Oct. 13, 1925. 1,556,595

W. R. EWING

EXCAVATOR CONTROLLING APPARATUS

Filed June 8, 1923 3 Sheets-Sheet 1

FIG. 1.

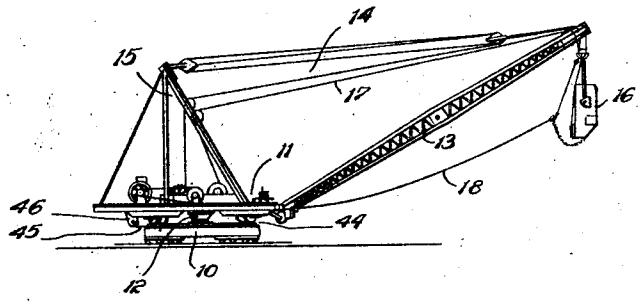
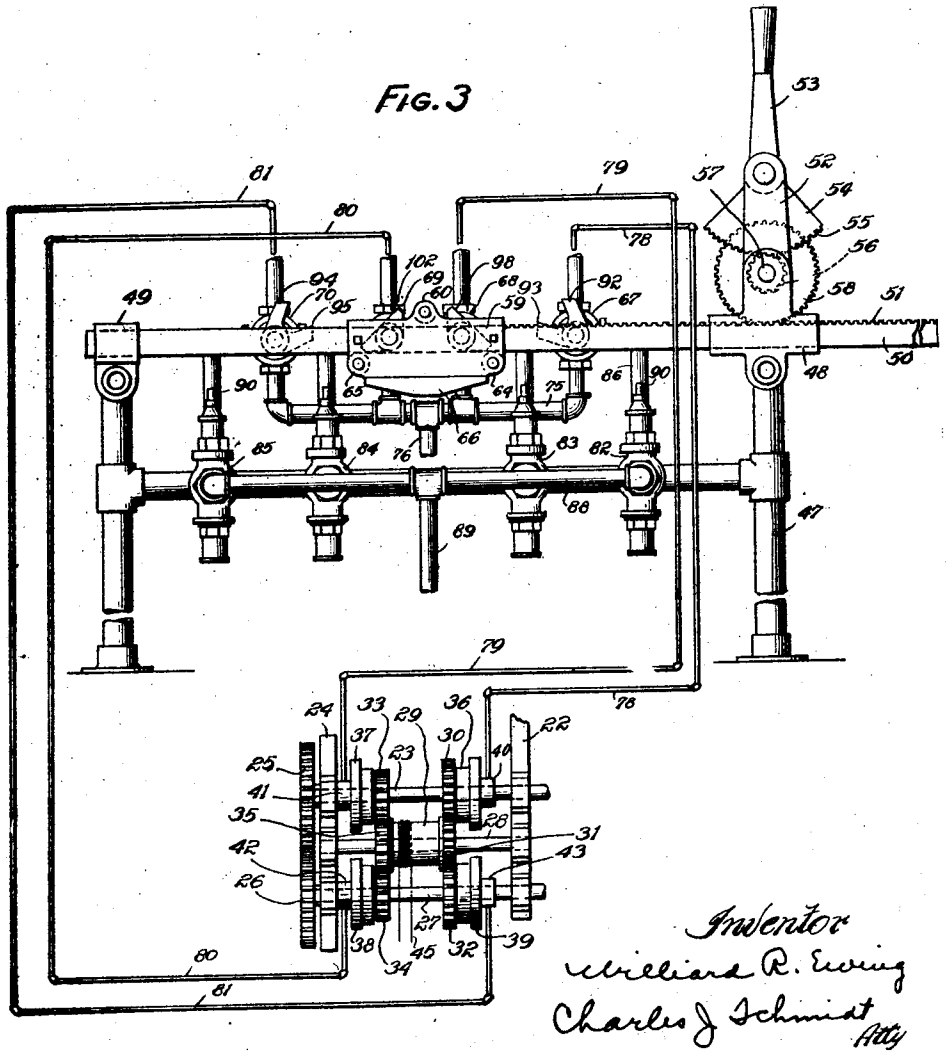


FIG. 3



Inventor
William R. Ewing
Charles J. Schmidt
Atty

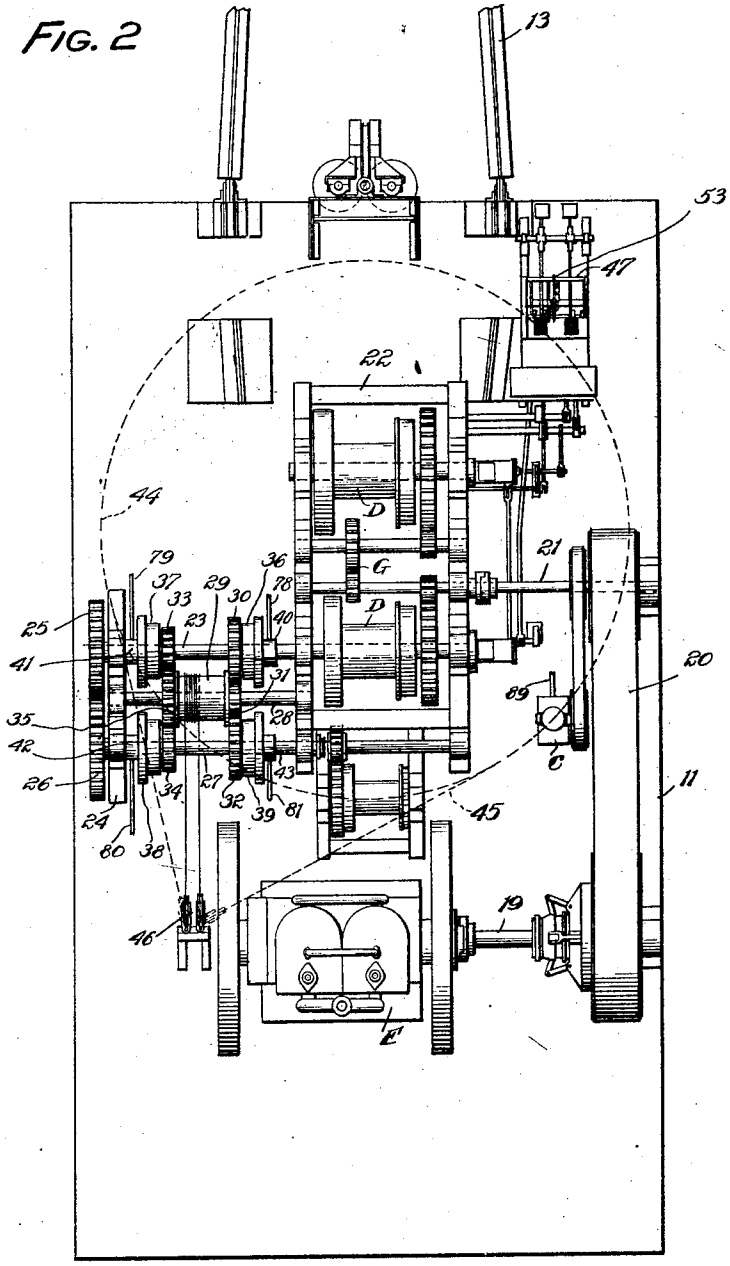
Oct. 13, 1925. 1,556595

W. R. EWING

EXCAVATOR CONTROLLING APPARATUS

Filed June 8, 1923 3 Sheets-Sheet 2

FIG. 2



Inventor
William R. Ewing
Charles J. Schmidt
Atty

Oct. 13, 1925. 1,556,595

W. R. EWING

EXCAVATOR CONTROLLING APPARATUS

Filed June 8, 1923 3 Sheets-Sheet 3

FIG. 4

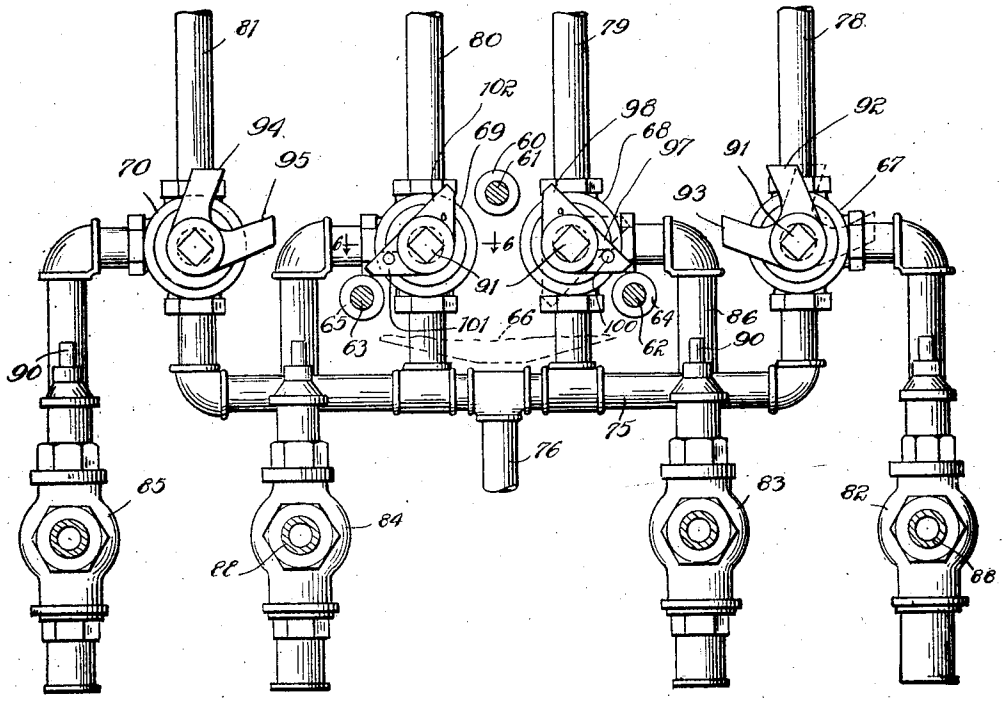


FIG. 5

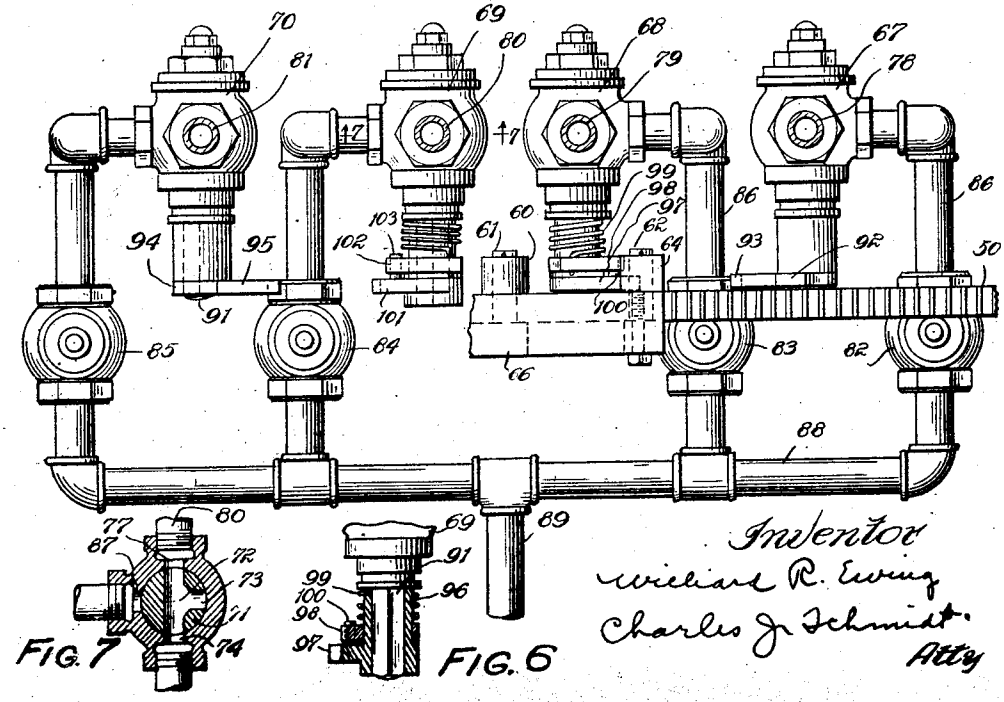


FIG. 7

FIG. 6

Inventor
William R. Ewing
Charles J. Schmidt.
Atty

Patented Oct. 13, 1925. 1,556,595

UNITED STATES PATENT OFFICE.

WILLIARD R. EWING, OF CHICAGO, ILLINOIS, ASSIGNOR TO McWILLIAMS DREDGING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

EXCAVATOR-CONTROLLING APPARATUS.

Application filed June 8, 1923. Serial No. 644,088.

To all whom it may concern:

Be it known that I, WILLIARD R. EWING, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Excavator-Controlling Apparatus, of which the following is a specification.

My invention relates to excavator controlling apparatus and is particularly useful in connection with excavators in which the bucket controlling boom is swung through maximum range and to a long reach in order to deposit excavated material at great distances from the point of excavation, as for example in dragline excavators or in excavators where the bucket travels directly along the boom.

In excavators of this type where the bucket is of large capacity and considerable weight the overcoming of the inertia is a serious problem. Where a steam engine or other variable speed engine is used for driving the boom swinging drums the boom can be readily gradually started and stopped. However, gasoline and oil explosive engines are coming into use on excavators and such engines have of themselves practically no speed control and for this reason the length of boom has been necessarily limited. The usual arrangement has been to interpose forward and reverse gearing trains between the engine and the swing controlling apparatus, the connection of the trains with the driving shaft being controlled by clutches operated by air pressure. With a single forward driving train and a single reverse driving train the friction clutches will not hold on account of the tremendous inertia where the boom is long and the buckets of large capacity. One of the important objects of my invention is therefore to provide for more gradually and powerfully starting and swinging the boom and for stopping it. In accordance with my invention I provide a low speed gearing train and a high speed gearing train for controlling the swing of the boom in one direction and also a low speed gearing train and a high speed gearing train for controlling the swing in the opposite direction, the connection of each train with the engine drive shaft being controlled by a brake band or clutch operated by air pressure with the available pressure for the low speed train controlled so that it will be impossible to start or stop the boom too suddenly. With my improved arrangement each set of low and high gearing trains may be used to positively swing the boom in one direction or to gradually brake the swing and to bring the boom to a stop.

Another important object of my invention is to efficiently control the operation of the clutches and gearing trains in proper sequence by means of a single lever. The above and other features of my invention are incorporated in the structure shown on the accompanying drawing, in which—

Fig. 1 is a side elevational view of an excavator,

Fig. 2 is an enlarged plan view more or less diagrammatic of the controlling machinery,

Fig. 3 is an enlarged side elevational view of the air pressure controlling mechanism and its connection with the clutch mechanism,

Fig. 4 is an enlarged side elevational view of the valve structures and controlling mechanism with parts broken away,

Fig. 5 is a plan view of the parts shown in Fig. 4,

Fig. 6 is a sectional view on plane 6—6, Fig. 4 showing the arrangement of the valve controlling levers on the valve stems, and

Fig. 7 is a sectional view on plane 7—7, Fig. 5 showing the valve construction and operation.

The excavator shown in Fig. 1 is of the drag line type, the base 10 supporting the platform 11 which is pivoted for rotational movement at 12 by any suitable mechanism. The boom 13 is hinged at its inner end to the front end of the platform in any suitable manner, its outer end being connected by suitable tackle 14 with the tower 15 mounted on the platform. The bucket 16 is raised and lowered by means of tackle 17 and its excavating operation is controlled by the drag line 18 all in the well known manner.

On the platform is mounted the gasoline or oil engine E whose driving shaft 19 is connected by belt 20 with the counter shaft 21 which is journaled in the framework 22. In this framework are journaled the various hoisting and loading drum structures designated as a whole D, and the various gear-

ing trains G which connect the drum structures with the counter shaft 21.

For the purposes of my invention I extend one of the shafts 23 from the housing 22 and journal its outer end in the bearing framework 24. A gear 25 at the end of this shaft meshes with the gear 26 on the end of the shaft 27 which is parallel with the shaft 23 and is journaled in the framework 24 and framework 22. Between these shafts is the drum shaft 28 journaled in the framework 22 and 24 and supporting the boom swing controlling drum 29. The shaft 23 is driven at substantially constant speed and through the gears 25 and 26 the shaft 27 is rotated in the opposite direction. Normally loose on the shaft 23 is the gear 30 which meshes with the pinion 31 secured on the drum shaft 28, and on the reverse shaft 27 is the gear 32 normally loose on the shaft and which also meshes with the pinion 31. Normally loose on the shafts 23 and 27 are the gears 33 and 34 which mesh with the gear 35 secured to the drum shaft, this gear being larger than the pinion 31 and the gears 33 and 34 being smaller than the gears 30 and 32. Suitable friction clutch mechanisms 36, 37, 38 and 39 are associated with the gears 30, 33, 34 and 32 respectively and air rams 40, 41, 42 and 43 are associated with the clutches 36, 37, 38 and 39 respectively for controlling the operation thereof to couple the respective gears with the shafts 23 and 27 so that either forward or reverse rotation of the drum may result at either low or high speed, and the boom swung laterally accordingly. As will be disclosed more clearly later the clutches can be operated to gradually connect the gears to the respective shafts or gradually release them therefrom and the clutches may also act as friction brakes.

Secured on the base 10 concentric with the pivot connection 12 is the track 44 around which engages the cable 45, the cable being guided around suitable pulleys 46 to the upper side of the platform where it loops around the drum 29 as clearly shown in Figs. 2 and 3. When the drum 29 is rotated the platform with the boom thereon will be swung around in the corresponding direction in a manner well understood in the art.

In Figs. 3, 4 and 5 my improved controlling system and apparatus for the various pneumatic clutch mechanisms is shown. On the supporting framework 47 are mounted the slide bearings 48 and 49 in which is slidable a bar 50 having rack teeth 51 on its upper edge. On the bearing 48 is the standard 52 at whose upper end is pivoted the operating lever 53, the lever having the segmental lower end 54 provided with gear teeth 55 which mesh with the teeth of the pinion 56 on the shaft 57, the shaft supporting also the gear 58 which meshes with the rack teeth 51. When the lever is swung the bar 50 will therefore be reciprocated laterally.

Intermediate the bearings 48 and 49 the bar 50 has secured to it the frame 59 which at its upper side journals the abutment roller 60 on the pin 61. At its lower corners the frame has the pins 62 and 63 which journal the abutment rollers 64 and 65 respectively, between these rollers the cam plate 66 depends from the frame.

At one side of the bar 50 is a row of valve structures 67, 68, 69 and 70 each constructed as shown best in Fig. 7. Within the body of each valve structure is a cylindrical valve 71 having the diametral port 72 and the side port 73 at right angles thereto. At its lower end each valve body has the exhaust port 74 and these ports all connect with the exhaust manifold 75 leading to the exhaust pipe 76. At its upper end each valve body has the outlet port 77, these ports communicating with the pipes 78, 79, 80 and 81 respectively which lead to the pneumatic rams 40, 41, 42 and 43 respectively which control the clutch mechanisms for the respective forward and reversing gearing trains controlling the boom swinging drum.

Below the bar 50 there is a row of pressure regulating valve structures 82, 83, 84 and 85 connected at their outlet ends by pipes 86 with the inlet ports 87 of the valve structures 67, 68, 69 and 70 respectively, a manifold 88 connecting with the inlets of the pressure regulating valve structures, the manifold being connected by pipe 89 with the air compressor C shown on Fig. 2. The pressure regulating valve may be of standard construction and I have shown only the valve stems 90, which project upwardly in the path of the cam plate 66 on the frame 59, the cam edge of this plate being beveled at its ends in order to gradually press down the valve stems with which the plate cooperates during shifting of the bar 50, so that the pressure will be gradually released and gradually shut off.

Each of the air valves 67, 68, 69 and 70 has a valve stem 91 extending laterally therefrom toward the bar 50, the stems having lever mechanisms secured thereto in the paths of the rollers 60, 64 and 65. On the stem for the air valve 67 is mounted the bell crank lever having the forward and reverse arms 92 and 93 for cooperating with the roller 60 to effect opening and closing of the valve, the arm 92 extending normally upwardly and the arm 93 inwardly. On the valve stem of the valve 70 is secured a similar lever having the forward and reverse arms 94 and 95 extending respectively upwardly and inwardly to be engaged by the roller 60 to effect opening or closing of the valve. These valves 67 and 90 receive air supply from the regulating valve structures

82 and 85 and deliver the air to the high speed clutch structures 36 and 39 of the boom swinging drum controlling mechanism.

The squared end of the valve stem of the air valve 68 has secured thereto a hub 96 (Fig. 6) from which extends the lever arm 97, the arm extending normally laterally outwardly as shown in Fig. 4. Rotatable on the hub 96 is the pawl arm 98 engaged by one end of the spring 99 coiled around the hub 96 and secured at its other end thereto. The spring tends to hold the pawl arm 98 at right angles to the lever 97 and against the abutment pin 100 extending from the lever 97. The pawl arm normally extends upwardly in the path of the upper abutment roller 60.

The valve stem for the valve 69 has the same lever arrangement thereon as the valve 68, the arm 101 being secured to the valve stem and extending normally laterally outwardly, while the pawl arm 102 is rotatable on the lever 101 and extends normally upwardly and is held by its spring in engagement with the abutment pin 103.

Describing now the operation, the controlling lever 53 is normally in vertical position with the frame 59 positioned to hold the abutment roller 60 midway between the upwardly extending pawl arms 98 and 102 and with the abutment rollers 64 and 65 below the levers 97 and 101, the cam plate 66 being midway between the pressure regulating valve structures 83 and 84, all as shown in Figs. 3, 4 and 5. The valves 67, 68, 69 and 70 are normally closed to compressed air flow and in position to exhaust the respective clutch controlling rams. If it is desired to swing the boom 13 to the right (Fig. 2) the lever 53 (Fig. 3) is swung toward the right. The frame 59 will then be carried toward the right by the bar 50 and the roller 60 will abut against the pawl arm 98. As this pawl arm abuts against the lever 97 the stem and valve of the air valve structure 68 will be rotated to effect communication between the pipe 79 and the pipe 86 leading to the pressure regulating valve structure 83. As the frame 59 continues to travel the valve 68 will be completely opened and the lever 97 will extend downwardly. After opening of the valve 68 the cam plate 66 will gradually engage the stem 90 of the regulator valve 83 and as the cam plate is beveled it will gradually depress the valve stem so that air under gradually increasing pressure will flow through the air valve 68 and through pipe 79 to the air ram 41 which controls the pneumatic clutch 37, and the clutch will be operated to gradually couple the gear 33 to the shaft 23. The drum 29 will then be powerfully and slowly started to cause travel of the cable 45, and as this cable engages the track 44 secured on the base 10 the platform 11 will be revolved to cause the boom to swing toward the right. When the lowermost point of the cam plate 66 engages with the stem of the regulating valve 83 the valve will be wide open and will deliver the maximum pressure for which it is designed. After the boom has thus been slowly and powerfully started from a state of rest through the low speed train 33, 35, and the plate 66 continues to travel to the right the regulating valve 83 will be gradually closed, and then the abutment roller 65 will engage with the depending lever 97 and will rotate the lever structure back to normal position so that the air flow to the low speed gearing train 33—35 is shut off. The abutment roller 60 will then engage with the arm 92 of the air valve 67 and this valve will be opened so that when the cam plate 66 travels over the stem of the regulating valve 82 air at gradually increasing pressure will flow through pipe 78 to the air ram 40 which controls the operation of the clutch 36, and the high speed gearing train 30—31 will become effective to rotate the drum 29 at increased speed so that the boom which has been slowly and powerfully started will be rapidly swung toward the position desired.

After the boom with the heavy loaded bucket thereon has acquired considerable speed it has also acquired a corresponding inertia and it must be gradually stopped before the bucket is unloaded, and then gradually and powerfully started in return direction for another loading operation. After sufficient driving force has been applied to swing the boom toward the place desired the attendant swings the lever 53 in the opposite direction to cause the frame 59 to move toward its normal position. During such movement the cam plate 66 is first removed from the stem of the regulating valve 82 to shut off the air, and then the abutment roller 60 engages with the now upstanding arm 93 of the valve 67 so that this valve will be returned to closed position. After leaving the valve 67 the roller 60 will engage with the pawl arm 98 of the valve 68 which was reclosed by the roller 65 when it traveled to the right. The arm 98 when thus engaged by the roller 60 will merely swing away from the pin 100 against the force of the spring 99 and as soon as the roller has traveled past the arm 98 will be restored by the spring to normal position in abutment with the pin. During this back travel of the frame 59 the cam plate 66 traveled against the stem of the regulating valve 83. but as the valve 68 was closed during that time there was no flow of air.

As the frame 59 continues toward the left the cam roller 60 will cooperate with the lever 102 of the valve 69 and this valve will be opened preparatory to opening of the regulating valve 84 by the cam plate

66, and air will then flow through the pipe 80 to the air ram 42 which controls the pneumatic clutch 38 for the gear 34 on the reverse shaft 27. Before the valve 69 was opened the boom was swinging along under inertia, but as air is gradually applied to the clutch 38 braking effort will be gradually applied to the drum 29 through the low speed gearing train 34—35. After this preliminary braking effort the roller 60 will cooperate with the lever arm 94 of the valve 70 and this valve will be opened and air gradually admitted as the cam plate travels over the stem of the regulating valve 85, and this air is delivered through the pipe 81 to the ram 43 which controls the pneumatic clutch 31 for the high speed gearing train 32—31. Thus the operator after having started the braking operation through the low speed train can shift to the high speed train to increase the braking effort and quickly bring the boom to rest. The boom having been brought to rest and the bucket having been unloaded the operator swings the lever 53 back to normal position, this movement causing the valve 70 to be closed by cooperation of the roller 60 with the lever 95, and the cam plate 66 to be released from the valve 85. The travel of the cam plate over the valve 84 produces no air flow as the valve 69 was reclosed by cooperation of the roller 64 with the lever 101 immediately after the cam plate left the valve 84 on its travel to the left. The travel of the roller 60 toward the right has no effect on the valve 69 as the pawl 102 will merely rotate relative to the valve stem and against the force of the spring, to be returned to normal position by the spring after the roller has released it.

The lever 53 and frame 59 are now back to normal position and to positively swing the boom 13 toward the left for another loading operation the lever 53 is swung toward the left. The valve 69 will first be opened by the roller 60 and air controlled by the valve 84 is delivered through the pipe 80 into the clutch mechanism 38 and the gear train 34—35 becomes effective to positively, powerfully and slowly start the boom swinging toward the left. The valve 69 is then reclosed by the roller 64 and the regulating valve 84 is closed, the roller 60 then causing opening of the valve 70 and the cam plate cooperates with the regulator valve 85 to admit air to the clutch mechanism 39 so that the high speed gearing train 32—31 becomes effective to take up the swing of the boom at increasing speed. The lever is then shifted back to the right to reclose the valves 85 and 70 and the boom is then pneumatically braked first through the valve 68 and then through the valve 67, and after it has come to rest the lever 53 is swung back toward the left to normal position and the excavator is ready for another loading operation. Under certain conditions it will be necessary only to use the low pressure low speed drum driving trains, as for example where the boom is swung slowly or through short distances, the operator then shifting the controlling lever 53 only a sufficient distance to cause operation of the valves 68 and 69 and their pressure regulating valve structures 83 and 84. However when greater speed is desirable the valves 67 and 70 are brought into play and the high speed gearing trains utilized, and then the low speed trains will necessarily cooperate and prevent extraordinary inertia strain and thus protect the apparatus besides enabling the boom to be started with greater power and without slippage at the clutches particularly when the load is heavy.

With my improved valve controlling arrangement the operator need only swing a single lever either in one direction or the other, the sequence of operation of the valve structures being automatically controlled and regulated so that there can be no chance for confusion and the operator will have the swinging of the boom under absolute control. My improved arrangement requires no special expensive parts, as standard valve structures can be utilized. The present types of excavators can therefore be readily and inexpensively fitted with my improved boom swinging controlling apparatus and the capacity and range greatly increased.

I do not desire to be limited to the exact construction and arrangement shown and described, as modifications are possible which would still come within the scope of the invention.

I claim as follows:

1. In apparatus of the class described, the combination of a rotary member, an engine, a forward driving shaft and a reverse driving shaft connected with said engine, a low speed transmission train and a high speed transmission train between said forward driving shaft and said rotary member, a low speed transmission train and a high speed transmission train between said reverse driving shaft and said rotary member, means for connecting said trains with the respective shafts, and means for preventing connection of either high speed train until its associated low speed train has been effective.

2. In apparatus of the class described, the combination of a rotary member, a forward driving shaft and a reverse driving shaft for said rotary member, a low speed transmission train and a high speed transmission train between each shaft and said rotary member, pneumatic clutch mechanism for

each train, an air controlling valve for each clutch mechanism, said valves being arranged in a row, and actuator mechanism for consecutively actuating said valves to cause operation of the corresponding clutch mechanisms and the transmission trains controlled thereby.

3. In apparatus of the class described, the combination of a rotary member, a forward and a reverse driving shaft for said rotary member, a low speed and a high speed transmission train between each shaft and said rotary member, a pneumatic clutch mechanism for each train, an air valve for each clutch mechanism, said valves being arranged in a row with those for the clutch mechanism of the low speed trains in the middle, and a valve actuating member normally positioned between said middle valves and shiftable between said normal position and the ends of said row whereby either high speed train can be connected for operation only after its associated low speed train has been operated.

4. In apparatus of the class described, the combination of a rotary member, a forward and a reverse driving shaft associated with said rotary member, a low speed gearing train and a high speed gearing train between each shaft and said rotary member, pneumatic clutch mechanism for each train for connecting it in service, air flow controlling mechanism for each clutch mechanism, means for consecutively actuating said air flow controlling mechanisms to cause either low speed train to become effective before its associated high speed train is connected, and means for regulating the pressure of the air delivered to the clutch mechanisms.

5. In apparatus of the class described, the combination of a rotary member, a driving shaft associated with said rotary member, a low speed transmission train and a high speed transmission train between said shaft and member, pneumatic clutch mechanism associated with each train, an air valve for each clutch mechanism for controlling the flow of air thereto, a pressure regulating valve associated with each air valve for controlling the pressure of the air, and actuating mechanism for actuating said valves and for causing full opening of the air valves before operation of the associated regulating valves.

6. In apparatus of the class described, the combination of a rotary member, a driving shaft for the rotary member, a low speed transmission train and a high speed transmission train between said shaft and member, pneumatic clutch mechanism for each train, an air valve for each clutch mechanism, a pressure regulating valve associated with each air valve, and actuating mechanism for said valves restricted in its movements to operate first the low speed train air valve and its associated regulating valve and then the high speed train air valve and its associated regulating valve.

7. In apparatus of the class described, the combination of a rotary member, a forward driving shaft and a reverse driving shaft associated with said rotary member, a forward low speed train and a forward high speed train between said forward driving shaft and said member, a low speed reverse train and a high speed reverse train between said reverse shaft and said member, pneumatic clutch mechanism associated with each train, an air valve for controlling the flow of air to each clutch mechanism, a pressure regulating valve associated with each air valve, and actuating mechanism associated with said valves and restricted in its movement to cause operation first of a low speed train air valve and its associated regulating valve before the associated high speed train and its regulating valve can be operated.

In witness whereof, I hereunto subscribe my name this 5th day of June, A. D. 1923.

WILLIARD R. EWING.