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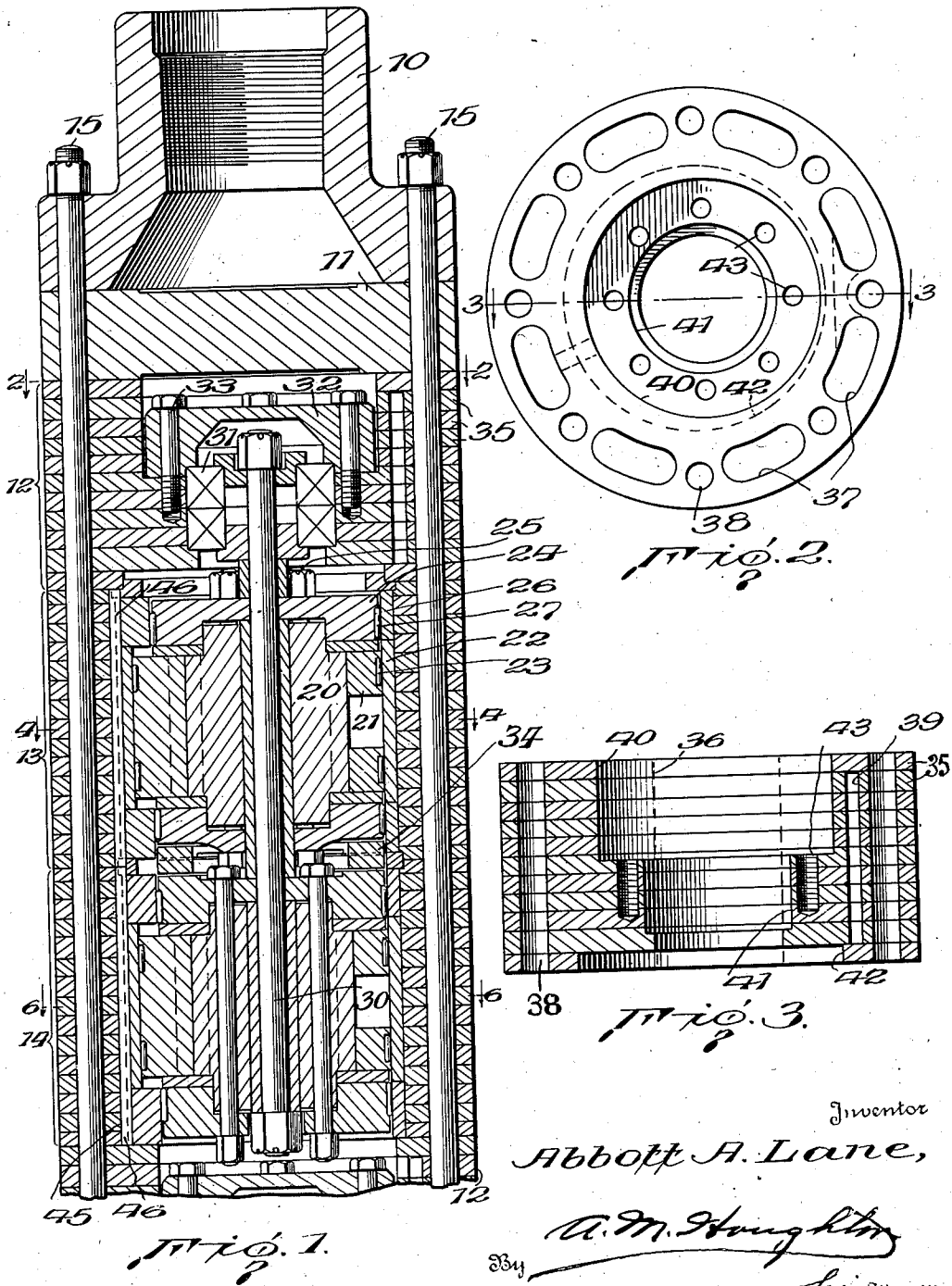
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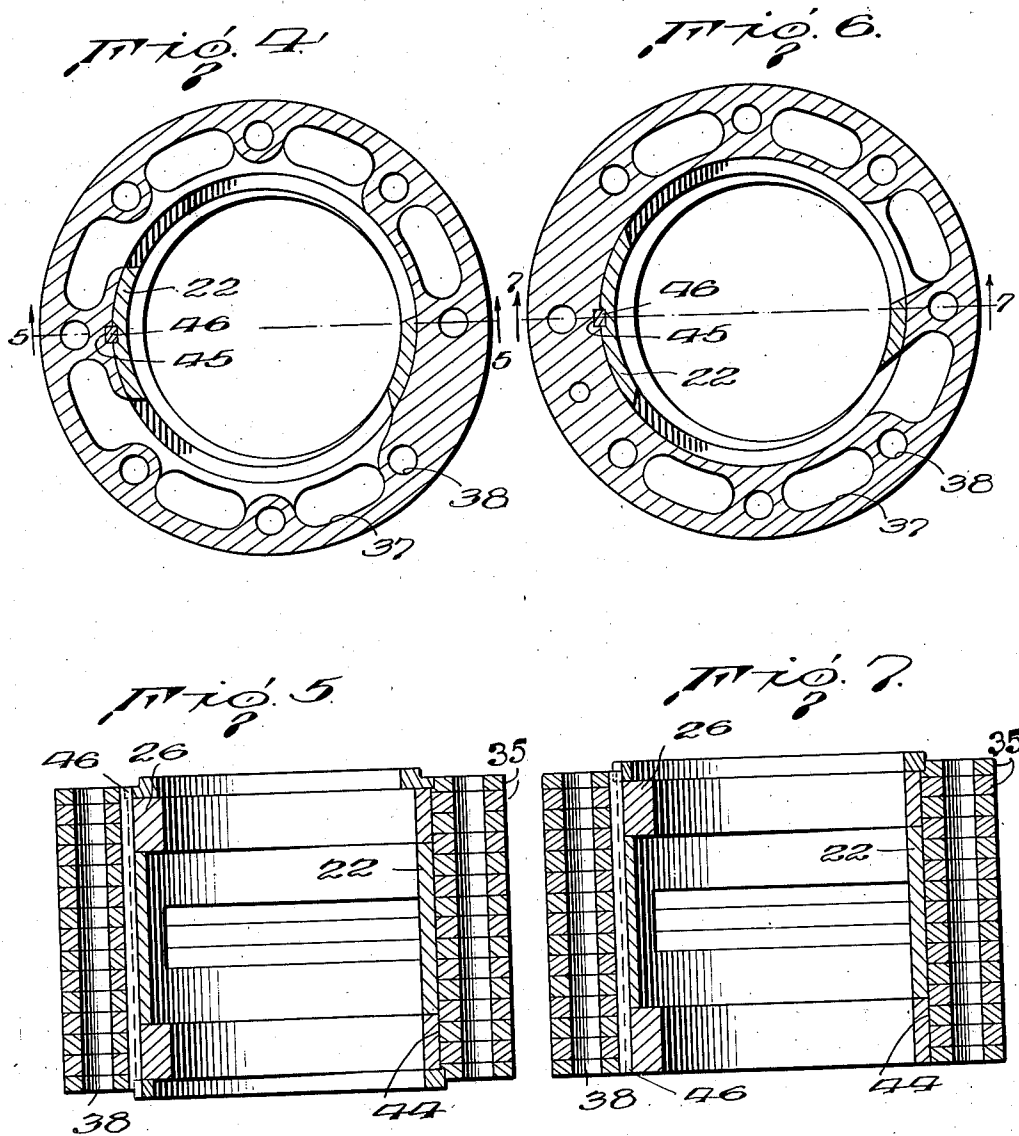
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This invention relates to pumps; and it comprises a pump or other device having pumping elements for operating with fluid pressures and having an improved casing, the casing being made up of stacked relatively thin laminations, each lamination being appropriately shaped and ported so that the laminated casing is provided with fluid ports and passages communicating with the pumping elements and having spaces to receive and support the pumping elements; all as more fully hereinafter set forth and as claimed.

Pumps of the rotary type employ rotating pumping elements such as meshing gears mounted in an enclosing casing. The casing is fluid-tight and is provided with means for supporting the pumping elements. Ports and passages are provided for leading fluid in and out. In some cases a pumping element and a motor element, or a plurality of pump or motor elements, are mounted in a casing. In such cases the casing is a complicated structure of irregular shape. In order to insure fluid-tightness it has been considered necessary to make the casing in one piece or in large units; usually as a unitary metal casting. Casting of these irregular shapes is difficult. This is especially true when the casing contains inner passages for fluids. Even if a perfect casting is made, it is impossible in many cases to finish inner passages and cavities, which must be left rough. Friction of rapid flows against the rough surfaces causes losses. The difficulties and costliness of making complicated castings have militated against the use of certain pumping combinations, otherwise useful and desirable.

There has been developed a pumping apparatus comprising a plurality of pumps and hydraulic motors for operating the pumps, these elements being mounted in an enclosing casing provided with ports and passages for delivering motive power fluid to the motors and exhausting fluid therefrom, and for drawing in and exhausting a fluid being pumped. The fluid connections are such that motive power fluid is forced through the motors in parallel fluid flow, and fluid being pumped is drawn through the pumps in series. The pumping elements in the pumps and the motors often take the form of meshing ring gears and pinions, mounted eccentrically in the casing for rotation. The pumping combination is made up of a plurality of units, each comprising a pump unit, a motor unit and a cross-over for making fluid connections with other units in the combination.

The present invention, while applicable to all

kinds of rotary pressure operable devices, finds particular utility in pumping apparatus of the type described. According to my invention the casing is made up of a plurality of relatively thin, ported laminations joined together into a unitary stack or into unitary sub-units. The orifices and ports in the laminations are so disposed that in the completed stack ports and passages are provided for all the fluids and means are provided for retaining the pumping elements. The laminations are so designed that they can be produced by simple stamping, die-cutting, casting or machining operations. In making up a laminated casing the laminations are first die-cut or otherwise formed; ports and other orifices being simultaneously formed in this operation. Then the laminations are stacked together in units and joined together as by soldering. Finally those interior surfaces which require tooling or finishing are machined. The pumping elements and bearings are next assembled into the units which are in turn assembled into the complete combination. This construction is found to present many advantages over unitary castings; it is cheaper in all phases of the manufacturing process.

In the accompanying drawings I have shown more or less diagrammatically my invention applied to a particular form of pumping apparatus. In the showings,

Fig. 1 is a view, partly in elevation, partly in vertical section, of the invention embodied in a particular form of pumping apparatus;

Fig. 2 is a plan view of a portion of the casing alone, taken along line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken along line 3—3 of Fig. 2;

Fig. 4 is a sectional view of another portion of the casing, taken along line 4—4 of Fig. 1;

Fig. 5 is a sectional view taken along line 5—5 of Fig. 4;

Fig. 6 is a sectional view showing another portion of the casing, taken along line 6—6 of Fig. 1; and

Fig. 7 is a sectional view taken along line 7—7 of Fig. 6.

In the showings, in which like reference characters indicate like parts throughout, Fig. 1 shows the upper end of a pumping apparatus of the type referred to. As shown, the apparatus comprises an upper threaded adapter 10, a header 11, a cross-over 12, a motor unit 13, and a pump unit 14; all of cylindrical form and all tied together by a plurality of tie-bolts 15. In practice, the apparatus usually comprises a plurality of cross-overs, pumps, and motors, one above the other.

The top portion of a second cross-over 12 is indicated at the bottom of Fig. 1. The motor housing 13 contains the motor elements, comprising a pinion 20 engaging a ring gear 21. A sleeve 22 is fitted in housing 13 and the ring gear rotates in this sleeve on needle bearings 23. The bearings for the pinion comprise discoid end plates 24, bolted to the pinion by bolts 25 and rotating in a second sleeve 26 on needle bearings 27. The arrangement in the pump housing is similar; the pumping gears are duplicates of the motor gears. The pump and the motor pinions are coupled together by a rod 30, the upper end of which is rotatably mounted in the cross-over in bearings indicated at 31. The pinion of the pump drives the pinion of the motor through discoid end plates 24 and an Oldham coupling indicated at 34, engaging the adjacent end plates, as shown. The rod 30 couples the pinions and prevents end sway thereof. A cap piece 32 bolted into the cross-over by bolts 33 encloses the bearings.

According to the present invention, the cross-over, motor and pump housings are each made up of a plurality of discoid laminations 35. Figs. 2 and 3 are views of the laminated cross-over housing portion alone. In making up the cross-over the required number of laminations is cut out or otherwise formed; most of the laminations being alike. The thickness of the laminations may be the same for each lamination, or different. The thickness of each lamination is such that there are a plurality of laminations for each gear and pinion element, as shown, the axial length of the pumping gears being considerably greater than the thickness of any one lamination. Each lamination as originally formed is a disc with an eccentric circular bore 36 indicated in dotted lines in Fig. 3 and marginal port openings 37 and bolt holes 38 (Fig. 2). All but the two outer laminations are also provided with bores 39. The laminations, which are usually formed from soft steel, are stacked together and united as by tin or silver solder between the laminations, or by brazing or welding the outside. Any convenient metallic binding can be used; in some cases the binding can be omitted. Ordinarily solder suffices for a firm union. The stack is then bored out with an eccentric bore 40, a smaller eccentric bore 41 and a centered bore 42. Threaded holes 43 are then formed around bore 41, as shown.

Fig. 5 is a view of the finished laminated motor housing with sleeves in place but omitting the gears. The housing is formed of a plurality of laminations, originally stamped or die-cut with ports 37 and bolt holes 38 and a central bore 44. The central bore is machined out after assembly of the stack to receive the sleeves snugly. A keyway 45 is then machined in the stack to receive a key 46 for fixing the sleeves with respect to the housing. Fig. 4 is a sectional view through the finished stack. Figs. 6 and 7 show the pump housing, which is made up in a similar manner.

The bolt holes and fluid port openings can be formed in the laminations with sufficient accuracy, directly by die-cutting or the like; but it is usually advisable to machine out the bores for receiving the sleeves and the bearings. The cross-over, pump and motor housings are assembled into a unit with the gears and bearings in place. In some cases it is desirable to join the three housings by soldering or brazing. Ordinarily it is convenient to join the motor and the pump units together, after assembly of the gears, leaving the cross-over as a separate unit.

Pumping apparatus made with a laminated casing according to the invention is found to be as strong and as fluid-tight as ordinary integral casing construction; while being less costly in every stage of the manufacturing process. Moreover, construction according to the present invention readily allows of the casing being made of various materials other than iron or steel. For example the laminations may be formed from brass or aluminum in case it is desired to produce a pumping apparatus for resisting certain sorts of corrosion. The individual laminations may be produced by any suitable forming process, including forging. They can be heat treated individually. Heat treatment can be much more simply and efficiently carried out on the relatively thin laminations than in large unitary casings, which are of complicated shape and which vary in thickness in different parts of the casings. The individual laminations, after the bores and ports are formed to approximate size by stamping, punching or the like, can be heat-treated to give great hardness and strength. Then, after assembly, the bores can be finished by grinding.

What I claim is:—

1. In a fluid pressure apparatus having a ring gear and pinion combination and bearing means for the ring gear and pinion, an improved casing having a cavity for the ring gear and pinion and a cavity for the bearing, and comprising a stack of assembled metal laminations of a form adapted for production by punching or stamping operations, the laminations extending along the length of the ring gear and pinion and bonded together with metallic binding as a rigid, unitary, fluid-tight stack to prevent displacement of the laminations and distortion of the cavity, the individual laminations comprising the stack each having a thickness less than the axial extension of the ring gear and pinion, and being appropriately shaped and provided with openings serving as fluid passages extending therethrough in a direction parallel to the axis of the stack.

2. In a fluid pressure apparatus having a ring gear and pinion combination and bearing means for the ring gear and pinion, an improved casing having a cavity for the ring gear and pinion and a cavity for the bearing, and comprising a stack of assembled metal laminations of a form adapted for production by punching or stamping operations, the laminations extending along the length of the ring gear and pinion, compression means extending through the stack and metallic binding between the laminations arranged to bond the laminations together as a rigid, unitary, fluid-tight stack to prevent displacement of the laminations and distortion of the cavity, the individual laminations comprising the stack each having a thickness less than the axial extension of the ring gear and pinion, and being appropriately shaped and provided with openings serving as fluid passages extending therethrough in a direction parallel to the axis of the stack.

3. Hydraulic-motor-driven pumping apparatus comprising a ring gear and pinion pumping combination and a ring gear and pinion motor combination, the motor combination driving the pumping combination, and having an improved casing, the casing being formed of stacked laminations fastened together in unitary assemblage, the thickness of each lamination being less than the axial extension of each of said combinations and a plurality of such laminations being provided along the length of each combination, each

lamination being of a form adapted for production by punching or stamping and being appropriately shaped and ported so that the laminated casing is provided with cavities for receiving said gear combinations, and outer fluid ports and passages, separate from said cavity and communicating therewith.

4. In apparatus of the type described and having a ring gear and pinion combination for operating with fluid pressures, and bearing means for said ring gear and said pinion, an improved casing for the ring gear and pinion formed of a stack of individually heat treated laminations, each of a shape adapted to be made by punching or stamping and being provided with holes extending therethrough in a direction parallel to the axis of the stack, certain of said holes serving as fluid passages, the thickness of each of the laminations being less than the axial extensions of the ring gear and pinion and a plurality of such laminations being provided along the length of the ring gear and pinion, the laminated casing having outer fluid ports and passages and an inner cavity for the ring gear and pinion separated from the ports and passages, and metallic binding between the laminations and arranged to fasten them together in rigid, unitary, fluid-tight assemblage.

5. In apparatus of the type described and having hydraulic pumps and motors, the motors driving the pumps, and means for making fluid connections to the pumps and motors, an improved casing for the pumps and motors formed of a plurality of thin stacked laminations fastened together in rigid, unitary assemblage, the thickness of the laminations being less than the axial extension of the pumps and motors and a plurality of such laminations being provided along the length of each pump and motor, each lamination being of a shape producible by stamping or punching and appropriately shaped and ported so that the complete laminated casing is provided with cavities to receive the pumps and motors and is provided with outer fluid ports and passages communicating with the pumps and motors.

6. Apparatus operating with fluid pressures

having a ring gear and pinion hydraulic motor combination and a similar pumping combination and bearing means for said combinations and having an improved casing, the casing comprising stacked laminations, metallic binding bonding the laminations and fastening them together in rigid, unitary assemblage, each lamination being less in thickness than the axial extension of either combination and the stack of laminations extending along the length of both combinations, the laminations being of a form adapted for production by punching or stamping operations and being appropriately shaped and provided with holes extending therethrough in a direction parallel to the axis of the stack so that the laminated casing is provided with a cavity for the pumping element and the said bearing means and with separate outer fluid ports and passages communicating with said cavity and with the gear combinations, the metallic binding preventing distortion of the cavity or displacement of the laminations.

7. Apparatus operating with fluid pressure having at least one rotary pumping element for operating with fluid pressure, a shaft for driving the element and bearing means therefor and having an improved casing for the pumping element, the casing comprising stacked flat laminations fastened together in unitary assemblage, each less in thickness than the axial extension of the pumping element and the stack of laminations extending along the length of the pumping element, the laminations being provided with holes extending therethrough in a direction parallel to the axis of the stack, some of said holes serving as fluid passages, said laminations being of a form adapted for production by punching or stamping operations and being appropriately shaped, and metallic binding adjacent each lamination and arranged to bind the laminations together in rigid, unitary, fluid-tight assemblage, so that the laminated casing is provided with a cavity for the pumping element and the said bearing means and with separate, outer fluid ports and passages communicating with said cavity and with the pumping element.

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