July 10, 1956 J. L. REYNOLDS 2,753,847

APPARATUS FOR HYDRAULIC PRODUCTION OF METALLIC EXTRUSIONS AND FORGINGS

Filed Aug. 14, 1952

7 Sheets-Sheet 1

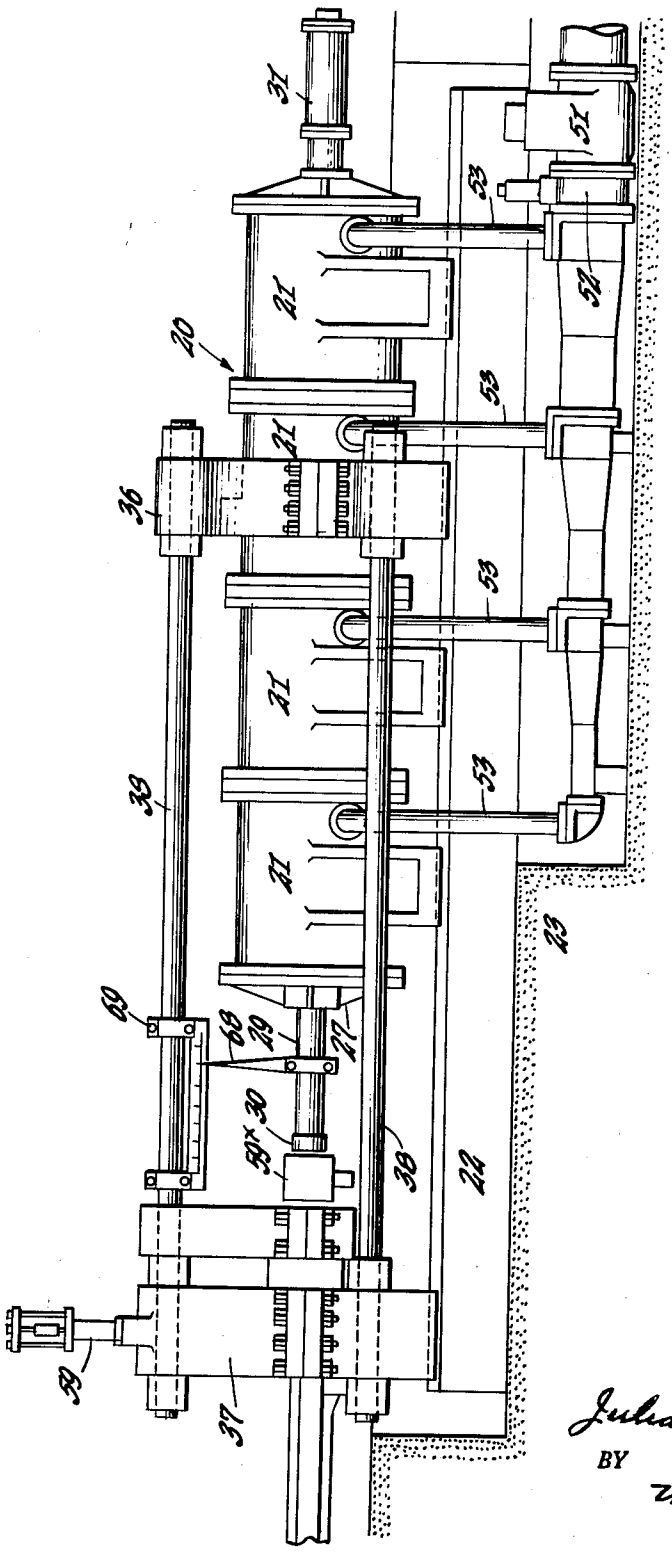


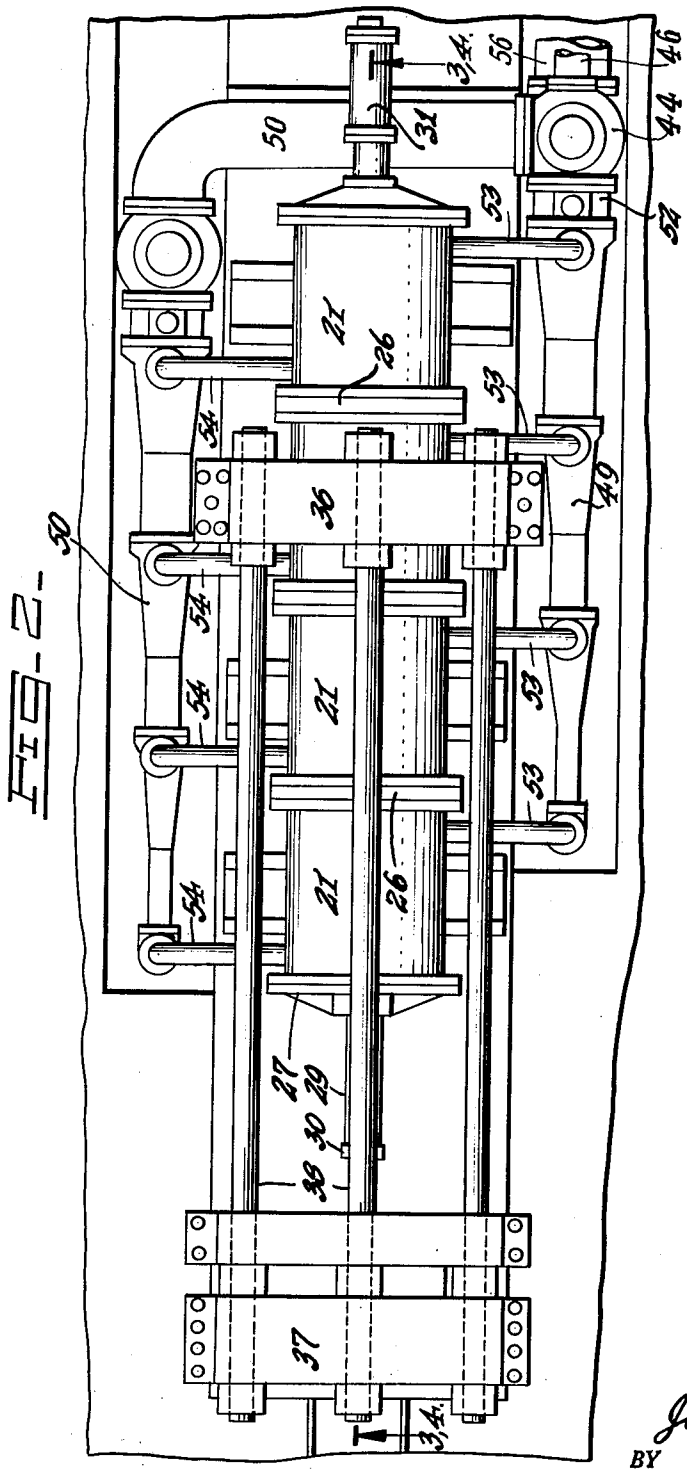
FIG. 1.

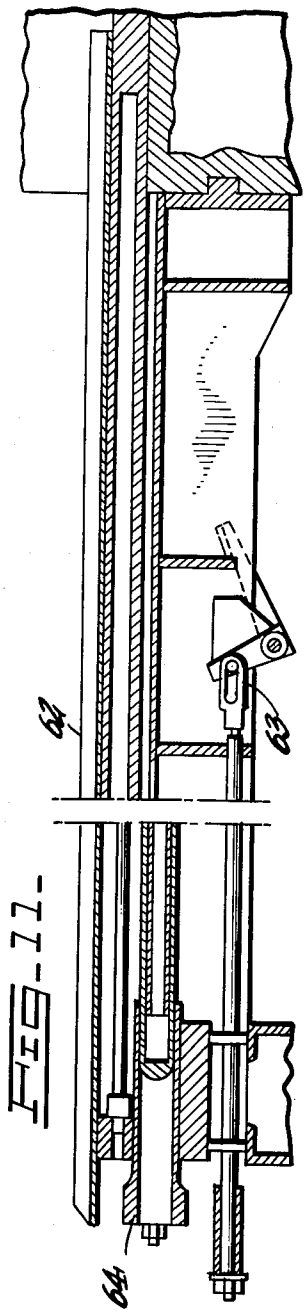
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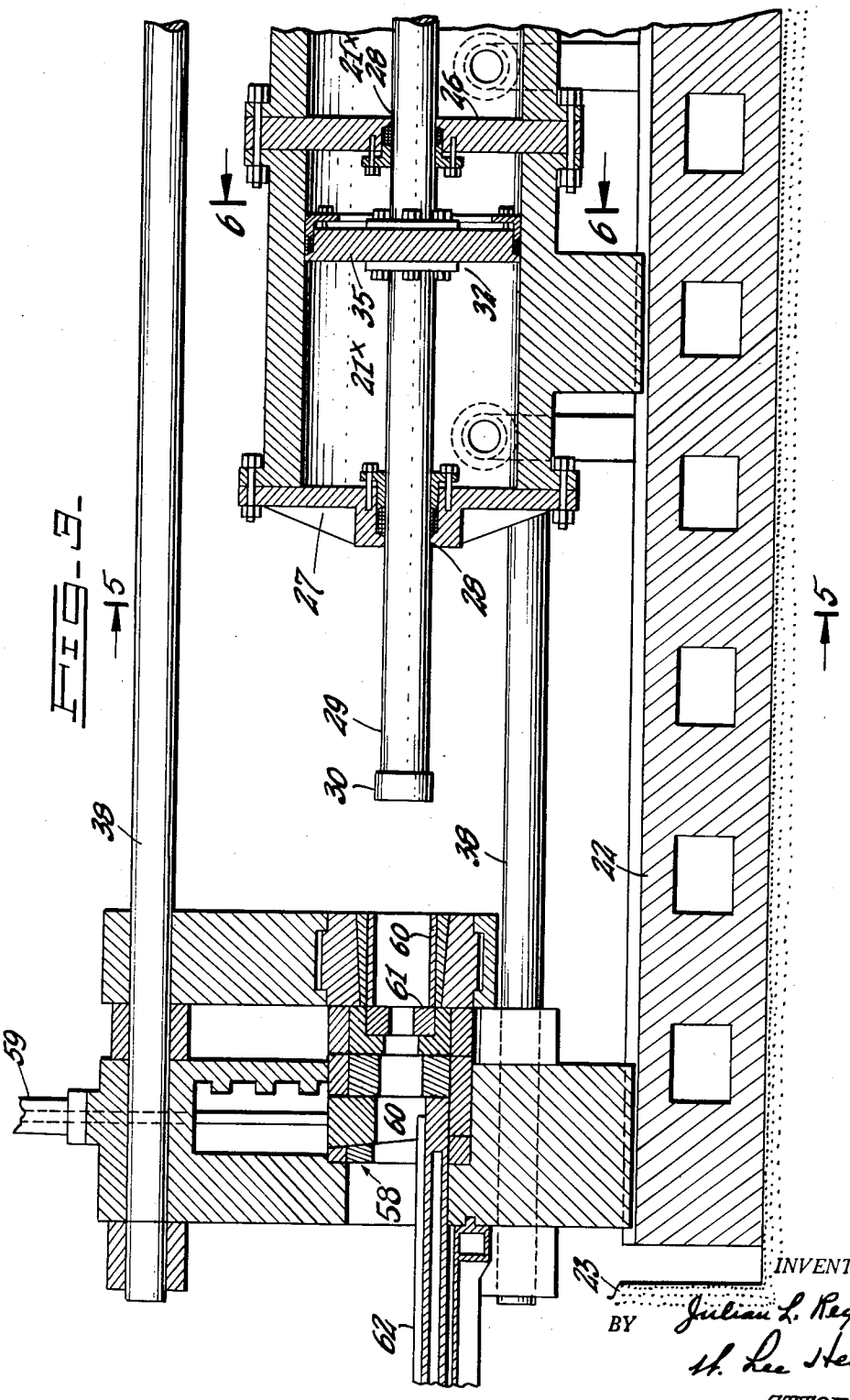


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APPARATUS FOR HYDRAULIC PRODUCTION OF METALLIC EXTRUSIONS AND FORGINGS

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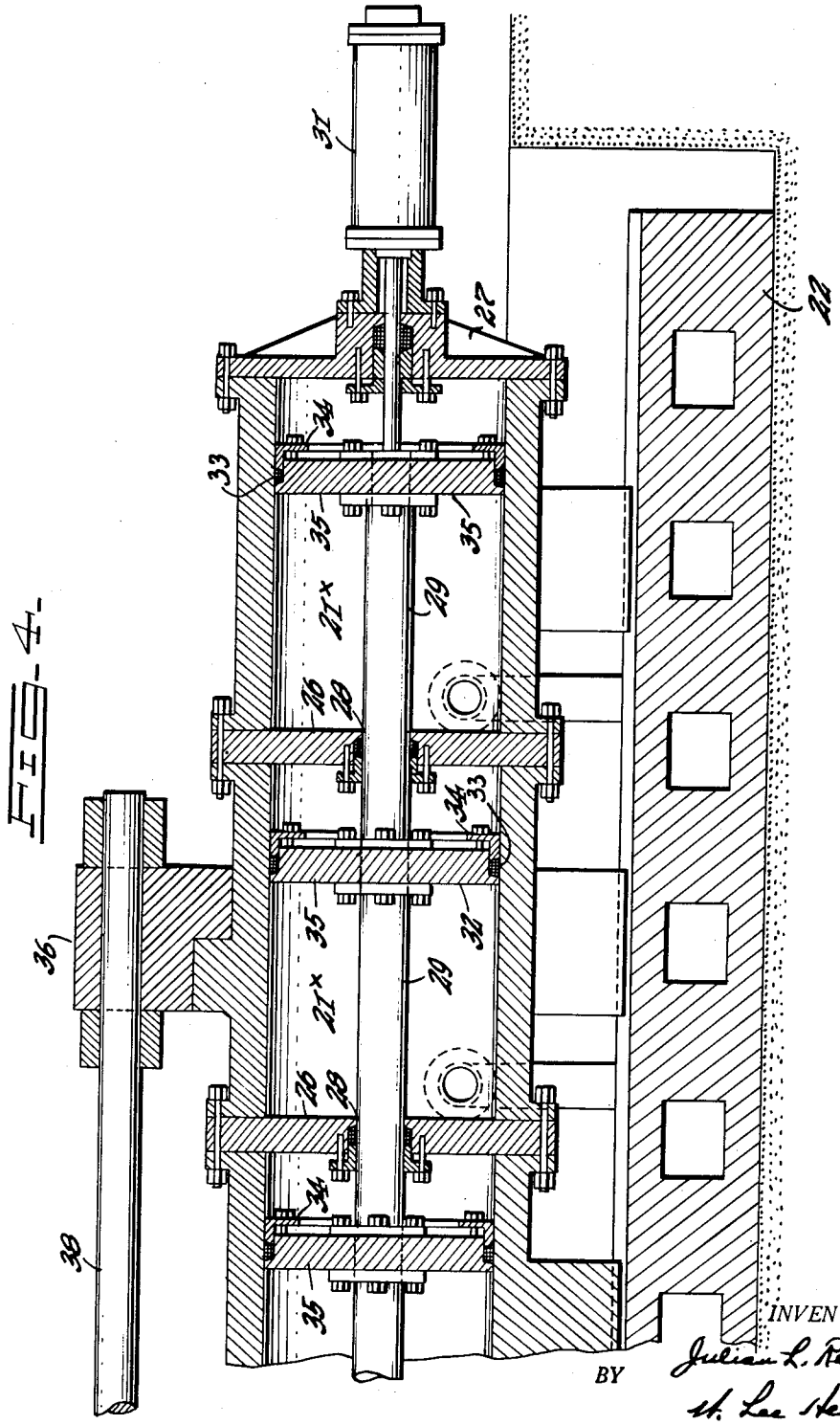


FIG. 4.

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Fig. 6.

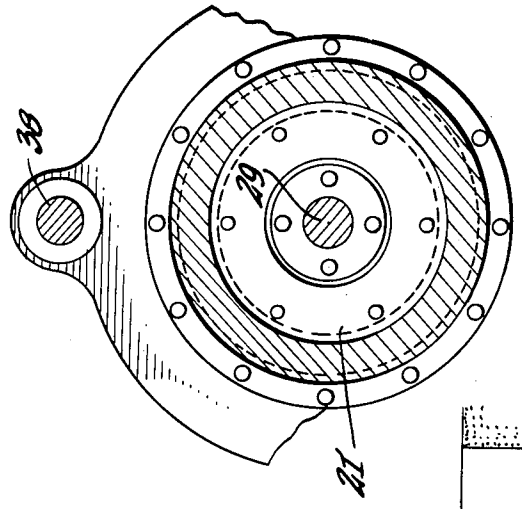
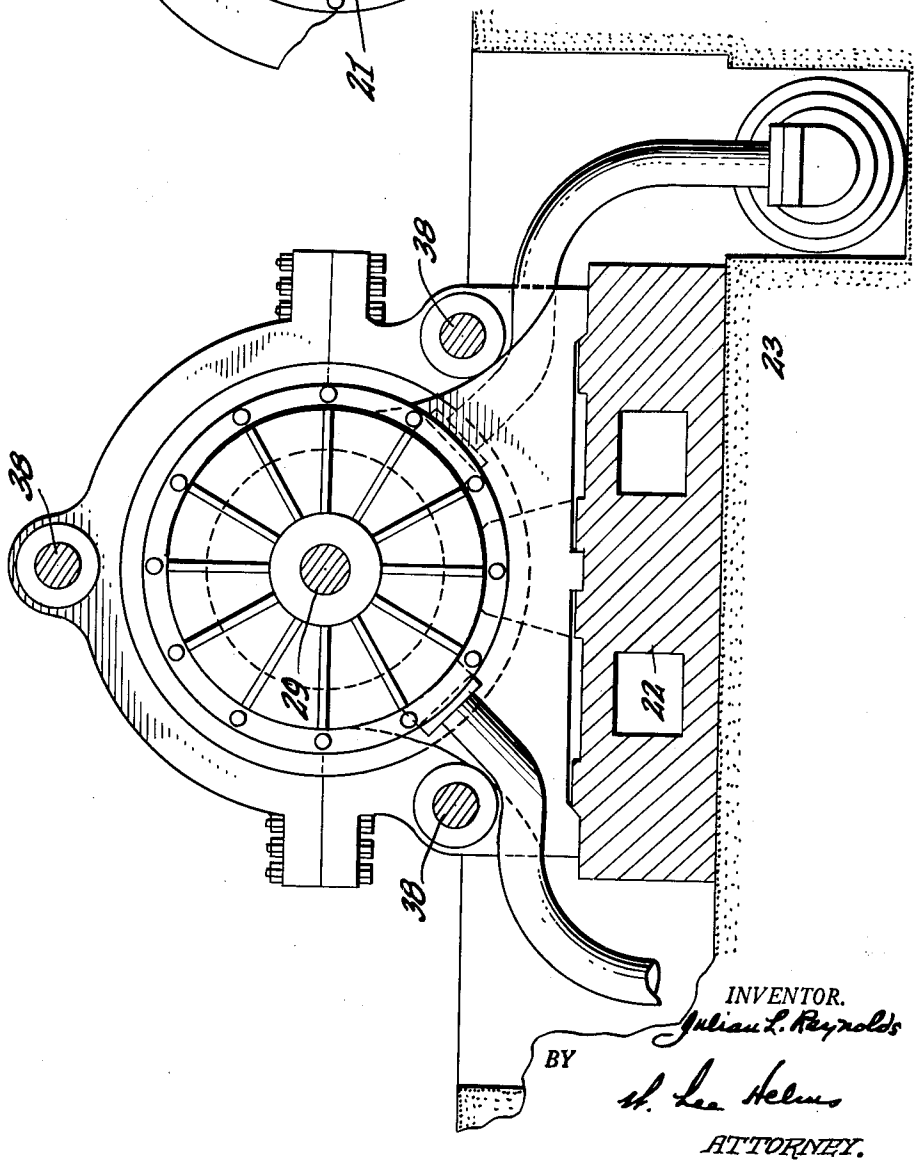


Fig. 5.

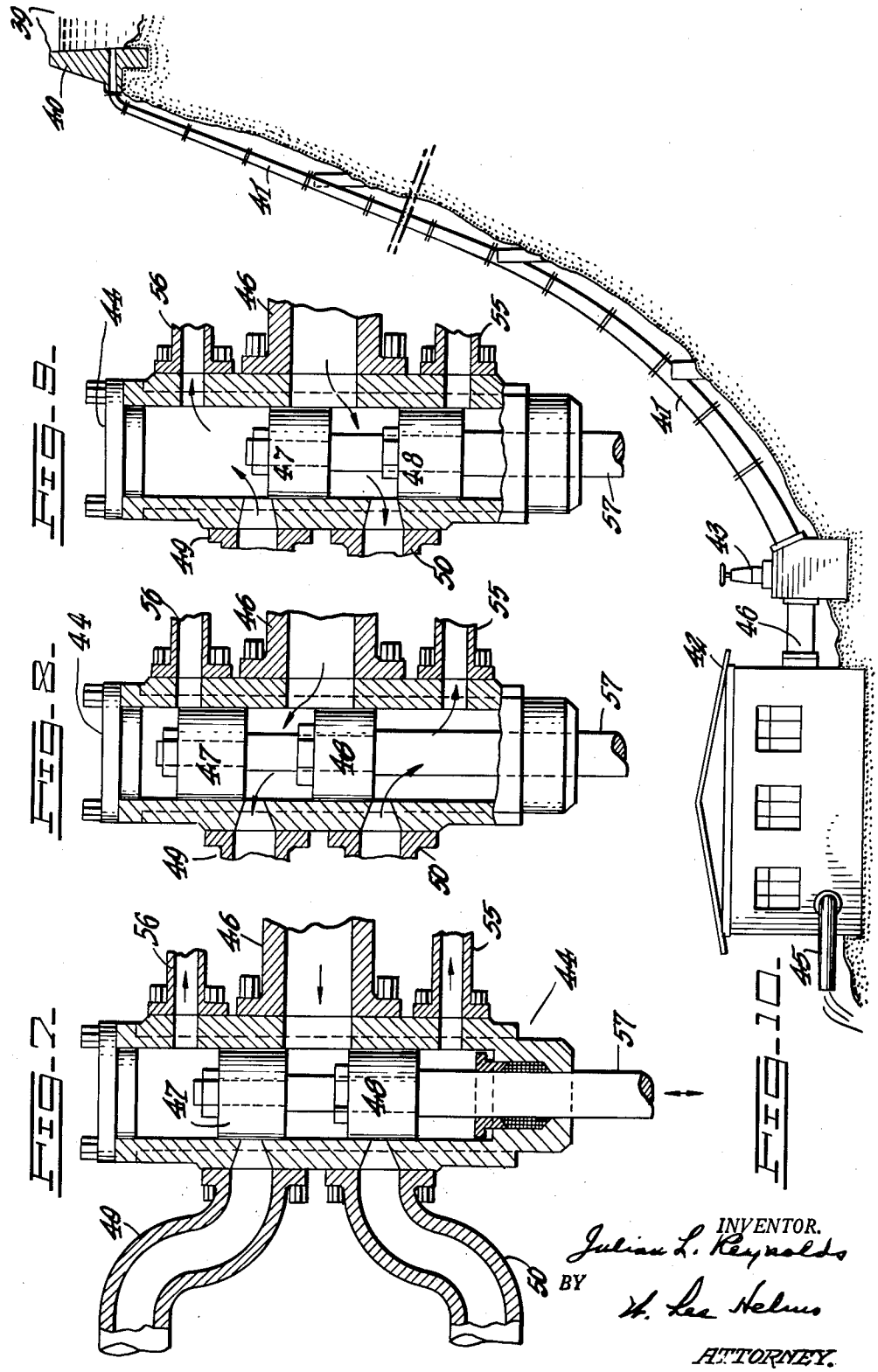


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FIG-13.

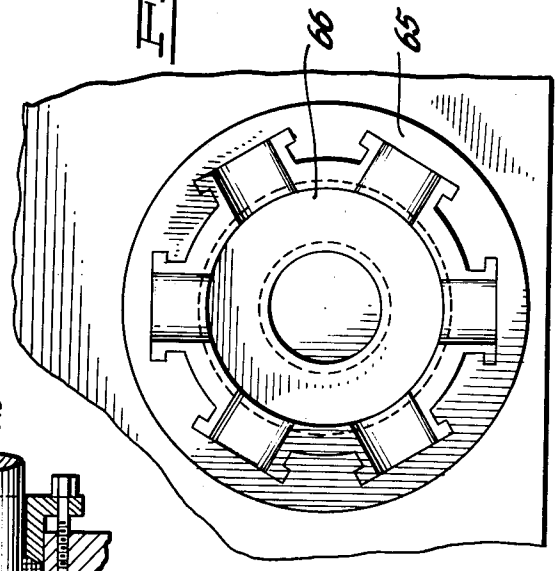


FIG-14.

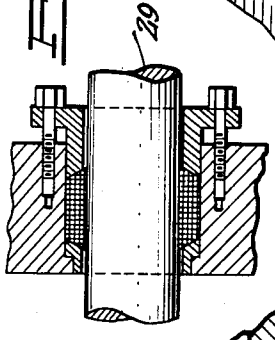


FIG-12.

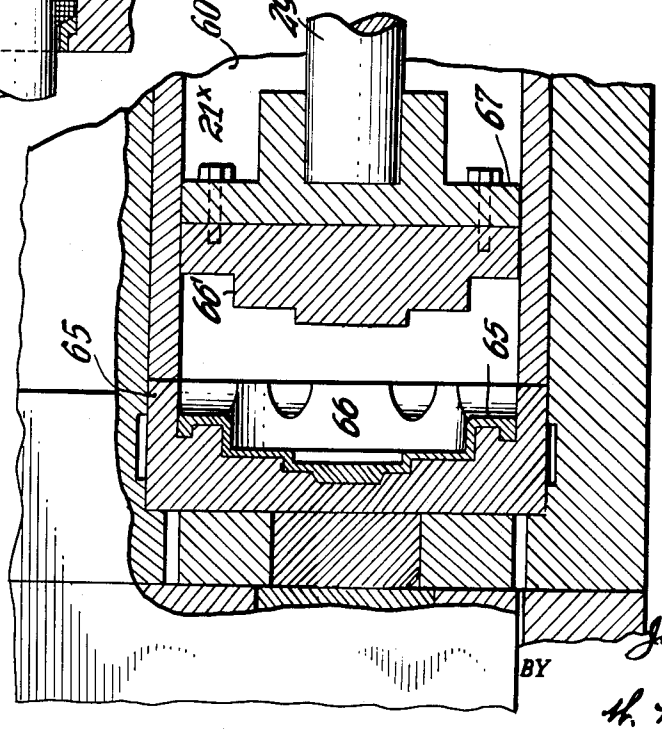
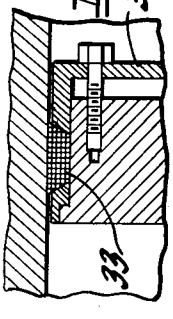


FIG-15.



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APPARATUS FOR HYDRAULIC PRODUCTION OF METALLIC EXTRUSIONS AND FORGINGS

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Application August 14, 1952, Serial No. 304,313

1 Claim. (Cl. 121—38)

This invention relates to an apparatus for using stored high pressure water.

Water power from high heads and carried through long penstocks or pipe-lines has long been employed in the use of the kinetic energy upon turbines and water wheels. Water flowing downward in a pipe system at the high velocity required by turbines is subjected to a loss of head which is due to friction. The greater the velocity of flow, the greater the frictional loss. Such loss increases approximately to the square of velocity of flow. An impulse turbine consists of a runner with a number of blades around its periphery. High velocity water, issuing from the discharge pipe or penstock, impinges by successive action upon the blades and causes the turbine to rotate. The pressure of the water causes the energy thereof to be converted into the kinetic form, and this is imparted to the turbine wheel.

The high power released through the use of turbines is dependent upon the velocity of the water flow, and therefore great loss by friction is inevitable. It is the object of the present invention to provide an apparatus which will employ the principle of kinetic force upon a plurality of force receiving elements so arranged as to transmit the force to a single force receiving carrier—which is the fundamental principal of the turbine wheel, by reason of the successive blades or buckets—and at the same time reduce the frictional losses. As a special utility of the invention, due to the very high degree of velocity reduction in the water flow, and the reduction, as compared with the turbine, of the volume of water required per interval, the diameter of the flow pipes or tubing, and hence the installation costs thereof, is greatly reduced.

The invention is particularly adapted for use in the production of metallic extrusions and forgings of that character requiring extremely high pressures.

The characteristic of the apparatus is in the provision of a high pressure water receiving cylinder with a multi-piston assembly, the water under high pressure being divided into a plurality of pressure streams, one for each of the pistons, whereby tremendous forces may be imposed upon the pressure member actuated by the pistons, and this pressure member may be a ram for extrusion or press-forging work. When three pistons are employed, for example, a four-way valve permits water to enter the cylinders on the pressure side of the pistons for the advance of the ram while exhausting water from the return side to the drain. On the return stroke, the four-way valve allows water to enter the return side while exhausting water to drain from the pressure or advance side of the pistons. In both cases, the exhaust water is discharged to waste. A small hydraulic cushioning cylinder may be attached to an extension of the press frame.

It is thus an object of this invention to change the potential energy of water located at a high elevation to kinetic energy by causing the water to flow in a conduit directly or substantially so against a plurality of pistons of a press located at a much lower elevation.

This invention will be described with reference to an embodiment thereof illustrated in the accompanying drawings, in which:

Fig. 1 is a side elevation of the plural piston hydraulic press, showing a high pressure water line and corresponding connectors to the press chambers;

Fig. 2 is a plan view of the hydraulic press showing the two high pressure water feed lines and the corresponding connectors to the press piston chambers, and showing tie or tension rods connecting the press to an extrusion head or die holder for metal press-forging blanks;

Fig. 3 is a left-hand longitudinal section, complementary with Fig. 4, taken on line 3—3 of Fig. 2;

Fig. 4, complementary with Fig. 3, is a right-hand longitudinal section, taken on line 4—4 of Fig. 2;

Fig. 5 is a vertical section on line 5—5 of Fig. 3 of the press, and showing the manner of introduction of feed water and removing of exhaust water from the press;

Fig. 6 is a fragmentary section, taken on line 6—6 of Fig. 3, and showing a front view of a piston in its cylinder;

Figs. 7, 8 and 9 are vertical sections of a double-acting valve, Figs. 8 and 9 showing the same in three positions each for simultaneous flow of incoming and exhaust water;

Fig. 10 is a schematic view, broken away, showing the manner of conducting high pressure water from a high elevation to the apparatus;

Fig. 11 is a longitudinal sectional view of an extensible or run-out table for extrusions;

Fig. 12 is a longitudinal section showing the manner of extruding a blank between a male and female die;

Fig. 13 is a view in elevation showing a female press forging die and one-half of an aeroplane crankcase pressed from a billet;

Fig. 14 is a vertical section through a dividing wall between two piston chambers; and

Fig. 15 is a vertical section view showing the manner of packing stuffing between a piston and the cylinder.

In the operation of my hydraulic apparatus, water located in a storage reservoir 39 (Fig. 10) located at a high or mountainous elevation is retained by a dam 40 and is conducted through conduit 41 to a hydraulic press house 42 located at a much lower elevation or near sea level. The diameter of conduit 41 may be uniform from the storage reservoir 39 to the hydraulic house 42, but because of the extreme hydraulic pressure increasing as the conduit 41 approaches the press house the conduit must be made of increasing heavier walls, thereby giving the conduit pipe an outside diameter of increasing dimensions.

For a capacity of 5,000 tons pressure with a water head of 2,000 feet, the diameter of each piston may be 72 inches, and a suitable maximum stroke may be five feet.

In Figs. 1 to 4 I have shown a high pressure cylinder assembly 20 comprising a plurality of individual cylinder sections 21 (four in the embodiment illustrated) mounted on a bed plate 22 resting on a concrete footing 23.

Each individual cylinder section 21 is supplied with two conduits 53 and 54 each conduit acting alternately as an inlet for incoming high pressure water and as an outlet for conducting exhaust or spent water out of the individual chamber.

Extended interiorly of the plural cylinder assembly are three dividing walls 26 which divide the cylinder area into four individual piston chambers 21x. The dividing walls 26, as well as end walls 27, are provided with apertures for passage of a piston rod or power ram 29 having a working head 30 and a conventional oil operated cushioning cylinder or choker valve 31, the latter to control the speed of the piston on return strokes.

Within each cylinder section 21 is located a piston

plate assembly **35** which is bolted to the piston rod **29** and which has circumferential packing **33** (Fig. 16) adapted to be packed inwardly by the force of the high pressure water exerted on circular packing pressure plate **34** at the working face on the piston, on the power stroke, which plates are bolted by conventional means to the pistons.

The pistons are bolted to the hydraulic piston rod by conventional means and are packed as shown in Fig. 14. The travel of the piston rod or ram within the piston chamber is such as to travel from one port opening located near the bottom of one end of the piston chamber to the other port opening offset and located at the other end of the piston chamber near the bottom thereof. The piston itself does not cut-off the ports. The control of flow of the water into one side or the other side of a piston chamber is performed by a double acting valve actuated in synchronism with the pistons, as will be described more fully hereinafter.

A pair of yokes **36** and **37** are keyed to bed-plate **22** and held together in spaced relationship by a plurality of tie or tension rods **38** (three in the embodiment shown) bolted to said yokes. Yoke **36** is bolted to the cylinder assembly (Figs. 1 and 4) whereas yoke **37** is in convenient spaced relationship to the working ram head and constitutes a press head allowing the insertion of dies and suitable billets or blanks to be inserted between said ram and said press head **37**.

Prior to entering the hydraulic press house **42** the flow of high pressure water may be controlled by a master valve **43**. The press is in turn operated by means of double acting valve **44** which receives the high pressure water from duct **46**. The exhaust water from the press is allowed to escape through tail pipe **45**.

The operation of the double acting valve **44** (Figs. 7, 8 and 9) is in synchronism with the movement of the pistons **32** in cylinder assembly **20**. As shown in Fig. 8, the high pressure water passes between valve pistons **47** and **48**, and thence flows directly to main high pressure conduit **49**. Inlet pipes **53** lead the high pressure water from conduit **49** having a graduated diameter to the forwardly movable working or pressure faces of pistons **32** and produce an even flow of high pressure water to these operating faces of pistons **32** on the forward or power stroke. The valve position shown in Fig. 8 allows exhaust water in the cylinders back of the piston working faces to flow through the conduits **54** (Fig. 2) into main exhaust conduit **50** and the exhaust water in turn is led to exhaust pipe **55**, which latter is connected to tail pipe **45**.

Fig. 9 shows the position of valve **44** when high pressure water is used to return the pistons **32** to their original or starting position. As shown in Fig. 9, high pressure water from conduit **46** is conducted into conduit **50** where it is conducted simultaneously through conduits **54** to the back faces of pistons **32**, thereby driving the pistons **32** back to their original or starting position, i. e., placing them in a position to receive the high pressure water for the next power stroke. During the return or back stroke of pistons **32**, the spent water of the former power stroke is exhausted through conduits **53** (Fig. 2) to conduit **49** and through the valve **44** (see arrows, Fig. 9) to exhaust pipe **56**, which latter is connected to tail pipe **45**. Thus Fig. 8 shows by its indicative arrows the valve-controlled flow of water on the power stroke. Fig. 9 shows the flow of high pressure water made to force the pistons **32** to return to their original position.

The operation of valve rod **57** for valve **44** is actuated in synchronism with the movement of pistons **32** by mechanism well known to the hydraulic art, which mechanism may include electrical motors.

Yoke **37**, which acts also as a press head and which is connected to yoke **36** by tie or tension bars **38**, is constructed in a manner to permit a locking-in of dies by means of a wedge block assembly **58** operated by a gate lock **59** of usual design.

As shown in Figs. 1 and 3, the extrusion ram is set up, as an example, to produce bars of metal from billets **59***x*. These billets, which preferably are heated according to usual practice, are charged into extrusion cylinders **60** and extruded through die **61** onto the extension or run-out table **62**.

Run-out table **62** may be lengthened or shortened by a linkage assembly **63** co-acting with a telescopic table assembly **64**.

In place of extrusion of shapes or tube material from billets, various large articles may be press-forged each from a single billet by a single power stroke. Fig. 12 shows a die such as adapted for radial aeroplane engine crankcases **66**. The female die **65** is set into an appropriate assembly located in press head **37**, and the male die **67** is actuated by ram **29**. This extruded or press-forged piece forms but one-half of the crankcase, the other half is similarly extruded or press-forged.

Fig. 1 shows a stroke pointer **68** and scale **69** assembly which indicates the travel of the ram. Figs. 1 and 2 also show the diminishing diameter of the conduits **49** and **50** allowing for the passage of water into the chambers at an equal pressure. Water not being compressible, the four chambers are fed through conduits **53** or **54** having equal cross-sectional areas, thereby necessitating a corresponding diminution of area as the last chamber is approached. Thus at the first or right side chamber **21** conduits **49** and **50** have a cross-sectional area equal to four times that of conduit **53**, but at the last or left side conduits **53** or **54** the area or diameter of conduits **49** and **50** have been reduced to equal that of conduit **53** or **54**.

This invention has been described by means of an illustrative example, but it is not to be restricted thereto.

Having described my invention, what I claim and desire to secure by Letters Patent is as follows:

A hydraulic actuating apparatus utilizing a natural head of high pressure water, comprising conduit means for said water, a plurality of piston cylinders in tandem to which said water is conducted, a closely fitted hydraulically operated piston in each cylinder, division walls for said cylinders constituting end-brace connectors therefor, each cylinder having an inlet port for introducing high pressure water to the working face of its piston and further having an outlet port for removing the exhaust water from the rear of the piston, a ram carrying all of said pistons, a double acting valve for simultaneously introducing power water to the working face of each piston and removing the spent ram return water located behind the piston face and returning the piston to the beginning of its power stroke, and conduit means graduated in diameter for introducing the high pressure water at uniform pressure simultaneously to all piston cylinders.

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