on which the secondary crankshaft is mounted will move laterally and thereby permit transit location of the secondary crankshaft axis. This is due to the fact that the secondary crankshaft is mounted for rotation in tiltable bearing blocks 22 forming part of my hydraulic release, adjustment and indicating assembly.

The set adjustment for the jaw and crankshaft assemblies as well as the movement for overloads is directly controlled by the two spaced apart double acting hydraulic cylinders C1, C3 which have the corresponding ends of their piston rods functionally connected to the spaced rockable bearing blocks 22. Two means are provided for limiting and adjusting the forward motions of the piston rods and, therefore, for adjusting the close set of the jaws. They are:

First, by turning the screw threaded nuts 32 clockwise or counterclockwise as they bear against the trunnion supported ends of the cylinders.

In this connection it should be noted that motion of one of the bearing blocks 22 is automatically transmitted to the other through the torsion bar 23, and that the adjustment just described as well as the one described in the next succeeding paragraph hereof can be made without any interruption of the input power and without dephasing the mechanism and while the machine is in full operation. This is due to the fact that during overload release or any adjustment of the jaws made by either method the idler gears 12 and 15 will simply roll up or down between crankshaft gears 11 and 17 without changing the angular relationship of the two crankshafts with respect to each other.

Second, and referring to FIG. 4, by adjustment of the hydraulic fluid in one of the hydraulic cylinders. Removing hydraulic fluid advances the jaw assembly and reduces the set while adding fluid increases the set. When a fluid such as oil is regulated in only one of the two forward cylinder compartments C1, the motion and location of the piston of the other C3 is controlled by movement of entrained fluid to or from the rear fluid chamber of the first cylinder through a conduit to or from the forward chamber of the second. This movement of fluid transmits synchronous motion from one main bearing to the other and insures their continuous alignment on the crankshaft.

As will later be described in detail, this method of setting is further implemented by controlled metering of the hydraulic fluid which is removed from or added to the forward cylinder compartment of the control cylinder, by a system of valves, a graduated fluid set reservoir and a pump. The movement or position of the pistons are visually indicated by the fluid level in the set reservoir 39G which is designed to provide a greater movement in the fluid level therein than in the cylinders, for example, in the ratio of 5 to 1.

The backward stroke of the pistons, which is required for the adjustment of the set and for relief of overload of the machine, is restricted and controlled by hydraulic and pneumatic pressures which also can be regulated. An overload in the crushing cavity forces the jaw 21 and its assembly, including the hydraulically operated pistons, to move backward. This motion forces liquid from the rear compartment of cylinder C1 through a conduit 47 into the forward compartment of cylinder C3. At substantially the same time, the piston in cylinder C3 moves backward which forces the liquid in the rear compartment of cylinder C3 into the liquid or forward compartment of the accumulator, which accumulator is a pressure vessel for both liquids and gas, the gas being confined in the rear compartment thereof. Liquid from the rear compartment of cylinder C3 is forced through pipes 48 and 42 to the accumulator, the pipe 48 having incorporated therein a check valve 10A which will be later described. Inasmuch as the accumulator is provided with a divider or floating piston 36, the liquid thus entering the accumulator further compresses the captive gas in the accumulator. Regulation of the volume and precharged pressure of such gas determines the load in the crushing cavity which will cause the jaw 21 and its assembly to retreat. The size of the particles in the crushing cavity which must pass the outlet without being crushed may determine the length of this stroke.

The check valve 10A, which is in line 48 connecting the rear chamber of cylinder C3 to the accumulator, is freely opened under liquid pressure but closes against the return of liquid except through a very small orifice O, thus allowing such jaw to retreat rapidly. Such check valve, instead of being provided with an orifice O, may be by-passed through the relatively small orifices of a needle valve 11A, FIG. 6, thus allowing the pistons to slowly return to the selected positions of their stops when the overload ceases to exist. Thereby the machine is protected from possible serious shock stresses which might occur after an abrupt overload.

The pump 38, when coordinated with valve manipulations, provides means for adding liquid to any or either of the piston compartments and also provides power to increase the set adjustment or increase the overload pressure adjustment.

Also, the range of adjustable overload pressures can be increased by admitting gas to the forward chamber in the accumulator 35 from the gas holder 34, or gas pressure in the accumulator can be reduced by releasing gas.

Any appropriate gas may be used. I have selected nitrogen because it is inert and easily obtainable.

The accumulator 35 can be precharged at the factory to the desired pressure, say 1000 p.s.i., or it can be recharged on location from the bottle of compressed gas 34. Precharging the accumulator forces the piston to a mechanically stopped position within the cylinder and this provides the maximum gas volume and the minimum liquid volume. The liquid used may be oil.

As further explanatory of my invention and referring particularly to FIGS. 4, 5 and 6, the following numbered steps outline the procedures for precharging, bleeding, adjusting and operating my overload release mechanism, to-wit:

Assuming that an accumulator containing precharged gas is used and it is desired to check or change the pressure—

(1) Stop the crusher feed and drive. Open valve 27A which allows precharge gas to occupy the maximum volume or space in the forward part of the accumulator and to displace the piston 36 which, in turn, forces oil and entrapped air into the main hydraulic reservoir 37, where entrapped air will be separated from the oil. When pressure gauges 22G, 19G and 18G indicate zero hydraulic oil pressure, pressure gauge 25G will indicate the precharge gas pressure. To increase gas pressure, open valves 7A and 6A. To decrease this pressure open valves 7A and 9A thus allowing gas to escape through the vent pipe 40 to the atmosphere.

(2) Manually rotate either the flywheel W or the belt pulleys 4 and 6 in order to position the crankshaft centers where they are closest to each other, i.e., where jaws 10 and 21 are in close set position.

(3) Loosen the mechanical set adjustments 22 in order to allow freedom of motion for the pistons of both hydraulic cylinders.

(4) Fill hydraulic reservoir 37 with oil.

(5) Open valve 20A. This valve should be opened only when there is no applied crushing load. With the valve open fluid can by-pass the piston and will flow between the forward and rear chambers of cylinder C3. Equal pressures in these chambers allows the piston and its rod to move or be moved within the cylinder without bearing any load. This condition frees the connected bearing block and permits it to find its position only from the torsion tube 23 to which it is connected. And the position of the torsion tube is dependent only upon the position of the oppositely disposed bearing block to which the piston rod 28 of hydraulic cylinder C1 is connected. The addition or removal of fluid (oil) from the forward chamber of cylinder C1 limits the forward stroke of the piston and served as a stop for adjusting the set of the jaws. The calibrated oil level gauge 39G measures the changes in oil volume in the forward chamber of the cylinder C1, and serves to indicate and measure the changes in the set. It should be noted in this connection that the mechanical set adjustment assemblies 32 serves the same purpose in limiting the forward stroke of the pistons. These mechanical set adjustments are used as auxiliaries to limit the advance or closure of the jaws for maximum allowable jaw plate wear. With only valve 20A open, open valves 27A, 27C and 28B and operate pump 38. By so doing only oil will be removed from the main reservoir 37, and oil and entrapped air will be forced into the forward chamber of cylinder C1, thus forcing its piston and rod and jaw 21 to retreat. Entrapped air in the rear chamber of cylinder C1 will be forced through valves 20A and 27A and through the main oil reservoir 37 to atmosphere. Continue pumping until pressure gauge 18G indicates say 25 p.s.i.

(6) Close all valves. Open only valves 28A, 20A, 27B and 27C and operate pump 38. This will remove only oil from the main hydraulic reservoir 37 and force oil and entrapped air into the rear and forward chambers of cylinder C3 and into the rear chamber of cylinder C1, thereby forcing its piston forward. This will drive oil and entrapped air out of the forward chamber of cylinder C1 through valve 28A into the set oil reservoir 39G where the entrapped air escapes into the atmosphere. Continue pumping until the jaw plates touch, or until pressure gauges 22G and 19G begin to indicate about 25 p.s.i.

(7) Close all valves. Open valves 28A, 28B and 27C. Operate pump until oil level in set oil reservoir 39G reaches the level for "Zero Close Set."

(8) Close all valves. Open valves 28B, 27C, 20A and 27A. Operate pump until pressure gauge 18G indicates about 25 p.s.i. This step retracts jaw 21 because of the functional connection of piston 27 with it and bleeds entrapped air from both chambers of cylinder C3 through the main reservoir 37. Most of the air which may have been entrapped in the system will now have been replaced by oil.

(9) Open valves 20A, 27B and 27C. Operate pump until pressure gauge 22G indicates desired operating pressure (3000 p.s.i., which is the maximum for precharged gas pressure of 1000 p.s.i.). Pressure gauges 18G and 19G should also indicate this pressure. This step forces the divider or floating piston 36 in the accumulator to move forward and compress the precharged gas in the forward compartment of the accumulator. Thus the accumulator will now provide power for many of the required adjustments of the system as well as serving as a shock absorber for crushing overloads.

In this connection it should be observed that all of the procedural steps thus far discussed, 1 through 9, are necessary only when the hydraulic components and lines are first assembled or after their connections have been broken which would allow air to replace oil. Normally, replacement of worn jaw plates will require hydraulic adjustments including only procedural steps 1, 2, 3 and, possibly, 4. The next step, 10, will then be the fifth step for normal adjustment procedure following replacement of worn out jaw plates when the cylinder pistons and secondary jaw 21 will be almost fully retracted (open).

(10) Close all valves. Open valve 20A to equalize bearing loads, and then close when indications on pressure gauges 19G and 22G become steady and equal.

(11) Close all valves. Open valve 28A until newly installed jaw plates touch, or until pressure gauge 18G starts to indicate reduced pressure, then immediately close valve 28A.

(12) After procedural step 11, the oil level in the set oil reservoir 39G should be on line indicated as "Zero Set, New Jaw Plates." If the oil level lies below such line, add oil from the accumulator 35 by opening valves 28A and 28B. If the oil level lies above this line, remove oil by opening valves 28C and 27B and operating pump. Move, if necessary, the pointer for "Replace Jaw Plates" to the proper level above "Zero Set, New Jaw Plates."

It should be pointed out in this connection that if the metal to be worn is ¾" from the surface of each plate, and the anticipated close set is ¼", the superelevation should be the calibrated equivalent of 1¼". In that case, the pointer for "current close set" should be moved to the line below the indicated "Zero Close Set" line by a calibrated distance of ¼". The oil level indications of close set and of jaw plate wear are now calibrated for the life of the jaw wear plates. The mechanical set adjustment assemblies 32 may now be locked in positions which will allow a forward motion of the cylinder rods equal to the total jaw plate wear less the anticipated close set (1¼").

(13) Close all valves. To move jaw plates from "Zero Set" to ¼" close set, open valves 28B and 28C and operate pump until oil level has dropped to the "Current Set" pointer or a calibrated distance of ¼".

(14) Check pressure gauges 18G, 19G and 22G for indications of required equal pressures for crushing. If increased pressure is required, open valves 27B and 27C and operate pump until the gauges indicate the required pressure. If decreased pressure is required, slowly open valve 27A, then close when all gauges indicate the required pressure.

The metal rolling mill is similarly operated and controlled. However, the rollers 53 and 54 are mounted on straight shafts, one of said shafts 7 being journaled at its ends in bearings 8 carried by rigid bearing blocks mounted on the machine frame 1 and being driven by the motor 3 through the belt 5 and pulleys 4 and 6. The other roller shaft 16 is journalled at its ends for transistory movement in bearing blocks 52 slidably supported in vertically disposed channels 50 secured to the upright framework 2 of the machine.

The roller shafts are geared together by precisely the same kind of gearing as previously described with respect to the jaw crusher, and the overload release mechanism is also substantially the same as previously described except the torsion rod is not employed and the ends of the piston rods 28 are connected directly to the movable bearing blocks 52.

The hydraulic system illustrated by FIG. 4 is connected to the rolling mill pistons as follows: Pipes 44 and 47 are connected to the rear and forward chambers of cylinder C1 and pipe 48 is connected to the rear chamber of cylinder C3. Manifestly, during overload the upper mill roll 54 yields in the same manner as the yielding crusher jaw.

The normal operating control procedures for both machines are indicated in the table constituting FIG. 6 of the drawings. However, the procedures for precharging, bleeding, adjusting, and operating the set are slightly different. The procedural steps are as follows:

(1, 2) Follow the steps outlined under numbers 1 and 3 with respect to the crusher system.

(3) Place set gauge blocks between adjacent roll surfaces.

(4) Fill main hydraulic reservoir 37 with oil.

(5) Open valves 7A, 20A, 27B, 27C and 28B. Operate pump 38 until pressure gauges 18G, 19G and 25G indicate slightly higher than the precharged gas pressure. This operation will compress entrained air in all oil pressure chambers.

(6) Slowly open valves 28A and 27A. This operation will bleed entrained air from all oil chambers to the atmosphere through either of the vented reservoirs 39G or 37. Close all valves.

(7) Repeat steps 5 and 6 to bleed most of the entrained air from the system.

(8) Repeat step 5 to obtain desired overload. Close all valves.

(9) Open valves 27C and 28B. Operate pump 38 until secondary roll has been raised to a position near its limit. Close all valves.

(10) Slowly open valve 28A until the secondary roll engages set gauge blocks and pressure gauge 39G indicates zero. Open valves 27C and 28B. Operate pump 38 to fill oil level indicator to level for predetermined roll set. Close all valves.

(11) Open vave 20A to insure hydraulic alignment of rolls as indicated by equal pressures on gauges 19G and 22G. Close all valves.

(12) Open valves 27C and 28B. Operate pump until all hydraulic oil pressure gauges are indicating the overload pressure. Remove set gauge blocks. Close all valves.

(13) Slowly open valve 28A until the oil in indicator 29G has returned to the level predetermined for the roll set.

As is self evident, the system may be adjusted and controlled from an instrument and control panel or cabinet which is remotely located from the machine.

Having thus described my invention, what I claim and desire to secure by United States Letters Patent is:

1. In a crusher having jaws, one of said jaws being mounted on the eccentric portion of a primary crankshaft and another of said jaws being mounted on the eccentric portion of a secondary crankshaft, the said crankshafts being adjusted in a predetermined angular relationship with respect to each other for phasing the rotation of

said shafts, a gear train interconnecting said crankshafts for rotation in opposite directions at the same speed and permitting lateral displacement of the secondary crankshaft without dephasing the mechanism, the said primary crankshaft being journaled in fixed bearings and the said secondary crankshaft being journaled in displaceable bearings, and means constituting a hydraulically operated crushing overload release mechanism associated with the secondary crankshaft the said means comprising two cylinders provided with hydraulically operated piston rods operatively connected to said secondary crankshaft, each of said cylinders being provided with a front compartment and a rear compartment, the front compartment of one of said cylinders being connected by a conduit to the rear compartment of the other cylinder whereby to effect substantially synchronous and simultaneous action of said piston rods.

2. The invention as defined in claim 1 in which the said means includes instrumentalities for causing the overload release mechanism to return to its normal operating condition and position after cessation of overloads.

3. The invention as defined in claim 1 in which the displaceable bearings are carried by tiltable bearing blocks which are interconnected by a torsion rod, and the said cylinders are mounted on trunnions near the rear ends of said cylinders and the said piston rods are functionally connected to said bearing blocks.

4. The invention as defined in claim 1 in which the gear train comprises gears having the same number of teeth keyed to corresponding ends of the crankshafts; intermediate idler gears rotatably mounted on idler shafts and meshing with each other and with the crankshaft gears; a link interconnecting the idler shafts, and interconnected links, one of said interconnected links connecting the primary crankshaft with one of the idler shafts and the others of said interconnected links connecting the secondary crankshaft with the other of said idler shafts whereby the center line distances between adjacent shafts is maintained and the intermediate idler gears may roll up and down between the crankshaft gears with which they mesh and thereby change the center line distance between the crankshafts without changing the angular relationship of the crankshafts.

5. The combination as defined in Claim 1 in which the said piston rods have their corresponding ends functionally connected to said displaceable bearings; a gas holder; a two-compartment accumulator adapted to contain oil in one of said compartments and gas in the other; a main oil reservoir; a pump, and a set oil reservoir, the said gas holder, accumulator, main oil reservoir, pump, and set oil reservoir being coupled together by pipe lines having valves therein whereby selected ones of said elements may be successively interconnected through said pipe lines to precharge, bleed, adjust and operate the system while the others of said elements are cut off from the selected elements.

6. In a machine having juxtaposed elements adapted to exert force on external objects placed between them; an assembly including a gear train connecting said elements and causing them to act in synchronism, one of said elements being mounted for movement about a fixed axis and the other of said elements being mounted for movement about an axis which is displaceable, and a hydraulically operated overload release mechanism connected to the element mounted for movement about the displaceable axis, the said mechanism including means comprising two cylinders provided with piston rods having their corresponding ends functionally connected to the element mounted for movement about the displaceable axis; a two compartment accumulator adapted to contain oil in one of its compartments and gas in the other; a main oil reservoir; a pump, and a set oil reservoir, the said main oil reservoir, pump and set oil reservoir being coupled together by pipe lines having valves therein whereby selected ones of said parts may be connected through said pipe lines to bleed, and adjust the machine while the others of said parts are cut off from the selected parts.

7. A machine having juxtaposed pressure applying members carried by parallel shafts and arranged in predetermined phased relationship, one of said shafts being a primary shaft mounted in fixed bearings and the other of said shafts being a secondary shaft mounted in displaceable bearings; a gear train interconnecting said shafts for permitting the secondary shaft to move away from the primary shaft without destroying their phased relationship, and a hydraulic overload release mechanism connected to said secondary shaft, the said mechanism including fluid actuated means for phasing said shafts and means maintaining said shafts in their paralel relationship.

8. The combination as recited in claim 7 wherein the said gear train comprises gears having the same number of teeth keyed to corresponding ends of said primary and secondary shafts; intermediate idler gears rotatably mounted on idler shafts and meshing with each other and with the primary and secondary shaft gears; a link interconnecting the idler shafts; intergeared links, one of said intergeared links connecting the said primary shaft with one of the idler shafts and the other of said intergeared links connecting the secondary shaft with the other of said idler shafts whereby the center line distance between adjacent shafts is maintained and intermediate idler gears may roll up and down between the primary and secondary shaft gears with which they mesh and thereby change the center line distance between said primary and secondary shafts without changing the angular relationship of the primary and secondary shafts.

9. The combination recited in claim 7 wherein the fluid actuated means for phasing said shafts comprises an accumulator provided with a freely shiftable piston dividing said accumulator into a gas compartment and a liquid compartment, the said gas compartment being connected to a gas holder and the said liquid compartment being connected to a main liquid reservoir.

10. The combination as recited in claim 7 wherein the hydraulic release mechanism comprises an accumulator having a shiftable piston therein dividing said accumulator into a gas compartment and a liquid compartment; a main liquid reservoir; a pump, and a plurality of spaced apart cylinders each of which is provided with a piston head and a piston rod connected thereto adapted to be connected to said secondary shaft; valved conduits connecting said main liquid reservoir to said pump and to the forward compartment of one of said cylinders; a separate conduit connecting the rear compartment of the said one cylinder to the forward compartment of the other of said cylinders, and additional valved conduits interconnecting the rear compartment of the said other cylinder to said main liquid reservoir and to the liquid compartment of said accumulator through a check valve provided with a by-pass whereby movement of the piston in the said one cylinder will cause synchronous movement of the piston in the said other cylinder.

11. The combination as recited in claim 10 wherein the said gear train comprises gears having the same number of teeth keyed to corresponding ends of said primary and secondary shafts; intermediate idler gears rotatably mounted on idler shafts and meshing with each other and with the primary and secondary shaft gears; a link interconnecting the idler shafts; intergeared links, one of said intergeared links connecting the said primary shaft with one of the idler shafts and the other of said intergeared links connecting the secondary shaft with the other of said idler shafts whereby the center line distance between adjacent shafts is maintained and the intermediate idler gears may roll up and down between the primary and secondary shaft gears with which they mesh and thereby change the center line distance between the

primary and secondary shafts without changing the angular relationship of the primary and secondary shafts.

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