Sept. 20, 1960 O. H. JOHNSON ET AL 2,953,057

MACHINE

Filed Jan. 18, 1957 8 Sheets-Sheet 1

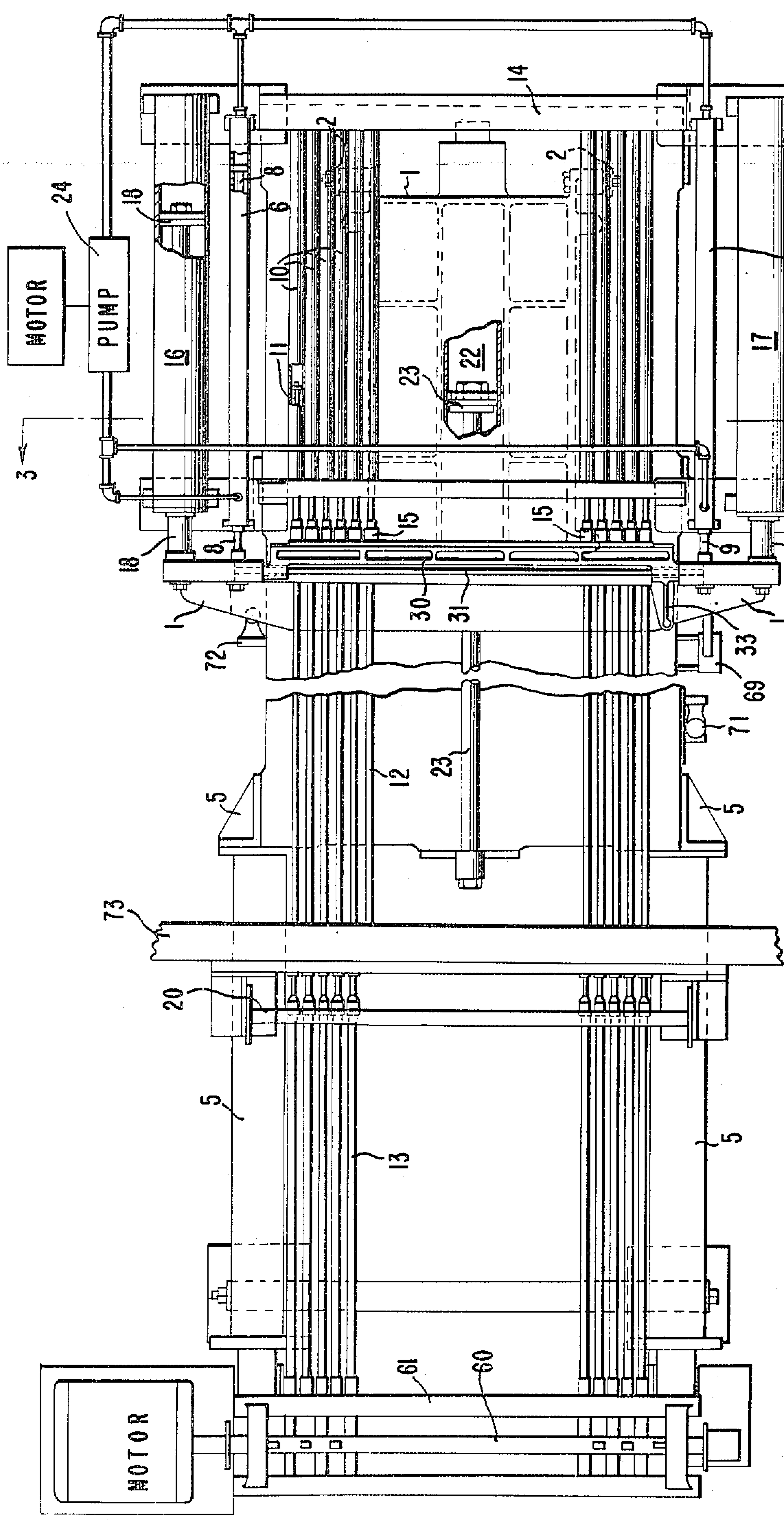


FIG. 1

INVENTORS
EDGAR HERMAN SCHMIDT
ORVILLE HOWARD JOHNSON

John F. Schmidt
AGENT

Sept. 20, 1960 O. H. JOHNSON ET AL 2,953,057

MACHINE

Filed Jan. 18, 1957 8 Sheets-Sheet 2

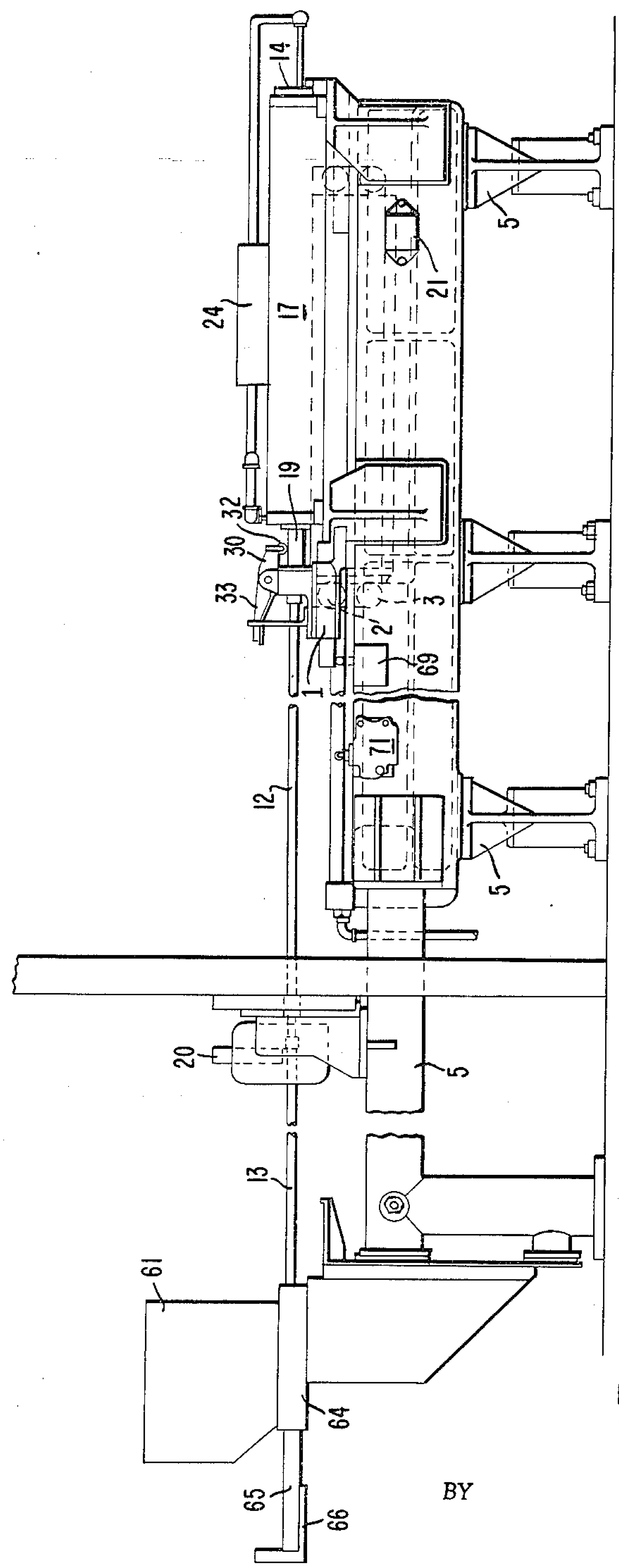


FIG. 2

INVENTORS
EDGAR HERMAN SCHMIDT
ORVILLE HOWARD JOHNSON

BY

John F. Schmidt
AGENT

Sept. 20, 1960 O. H. JOHNSON ET AL 2,953,057

MACHINE

Filed Jan. 18, 1957 8 Sheets-Sheet 3

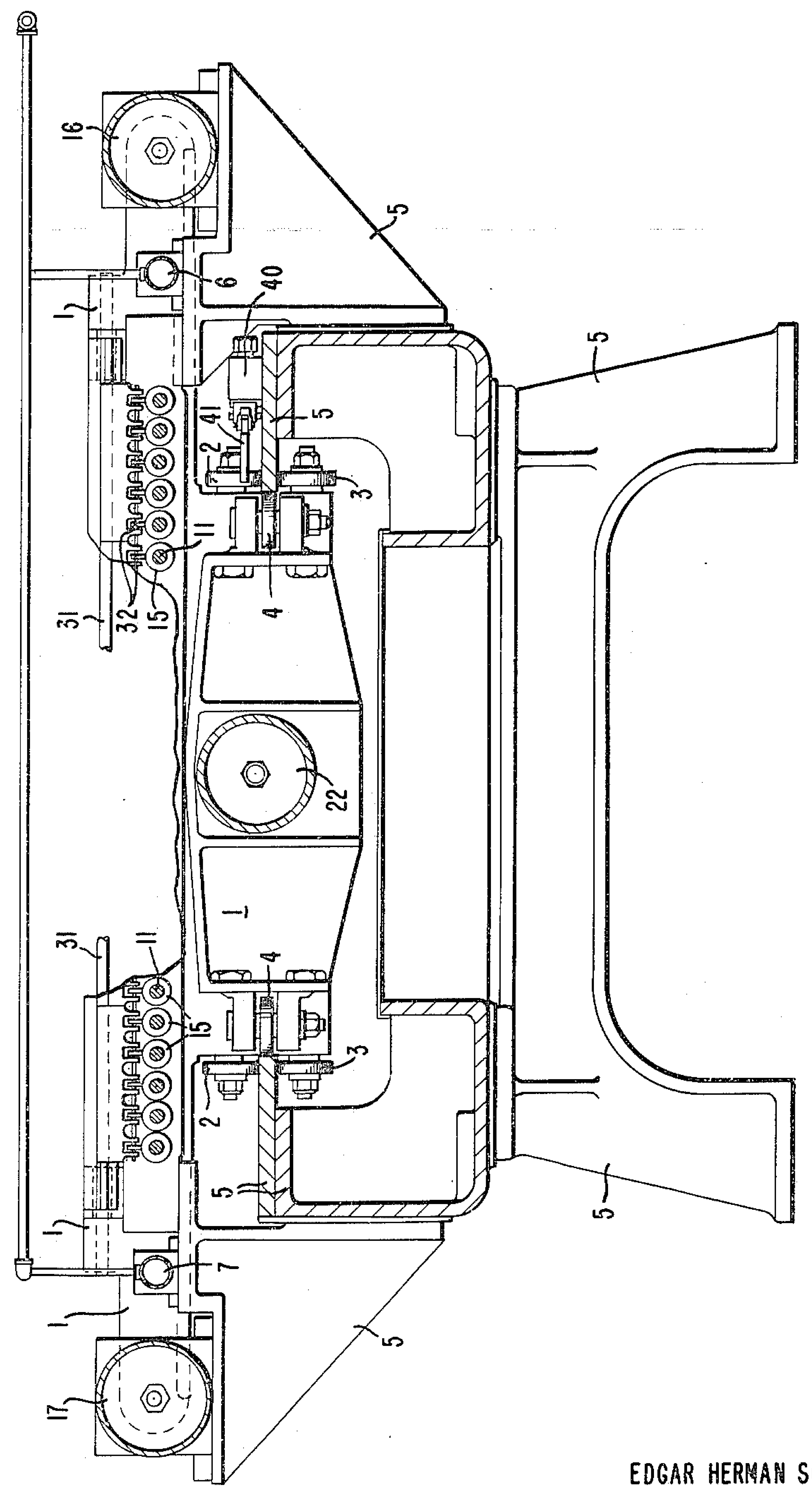


FIG. 3

INVENTORS

EDGAR HERMAN SCHMIDT

ORVILLE HOWARD JOHNSON

BY

John [signature]

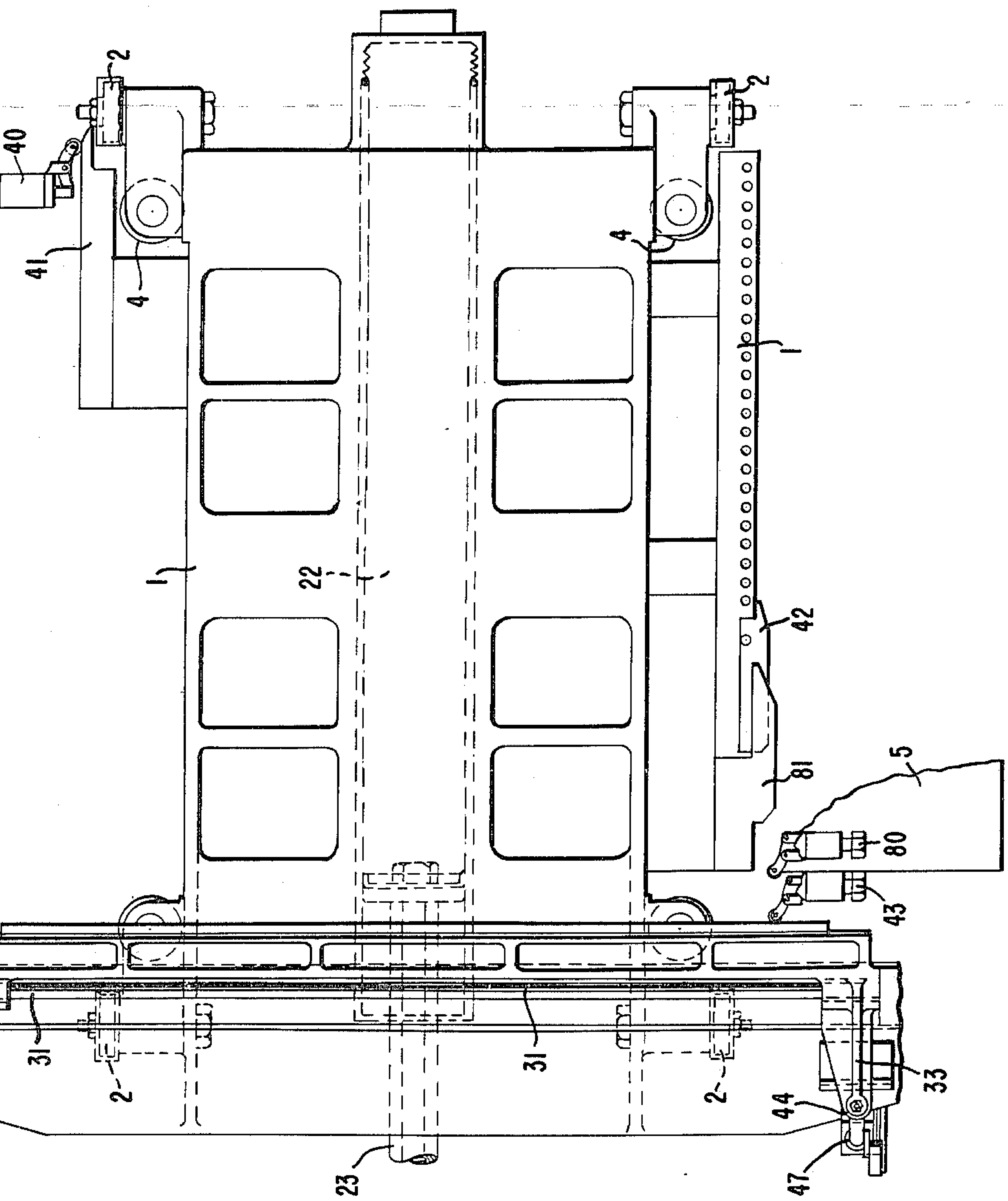
AGENT

Sept. 20, 1960 O. H. JOHNSON ET AL 2,953,057

MACHINE

Filed Jan. 18, 1957 8 Sheets-Sheet 4

FIG. 4



INVENTORS

EDGAR HERMAN SCHMIDT
ORVILLE HOWARD JOHNSON

BY John F. Schmidt

AGENT

MACHINE

Filed Jan. 18, 1957 8 Sheets-Sheet 5

FIG. 6

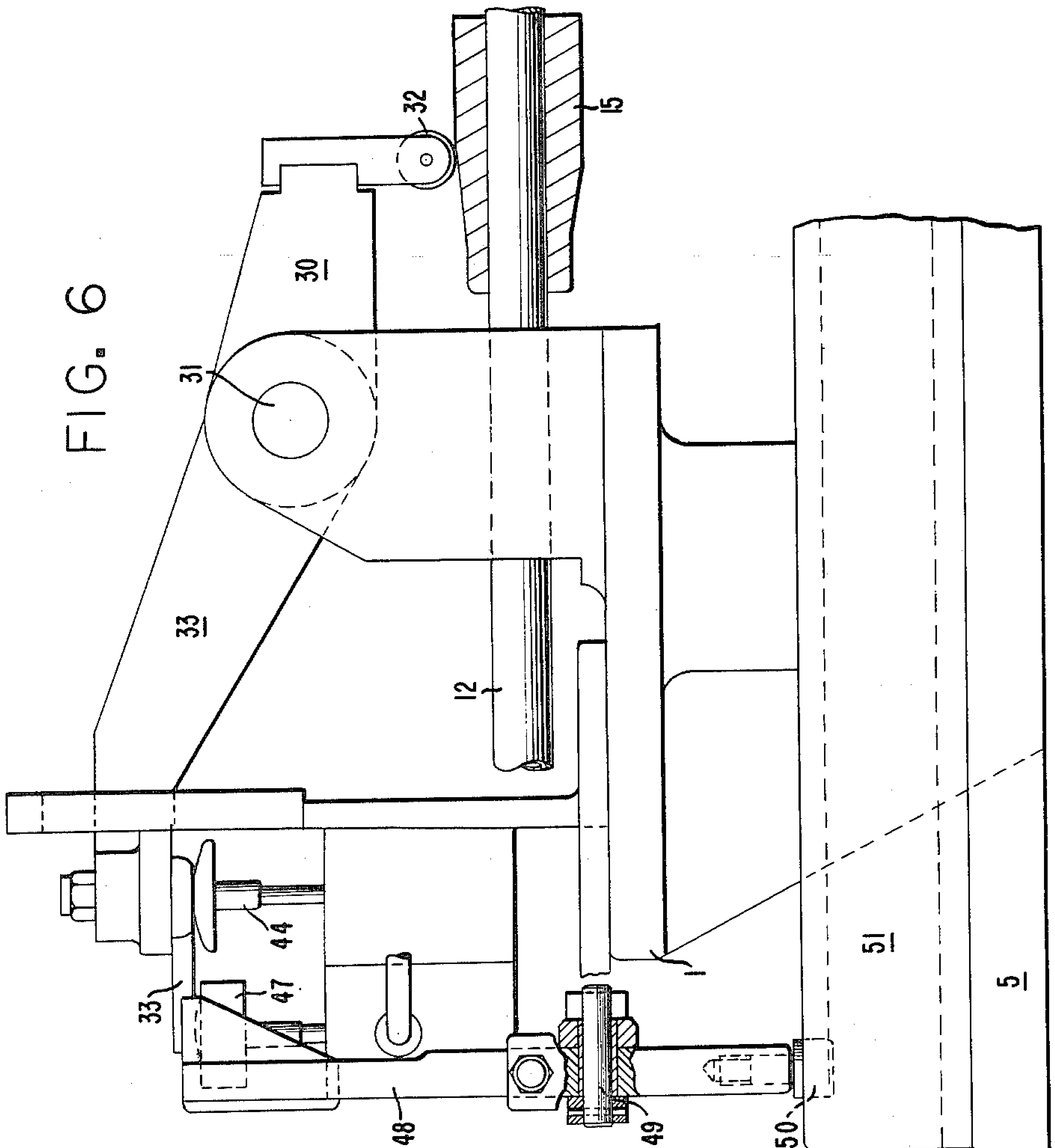
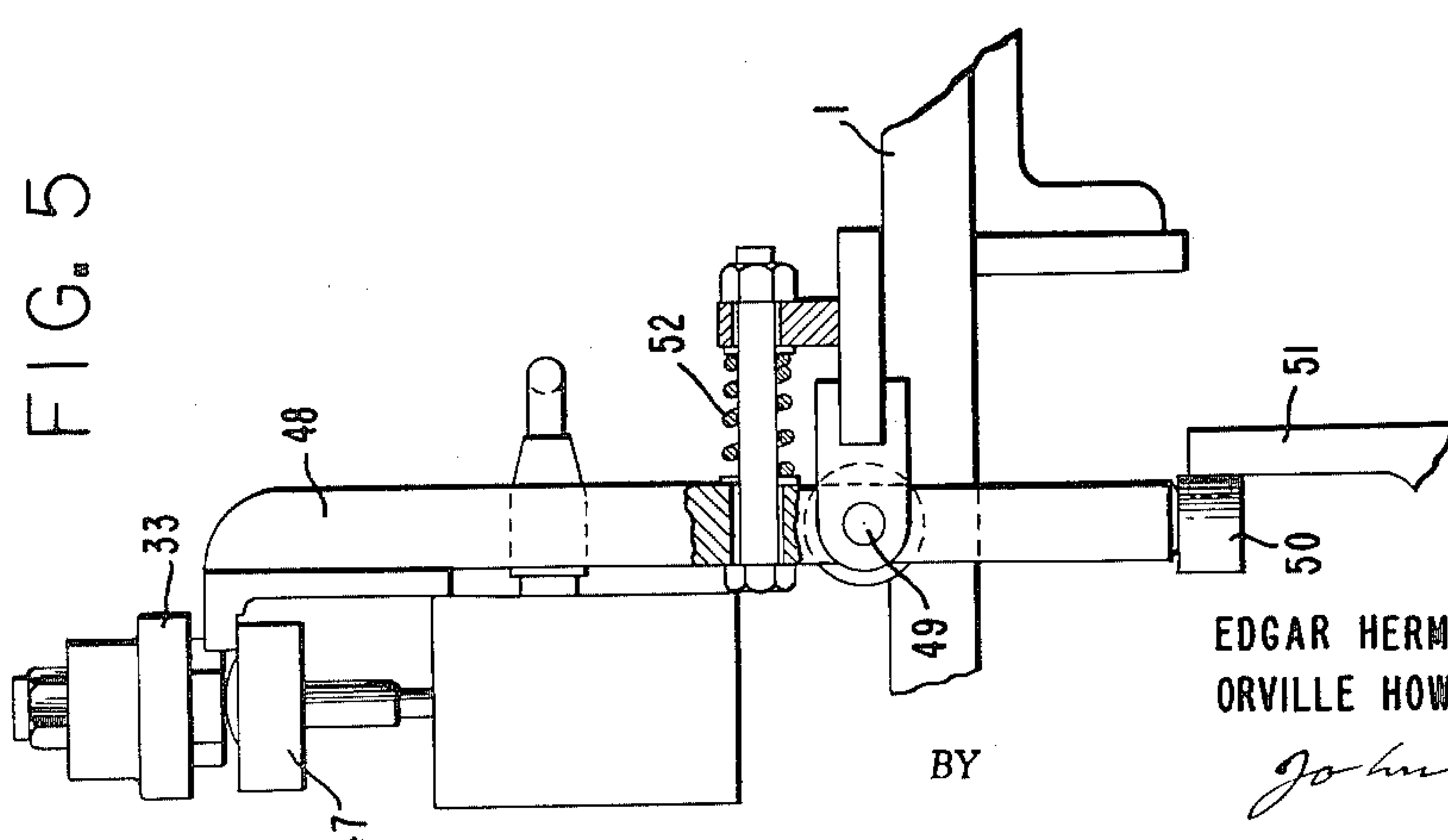


FIG. 5



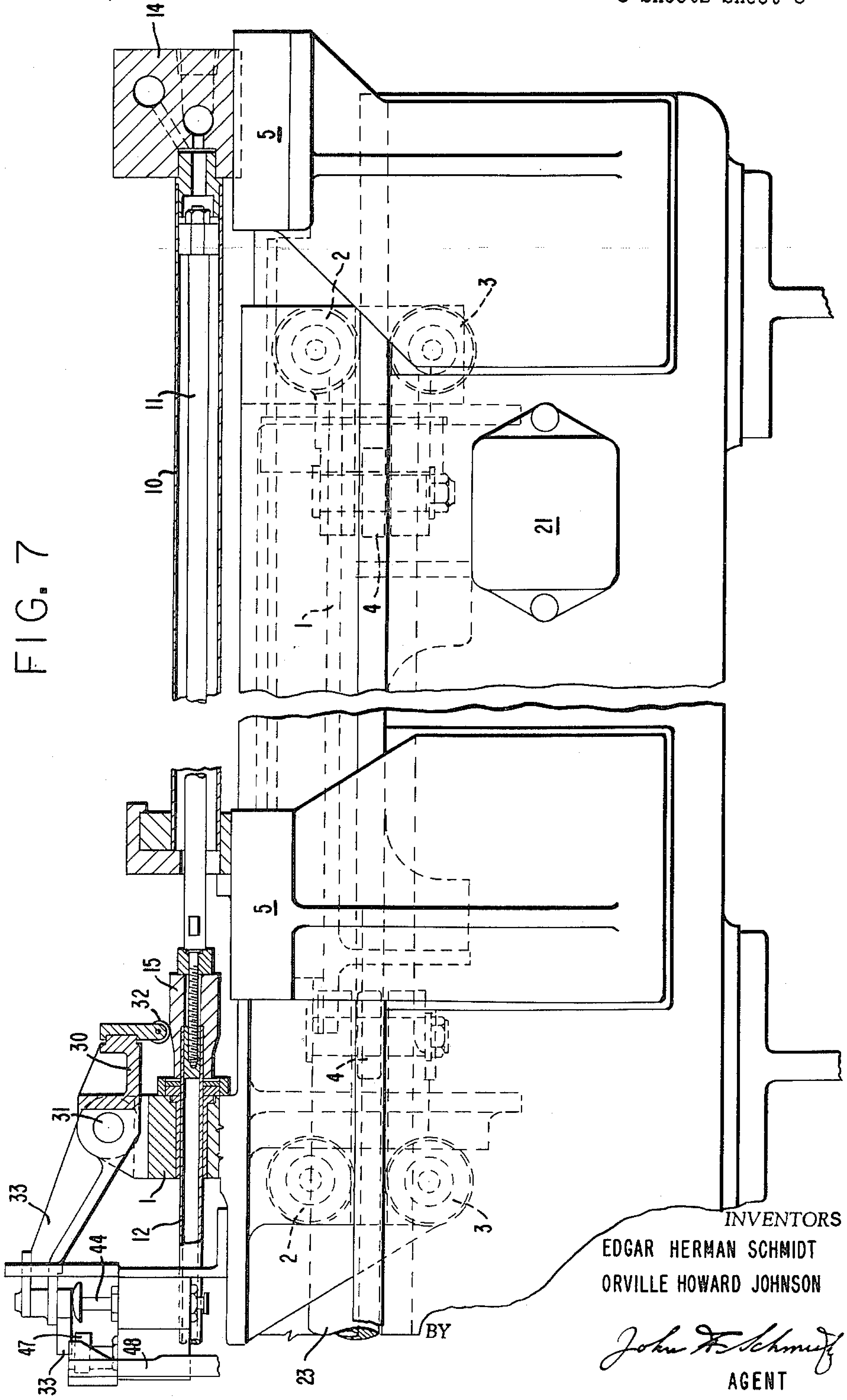
INVENTORS
EDGAR HERMAN SCHMIDT
ORVILLE HOWARD JOHNSON
BY John F. Schmidt
AGENT

Sept. 20, 1960 O. H. JOHNSON ET AL 2,953,057

MACHINE

Filed Jan. 18, 1957 8 Sheets-Sheet 6

FIG. 7



INVENTORS
EDGAR HERMAN SCHMIDT
ORVILLE HOWARD JOHNSON

BY John F. Schmidt

AGENT

MACHINE

Filed Jan. 18, 1957 8 Sheets-Sheet 7

FIG. 8

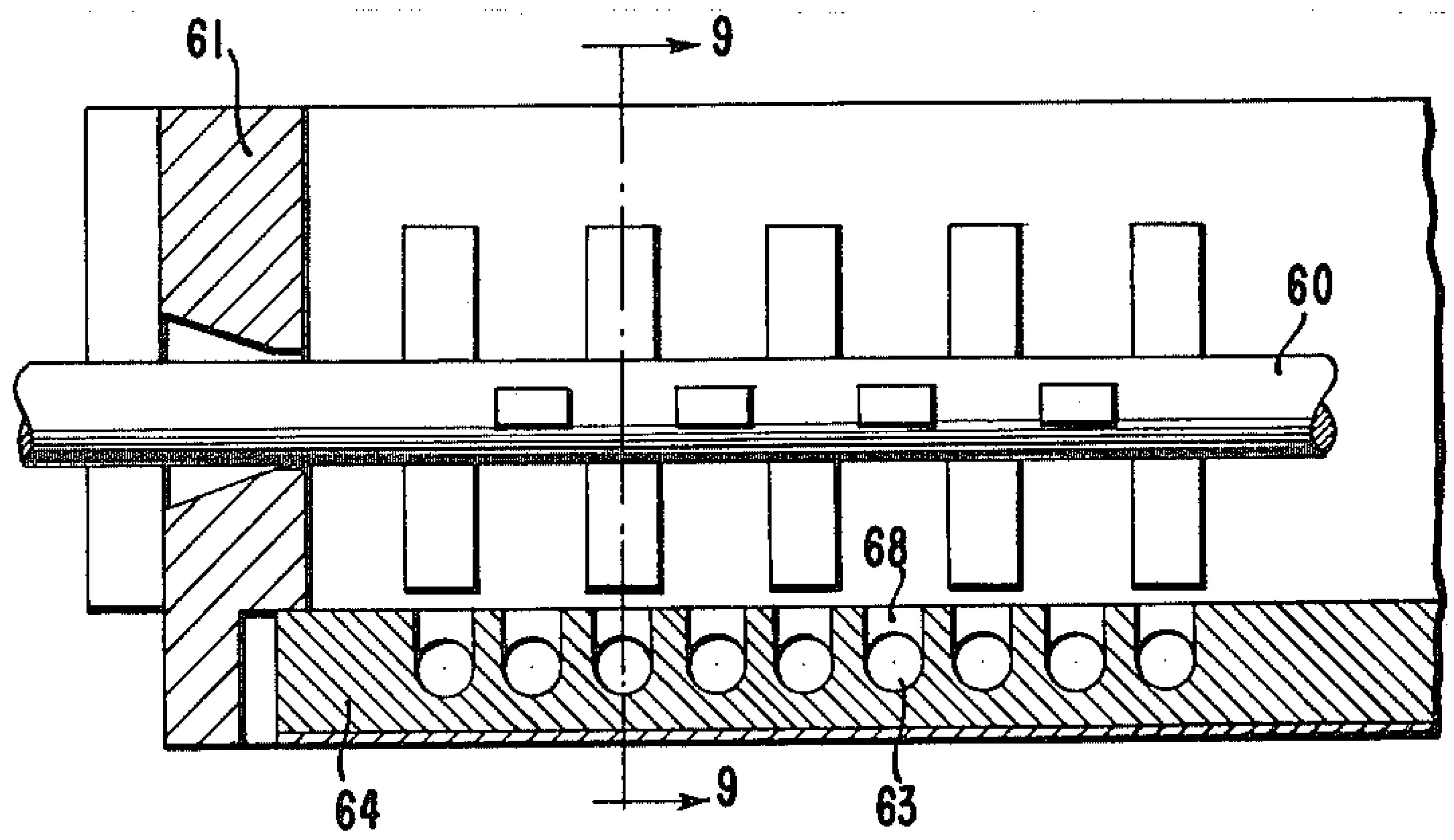
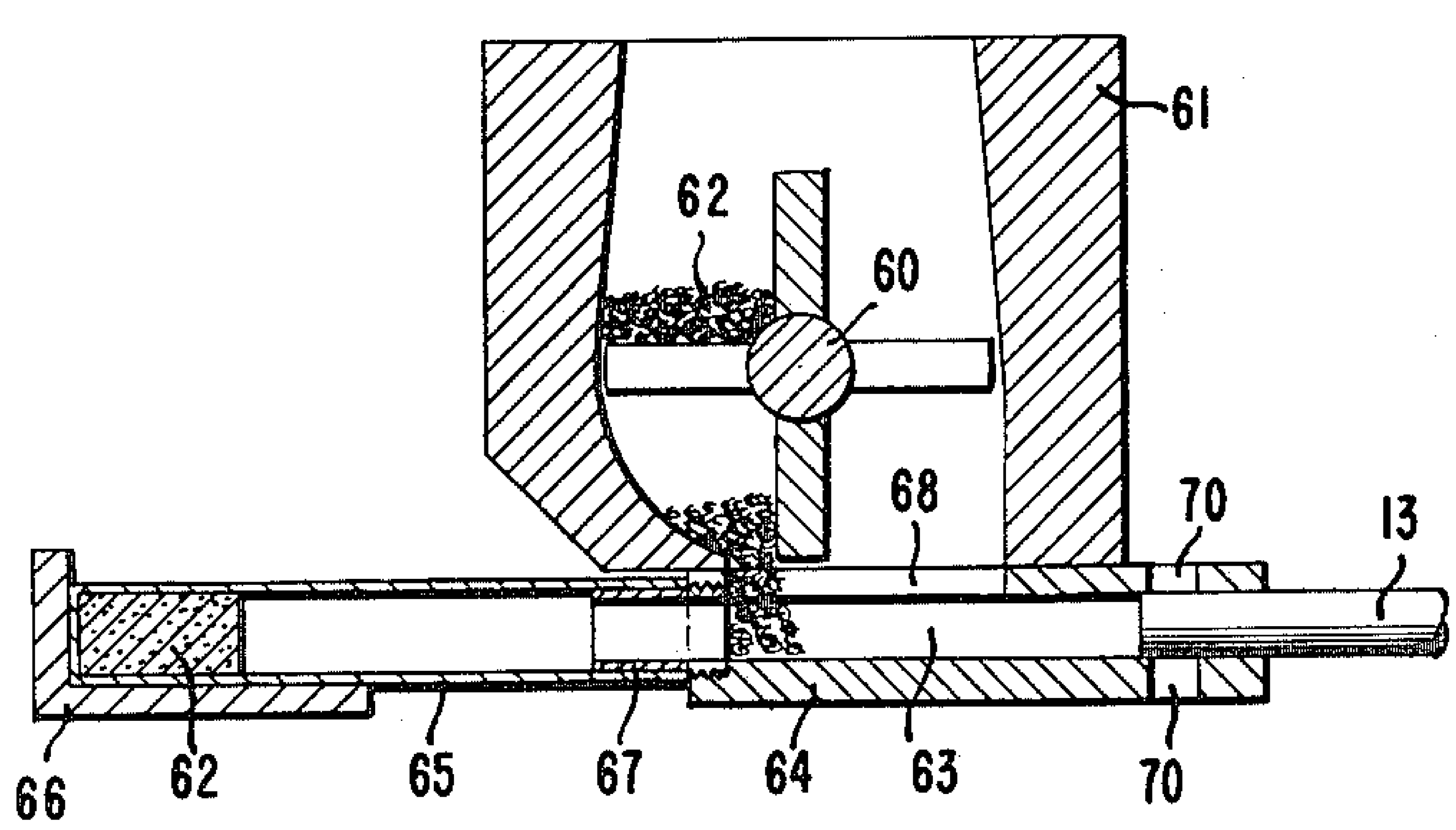


FIG. 9



INVENTORS
EDGAR HERMAN SCHNIDT
ORVILLE HOWARD JOHNSON

BY John F. Schmidt
AGENT

Sept. 20, 1960 O. H. JOHNSON ET AL 2,953,057

MACHINE

Filed Jan. 18, 1957 8 Sheets-Sheet 8

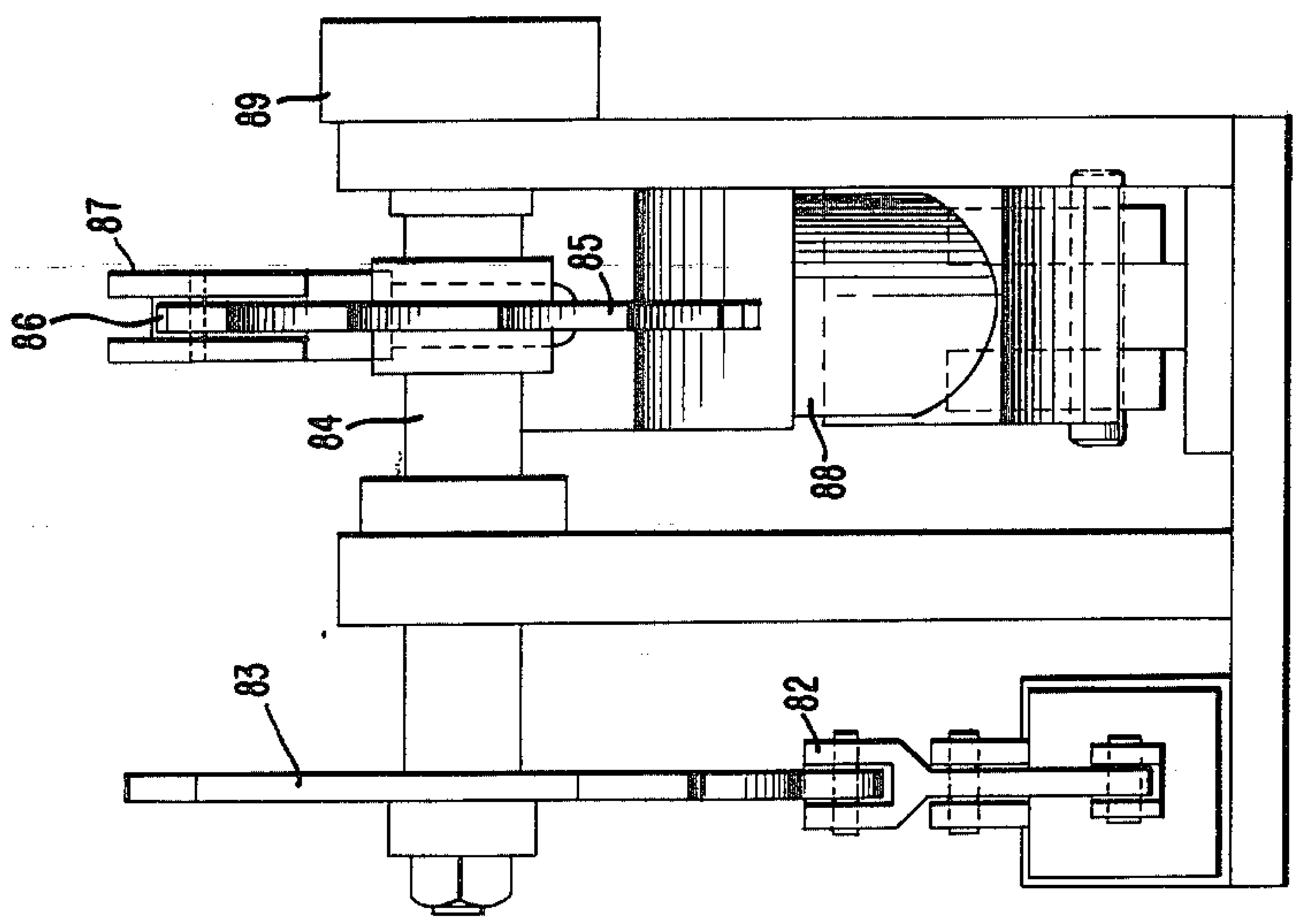


FIG. 11

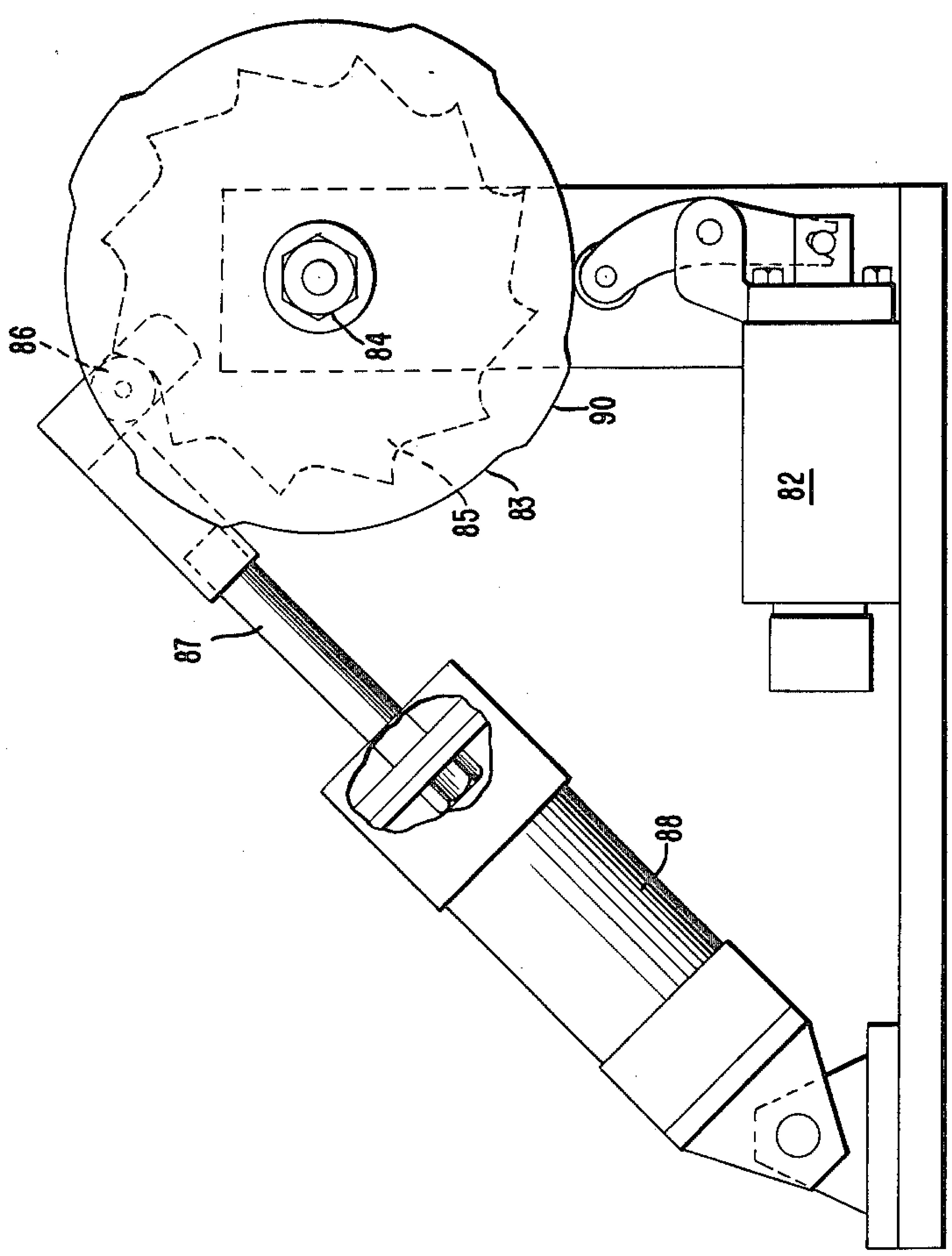


FIG. 10

INVENTORS
EDGAR HERMAN SCHMIDT
ORVILLE HOWARD JOHNSON

AGENT

United States Patent Office 2,953,057
Patented Sept. 20, 1960

1

2,953,057

MACHINE

Orville Howard Johnson and Edgar Herman Schmidt, Wilmington, Del., assignors to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed Jan. 18, 1957, Ser. No. 634,858

11 Claims. (Cl. 86—20)

This invention relates to a loading mechanism and more particularly to a device for loading and tamping explosive compositions into shells.

Dynamite and similar explosive cartridges are generally prepared by loading empty tubular shells with an explosive compositon, which can be either granular or gelatin, by means of reciprocating tamp arms. The loading machines normally employ a plurality of tamp arms each of which simultaneously tamps explosive into an empty shell. The density of the loaded composition is normally regulated by controlling the frequency and impact of the tamping strokes.

Known loading machines have several disadvantages. First, the time required for each cycle of the tamp arms does not change as the shells are filled; therefore, it takes as long to pack a portion of the charge in the bottom of each shell as it does to pack the last portion of the charge in the nearly filled shell. Secondly, most machines, especially those in which the tamps are driven frictionally, make an extra stroke after each set of shells is filled to reset the tamp arms to pack the charge in the bottom of the next set of empty shells. Thirdly, in most known loading machines, the efficiency of the machines decreases with the length of the shells packed.

It is an object of this invention to provide a shell loading machine which charges shells rapidly and efficiently. Another object of this invention is to provide a loading machine in which the time for each stroke decreases as the shells are filled. Still another object of this machine is to provide a machine the efficiency of which is substantially independent of the size of the shells charged. A further object is to provide a machine which will pack all shells to substantially the same even density. A still further object is to provide a novel loading machine and to advance the art. These and other objects will become apparent in the course of the following specification.

These and other objects of this invention are accomplished by providing, in a shell loading machine, the combination which comprises a plurality of fluid-driven tamping means, an independently fluid driven crosshead positioned to meter the forward and rearward motion of the tamping means, and means to decrease the length of time of succeeding packing strokes of the tamping means as the shells are filled. More particularly, the loading machine of this invention comprises a frame, a plurality of pneumatically driven tamp arms, a hydraulically driven crosshead movably secured to the frame and positioned to meter the forward and rearward motion of the tamp arms, and means to decrease the length of time of each stroke of the tamp arms as the shells are filled.

The invention is described in detail hereinafter by reference to a preferred embodiment shown in the accompanying drawings wherein:

Figure 1 is a plan view of the machine.

Figure 2 is a side elevation of the machine.

Figure 3 is a cross-sectional view of the machine along line 3—3 in Figure 1.

2

Figure 4 is an enlarged plan view of the reciprocating crosshead.

Figures 5 and 6 are end-elevation and side-elevation views respectively of the crosshead stopping and reversing mechanism.

Figure 7 is an enlarged cross-sectional view of the tamp manifold and the upper portion of the tamp arms.

Figure 8 is a cross-sectional vertical elevation of the explosive feed mechanism.

Figure 9 is a cross-sectional view taken along line 2—2 of Figure 8.

Figures 10 and 11 are side elevation and end elevation views respectively of a device which causes the machine to make intermittent short strokes and packing strokes.

In Figures 1, 2 and 3, crosshead **1** is movably secured through rollers **2**, **3** and **4** to frame **5** of the loading machine. Hydraulic cylinders **6** and **7** are fixed to frame **5**. The rod ends of pistons **8** and **9**, which operate within cylinders **6** and **7** are fixed to crosshead **1**. Hydraulic pressure can be applied to either the head or rod ends of the cylinders to drive crosshead **1** forward or backward respectively along frame **5**. This hydraulic pressure is applied to cylinders **6** and **7** by hydraulic pump **24** which is controlled by air signals sent to the pump by various valves on the loading machine as described hereinafter.

The particular means used to supply fluid to the hydraulic cylinders **6** and **7** forms no part of this invention. Standard variable displacement two-way hydraulic pumps, such as the "Oil Gear" pump manufactured by the Oil Gear Company, are preferred. The "Oil Gear" pump is controlled by air cylinders which are, in turn, controlled by the air signals from the loading machine. Other automatically controlled hydraulic pumps or combinations of hydraulic pumps can also be used. Electric and hydraulic signalling systems can be substituted for the air signals described in the disclosed embodiment; however, for packing high explosives the air signals are preferred.

In the particular embodiment shown in the drawings, the tamp assembly consists of tamp cylinders **10**, tamp pistons **11**, tamp tubes **12**, and tamp tips **13**. Tamp pistons **11**, tamp tubes **12** and tamp tips **13** are coupled together to give a set of continuous tamp arms. Alternatively, unitary tamp arms can be used. Air is supplied through manifold **14** to the head end of tamp pistons **11** forcing the tamp arms consisting of tamp pistons **11**, tamp tubes **12** and tamp tips **13** forward. Except when crosshead **1** is at the forward end of its stroke, tamp cams **15** fastened to the tamp arms at the head end of each tamp tube **12** abut against crosshead **1**; thus, the crosshead **1** limits the forward motion of the tamp arms. Figure 7 shows an enlarged cross-section of the manifold **14**, and the upper portion of the tamp arms. It also shows the abutment of cams **15** on the crosshead **1**.

In Figures 1, 2 and 3, pneumatic cylinders **16** and **17** are secured to frame **5**, and pistons **18** and **19**, which operate within these cylinders, are fastened to crosshead **1**. The total working area on the rod side of pistons **18** and **19** is equal to the total working area on the head side of the tamp pistons **11**. These two areas are connected to the same closed air circuit through manifold **14** so that as the crosshead **1** moves forward and air is forced out of the rod end of cylinders **16** and **17**, air is forced into head end of the tamp cylinders **10**. Air in this closed circuit is maintained at an elevated pressure by a control valve connected to the air supply. Pistons **18** and **19** in pneumatic cylinders **16** and **17** thus balance the force exerted on crosshead **1** by cams **15** and permit hydraulic pistons **8** and **9** to work against a load throughout the entire cycle of the machine.

When large diameter shells are loaded, alternate tamp arms are held back by bar **20**; thus the total working area on the heads of the operating tamp pistons **11** is reduced. For packing these large shells, the pneumatic cylinders **16** and **17** are disconnected from the closed air circuit by valve **21** and allowed to run free. The force on the crosshead **1** of the tamp cams **15** of the operating tamp arms is balanced by a third pneumatic cylinder **22** which is fastened to crosshead **1**. Piston **23**, fastened to frame **5**, has a hollow piston rod which, when large diameter shells are filled, is connected in the closed air circuit supplying tamp cylinders **10**. When the crosshead **1** moves forward carrying cylinder **22** forward, air is forced out of cylinder **22** through piston **23** and manifold **14** into the tamp cylinders **10**. The working area on piston **23** is equal to the working area on the alternate tamp pistons **11**; therefore, piston **23** in cylinder **22** acts to balance the load on the crosshead **1** in a manner similar to pistons **18** and **19** in pneumatic cylinders **16** and **17**.

Rocker beam **30** is rotatably mounted on rod **31** fixed to crosshead **1**. The rear edge of this beam carries a set of rollers **32** (see Figure 3), each of which rides on one of the cams **15**. Arm **33** attached to rocker beam **30** actuates the stopping and reversing mechanism (see Figures 5 and 6).

Figure 4 is an enlarged plan view of the crosshead **1**. Air valve **40** fixed to frame **5** is actuated by cam **41** secured to crosshead **1**. As the crosshead **1** approaches the rear end of its stroke, cam **41** engages valve **40** which reverses hydraulic pump **24** that feeds hydraulic cylinders **6** and **7**. This decelerates and stops crosshead **1**, and accelerates it on the forward stroke.

Cam **42** adjustably mounted on crosshead **1** engages air valve **43** fixed to frame **5** on the forward stroke of the crosshead **1**. The position of cam **42** determines the maximum forward stroke of the crosshead **1** and tamp tips **13** when the machine first begins to load empty shells. In addition, by reversing the crosshead **1**, it prevents the tamp tips **13** from striking the bottom of the empty shells. After a small amount of powder has been packed in shells **65**, air valve **44**, which is connected in parallel with air valve **43**, begins to reverse crosshead **1**. At this point cam **42** no longer moves far enough forward to contact valve **43** and the crosshead **1** controlled by valve **44** reverses progressively earlier in each cycle.

As shown in Figures 5 and 6, when the crosshead **1** and the tamp arms move forward at the beginning of each stroke of the machine, rollers **32** on rocker beam **30** (see also Figures 1, 2 and 3) ride on tamp cams **15**. When the forward motion of the tamps is stopped by the packed charge in shells **65**, crosshead **1** continues forward and rollers **32** ride off of cams **15**, thus actuating rocker beam **30**, raising arm **33** and allowing valve **44**, which is also attached to crosshead **1**, to extend. When valve **44** extends, it reverses pump **24** and starts crosshead **1** backward. As crosshead **1** picks up the tamp arms again on the backward stroke rollers **32** again ride up on cams **15** and valve **44** is ready for the next forward stroke.

Arm **33** also depresses valve **47** which is attached to crosshead **1**. When valve **47** extends, signals are set up so that valve **40** shifts pump **24** into neutral at the end of the next rearward stroke of crosshead **1**, thereby stopping the flow of fluid to hydraulic cylinders **6** and **7** and stopping crosshead **1**. Clip **48** is rotatably secured to crosshead **1** through pin **49**. Cam follower **50** which rides on cam **51** fixed to frame **5**, holds the top of clip **48** away from valve **47** until crosshead **1** allows tamp tips **13** to enter the part of the shells **65** that is to be packed (see Figure 9). When the tamp tips **13** enter this region, cam follower **50** rides off of cam **51** and spring **52** forces the top of clip **48** over valve **47**. In this manner, as long as at least one of the shells **65** is not filled, arm **33** holds valve **47** down until crosshead **1** moves forward to allow tamp tips **13** to enter the one or more unfilled shells. When the tamp tips **13** enter the shells **65**, clip **48** holds valve **47** depressed. After the tamp tips **13** have been stopped by the packed charge, arm **33** rises and releases valve **44** causing crosshead **1** to make another stroke. If all of the shells **65** are filled, when tamp tips **13** contact the packed charge, rollers **32** move off cams **15** allowing arm **33** to rise and valve **44** to extend, but, since crosshead **1** is not far enough forward, cam **51** still keeps the upper portion of clip **48** away from valve **47**. Since neither arm **33** nor clip **48** hold valve **47** down, valve **47** extends and shifts pump **24** to neutral and, indirectly, stops crosshead **1** at the end of its next rearward stroke. After valve **47** extends, crosshead **1** continues forward and is reversed on its last stroke by valve **44**. Since valve **47** is already extended, the upper portion of clip **48** merely rests against the side of the cap on valve **47** when crosshead **1** is in its forward-most position and does not depress valve **47**.

The explosive feed mechanism shown in Figures 8 and 9 is described in more detail in copending application Serial No. 534,498, filed by Edgar H. Schmidt on Sept. 15, 1955, now abandoned. This assembly, which is positioned at the forward end of the loading machine (see Figures 1 and 2), comprises essentially a stirrer **60** which rotates within hopper **61** to feed explosive **62** into the boreholes **63** of nipple plate **64**. Shells **65** held by a **V** groove shuttle **66** or other suitable means are slipped over replaceable nipples **67**. Tamp tips **13** pick up the explosive falling through channels **68** into boreholes **63** and carry it into shells **65**. Stirrer **60** can be operated either continuously or intermittently. However, it is preferable to stop the stirrer **60** while the tamp tips **13** are inside the shells **65**. This intermittent operation can be controlled by valve **69** (see Figure 2) which is actuated by a cam on crosshead **1**.

Throughout the charging cycle, tamp tips **13** remain within the boreholes **63**. Relief slots **70** are cut in nipple plate **64** to help prevent explosive from wedging the tamp tipe **13** in the boreholes **63**.

Various ancillary features have been added to the loading machine to ensure safe operation and to facilitate operation under special conditions. Valves **71** and **72** (see Figs. 1 and 2), contact and stop crosshead **1** on the forward and rearward strokes respectively if it is not reversed by the normal reversing mechanism. A manually operated air valve (not shown) is connected in parallel with valve **47** so that the machine operator can stop the machine at any time. An air control can be added to cause crosshead **1** to dwell between the end of the rearward stroke and the start of the forward stroke. With certain types of explosives, this is advantageous since it allows more time for the stirrer **60** to force explosive into the boreholes **63**. A barricade **73** can also be placed behind the feeding and packing area to shield this area from the rest of the machine.

Tamp tips **13** are coupled to tamp tubes **12** with Dardelet threads so that if one of the tamp tips **13** sticks and all the force of crosshead **1** is exerted on that tamp tip on the rearward stroke, the Dardelet coupling will pull apart, usually with a force of about 500 pounds. This coupling prevents the crosshead **1** from stalling or breaking some element of the machine if one of the tamp tips **13** sticks. Dardelet threads are a modified form of buttress screw threads in which the driving face of the threads is made perpendicular to the axis of the screw, as in a square thread, while the back face of the threads makes an angle with the axis as in a V-thread. Threaded couplings provided with such Dardelet threads are particularly adapted to withstand heavy thrust on the perpendicular driving face during packing strokes, yet will pull apart when the coupling is subjected to tension.

Another feature which can be added to the machine of this invention is a device for causing the machine to make intermittent packing strokes and short strokes. When the crosshead **1** is operated at high speeds, such as for example, 180 feet per minute, it is often difficult to pack a low-density or "soft" charge in the shells **65**. This problem is solved by providing one or more short strokes of the tamp arms between each packing stroke. During each short stroke, tamp tips **13** move forward just far enough to push a plug of powder out of nipples **67**, then during the next packing stroke the tamp tips **13** pack the accumulated charge into shells **65** as previously described.

The device for controlling the aforementioned intermittent packing stroke and short stroke operation is shown in Figures 4, 10 and 11. Air valve **80** fixed to frame **5** is connected in parallel with reversing valves **43** and **44**. Like valves **43** and **44**, valve **80** can reverse hydraulic pump **24**, hence crosshead **1**, on the forward stroke. Air valve **80** is actuated by cam **81** on crosshead **1**. Air valve **80** is energized (i.e., is connected in parallel with valves **43** and **44**), by valve **82**. When valve **82** is depressed, valve **80** is deenergized, thus crosshead **1** is reversed on its forward stroke either by valve **43** or valve **44**, and the machine makes a packing stroke as previously described. When valve **82** is extended, valve **80** is energized and, since during the forward stroke valve **80** is actuated before either valves **43** or **44**, it reverses crosshead **1** as soon as the tamp tips **13** approach the end of nipples **67**.

As shown in Figures 10 and 11, valve **82** is actuated by rotating cam **83**, which is fastened to axle **84**. Ratchet cam **85** is connected to the other end of axle **84**. Roller **86** is mounted at the end of piston **87** which operates within pneumatic cylinder **88**. Air is supplied alternately to the head and rod ends of piston **87**. Each time piston **87** moves forward, roller **86** forces ratchet cam **85** ahead one station. Frictional clutch **89** applies enough load to axle **84** so that roller **86** rides back to the next preceding ratchet when air is supplied to the rod end of piston **87**. Although air is preferred, some fluid other than air, such as water or oil, can be used to drive piston **87**.

The supply of air to the head and rod ends of piston **87** is controlled by the same signals which reverse crosshead **1**. Valve **40** causes air to flow into the head end of cylinder **88** when crosshead **1** completes its rearward stroke thereby indexing ratchet cam **85** one station. Valve **43**, **44** or **80** cause air to flow to the rod end of cylinder **88** when crosshead **1** has completed its forward stroke. If air cylinders are used to shift the hydraulic pump **24** which supplies fluid to hydraulic cylinders **6** and **7**, the air to drive piston **87** can be tapped from the air cylinders which shift pump **24**.

By increasing or decreasing the angular spacing between projections **90** on rotating cam **83**, the number of short strokes per long or packing stroke can be increased or decreased.

Briefly, the operating procedure for the loading machine just described consists of first positioning shells **65** over nipples **67** on nipple plate **64** and supplying air under pressure to the closed air circuit including tamp cylinders **10**, manifold **14** and pneumatic cylinders **16** and **17**. Next, stirrer **60** and pump **24** are started. Pump **24** forces fluid, preferably oil, into the head end of hydraulic cylinders **6** and **7** moving crosshead **1** forward. At the same time, the air pressure against tamp pistons **11** pushes the tamp arms forward and keeps tamp cams **15** abutted against crosshead **1**. As tamp tips **13** proceed through boreholes **63**, they pick up explosive **62** and pack it into the bottom of shells **65**.

When tamp tips **13** have almost reached the bottom of the shells **65**, cam **42** on crosshead **1** contacts valve **43** and reverses pump **24** so that pressure is applied to the rod ends of cylinders **6** and **7**. This stops and reverses the motion of crosshead **1**. As crosshead **1** starts on its rearward stroke, it carries the tamp arms backward with it withdrawing tamp tips **13** from shells **65**. When the crosshead **1** nears the rear end of the machine, cam

41 actuates valve **40** and starts the crosshead **1** on the next forward stroke.

Tamp tips **13** carry explosive forward into shells **65** until the packed charge stops the forward motion of the tamp arms; therefore, the end of the tamp tips **13** stop closer to the mouth of the shells **65** on each successive stroke of the machine.

When the tamp arms are stopped by the charge in the shells **65**, the crosshead **1** continues forward until it is reversed by valve **43**. Simultaneously, rollers **32** on rocker beam **30** begin to roll off tamp cams **15** on the tamp arms. After the machine has completed two or three cycles, rollers **32** ride completely off tamp cams **15** and, from then until all the shells are filled, valve **44** actuated by arm **33** on rocker beam **30** reverses the crosshead **1**. As the shells **65** fill and the tamp arms stop at a point closer to the rear of the machine on each stroke, cross-head **1** reverses earlier in each stroke. Consequently, since the rate of flow of fluid to the rod and head ends of hydraulic cylinders **6** and **7** remains constant during the whole loading operation, the time of each cycle of the crosshead **1** and tamp arms decreases as the shells **65** are filled. Typically, for shells 1½ inches in diameter and 30 inches long, the cycle time decreases from 2.6 seconds for the first cycle to 1 second for the last cycle.

If one of the shells does not fill as rapidly as the others, the crosshead does not reverse until the tamp tip **13** feeding that particular shell is stopped. The reason for this is that all the rollers **32** must ride off all the tamp cams **15** before arm **33** will allow valve **44** to extend and reverse the crosshead **1**.

Since each of the tamp arms is individually pressured and is not fastened to crosshead **1**, the pressure on the explosive in each shell **65** is the same whether or not the shells **65** fill at the same rate. When all the shells **65** are full, valve **47** extends on the forward stroke and the crosshead **1** stops on the next rearward stroke. The filled shells are then removed from the nipples **67** and crimped.

When different sizes of shells are to be charged, nipple plate **64**, nipples **67**, and tamp tips **13** are merely changed to fit the diameter of the shells. Tamp tips **13** fill essentially the entire cross-section of the boreholes **63**. When large diameter shells are packed, all the shells **65**, boreholes **63** and tamp tips **13** cannot be aligned in front of the plurality of closely spaced tamp arms; therefore, alternate tamp tips **13** are removed and the unused tamp arms are held back by projections on bar **20**.

All parts which move or contact moving parts near the explosive are constructed or protected with wood, nonferrous metals and alloys, moldable polymers and synthetic resins or other suitable non-sparking materials. Tamp tips of heavy wood are preferred. The lines which feed fluid to hydraulic cylinders **6** and **7** and air to manifold **14** and pneumatic cylinders **16**, **17** and **22** can be constructed of standard steel pipe. Rubber, plastic or other flexible tubing can be used for the lines which feed air signals from the various control valves on the machine to the variable displacement 2-way hydraulic pump **24**.

The loading machine of this invention charges a wide variety of sizes of shells rapidly and efficiently. Because the length and time of each stroke decreases as the shells are filled, the machine can often charge shells up to 2½ times as fast as other known machines. Since the tamp arms are driven independently of the crosshead and since the crosshead reverses shortly after the tamp arms pack the explosive, the machine of this invention is much more efficient than loading machines which drive tamp arms by frictional contact with a crosshead which has a stroke of fixed length. In addition, because all of the tamp arms are driven independently from a common closed air circuit, all shells are packed with the same even pressure.

The particular embodiment just described in detail is particularly suitable for packing shells ranging from ⅞ of an inch to 3 inches in diameter and from 6 to 30 inches in length. The density of the packed explosive can be regulated easily by varying the crosshead speed and the air pressure in the closed air circuit feeding the tamp cylinders; typical tamp pressures range from 10 to 50 p.s.i.g.

We claim:

1. A shell loading machine comprising a frame, a plurality of pneumatically driven tamp arms, a hydraulically driven crosshead movably secured to said frame and positioned to meter the forward and rearward motion of said tamp arms, and means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells comprising a control means for reversing the hydraulic force on said crosshead at a fixed point in its rearward stroke and a control means for reversing the hydraulic force on said crosshead during its forward stroke, said control means for reversing the hydraulic force on said crosshead during its forward stroke being fixed to said crosshead and actuated by means rotatably mounted on said crosshead and in movable contact with said tamp arms.

2. A shell loading machine comprising a frame, a plurality of pneumatically driven tamp arms, a hydraulically driven crosshead movably secured to said frame and positioned to meter the forward and rearward motion of said tamp arms, and means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells which comprises a control means for reversing the hydraulic force on said crosshead at a fixed point in its rearward stroke and a control means for reversing the hydraulic force on said crosshead during its forward stroke, said control means for reversing the hydraulic force on said crosshead during its forward stroke being fixed to said crosshead and actuated by an arm fastened to a rocker beam rotatably mounted on said crosshead, said rocker beam having attached thereto a plurality of rollers each of which rides on a cam fixed to one of said tamp arms.

3. A shell loading machine comprising a frame, a hydraulically driven crosshead movably secured to said frame, a plurality of pneumatically driven tamp arms each of which carries a cam positioned to abut against said crosshead during its forward and rearward motion, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells actuated by means rotatably mounted on said crosshead and in movable contact with said tamp arms, and means attached to said crosshead and positioned to exert a pneumatic force on said crosshead to balance the force on said crosshead of said cams fixed to said tamp arms.

4. A shell loading machine comprising a frame, a hydraulically driven crosshead movably secured to said frame, a plurality of pneumatically driven tamp arms each of which carries a cam positioned to abut against said crosshead during its forward and rearward motion, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells actuated by means rotatably mounted on said crosshead and in movable contact with said tamp arms, and means positioned to exert a pneumatic force on said crosshead to balance the force on said crosshead of said cams fixed to said tamp arms comprising a pneumatic cylinder attached to each side of said frame and a piston operating within each of said cylinders and attached to said crosshead.

5. A shell loading machine comprising a frame, a hydraulically driven crosshead movably secured to said frame, a plurality of pneumatically driven tamp arms each of which carries a cam positioned to abut against said crosshead during its forward and rearward motion, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells actuated by means rotatably mounted on said crosshead and in movable contact with said tamp arms, and means positioned to exert a pneumatic force on said crosshead to balance the force on said crosshead of said cams fixed to said tamp arms comprising a pneumatic cylinder fixed to said crosshead and a piston operating within said cylinder and fixed to said frame.

6. A shell loading machine comprising a frame, a hydraulically driven crosshead movably secured to said frame, a plurality of pneumatically driven tamp arms, each of which carries a cam positioned to abut against said crosshead during its forward and rearward motion, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells actuated by means rotatably mounted on said crosshead and in movable contact with said tamp arms, means attached to said crosshead and positioned to exert a pneumatic force on said crosshead to balance the force on said crosshead of said cams fixed to said tamp arms and means to stop said shell loading machine when said shells are substantially filled actuated by means rotatably secured to said crosshead coacting with means fixed to said frame.

7. A shell loading machine comprising a frame, a hydraulically driven crosshead movably secured to said frame, a plurality of pneumatically driven tamp arms each of which carries a cam positioned to abut against said crosshead during its forward and rearward motion, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells actuated by means rotatably mounted on said crosshead and in movable contact with said tamp arms, means attached to said crosshead and positioned to exert a pneumatic force on said crosshead to balance the force on said crosshead of said cams fixed to said tamp arms and means to stop said shell loading machine when said shells are substantially filled comprising a valve, fixed to said crosshead, which, when extended, stops the hydraulic driving force on said crosshead, means to hold said valve depressed until said tamp arms are stopped by the packed charge in said shells, a clip rotatably mounted on said crosshead and positioned to hold said valve depressed while the forward ends of said tamp arms are within said shells and a cam fixed to said frame and positioned to force said clip away from said valve when said ends of said tamp arms are not within said shells.

8. A shell loading machine comprising a frame, a hydraulically driven crosshead movably secured to said frame, a plurality of pneumatically driven tamp arms each of which carries a cam positioned to abut against said crosshead during its forward and rearward motion, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells actuated by means rotatably

mounted on said crosshead and in movable contact with said tamp arms, means attached to said crosshead and positioned to exert a pneumatic force on said crosshead to balance the force on said crosshead of said cams fixed to said tamp arms, means to stop said shell loading machine when said shells are substantially filled actuated by means rotatably secured to said crosshead coacting with means fixed to said frame, means to prevent said tamp arms from striking the bottom of substantially empty shells actuated by means fixed to said crosshead coacting with means fixed to said frame and a feeding means adapted to feed charge in front of said tamp arms before said tamp arms enter said shells.

9. A shell loading machine comprising a frame, a hydraulically driven crosshead movably secured to said frame, a plurality of pneumatically driven tamp arms each of which carries a cam positioned to abut against said crosshead during its forward and rearward motion, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells actuated by means rotatably mounted on said crosshead and in movable contact with said tamp arms, means attached to said crosshead and positioned to exert a pneumatic force on said crosshead to balance the force on said crosshead of said cams fixed to said tamp arms, means to stop said shell loading machine when said shells are substantially filled actuated by means rotatably secured to said crosshead coacting with means fixed to said frame, means to prevent said tamp arms from striking the bottom of substantially empty shells comprising a control means fixed to said frame for reversing the hydraulic force on said crosshead during its forward stroke actuated by a cam adjustably mounted on said crosshead and a feeding means adapted to feed charge in front of said tamp arms before said tamp arms enter said shells.

10. A shell loading machine comprising a frame, a plurality of pneumatically driven tamp arms, a hydraulically driven crosshead movably secured to said frame and positioned to meter the forward and rearward motion of said tamp arms, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells and a feeding means adapted to feed charge in front of said tamp arms before said tamp arms enter said shells in combination with a means fixed to said frame for reversing said shell loading machine actuated by said crosshead during its forward stroke at least once between each of said cycles during which said tamp arms pack shells as soon as said tamp arms have pushed said charge from said feeding means thereby causing said shell loading machine to make at least one short stroke between each packing stroke.

11. A shell loading machine comprising a frame, a plurality of pneumatically driven tamp arms, a hydraulically driven crosshead movably secured to said frame and positioned to meter the forward and rearward motion of said tamp arms, means, responsive to relative movement between said crosshead and said tamp arms during the forward motion thereof, to decrease the time of succeeding cycles of said crosshead and said tamp arms during which said tamp arms pack shells and a feeding means adapted to feed charge in front of said tamp arms before said tamp arms enter said shells in combination with a means which causes said shell loading machine to make at least one short stroke between each packing stroke comprising a reversing control means fixed to said frame and actuated by said crosshead of said shell loading machine on its forward stroke, a valve which energizes said reversing control means, a rotating cam positioned to actuate said energizing valve and secured to an axle, a ratchet cam secured to said axle, and a pneumatically driven piston positioned to turn said ratchet cam a fixed amount corresponding to each stroke of said crosshead of said shell loading machine.

References Cited in the file of this patent

UNITED STATES PATENTS

2,404,434	Clark et al.	July 23, 1946
2,515,323	Stuart	July 18, 1950
2,775,987	Bohlman et al.	Jan. 1, 1957

FOREIGN PATENTS

383,710	Italy	Oct. 23, 1940