Sept. 2, 1958 R. W. STOERTZ 2,849,791

OPERATING JIG FOR CALORIMETER BOMB

Filed Dec. 5, 1952 3 Sheets-Sheet 1

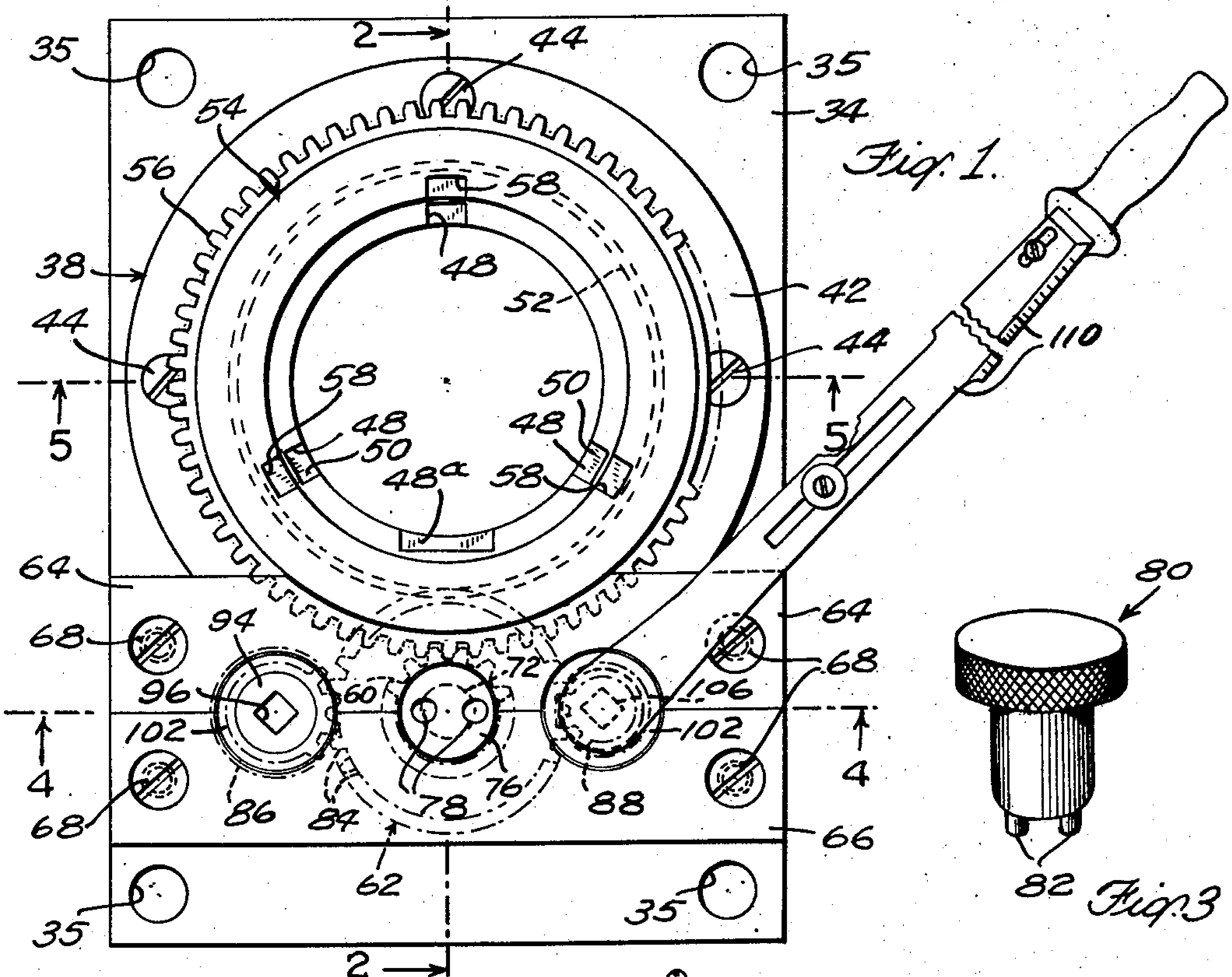

Fig. 1.

Fig. 3

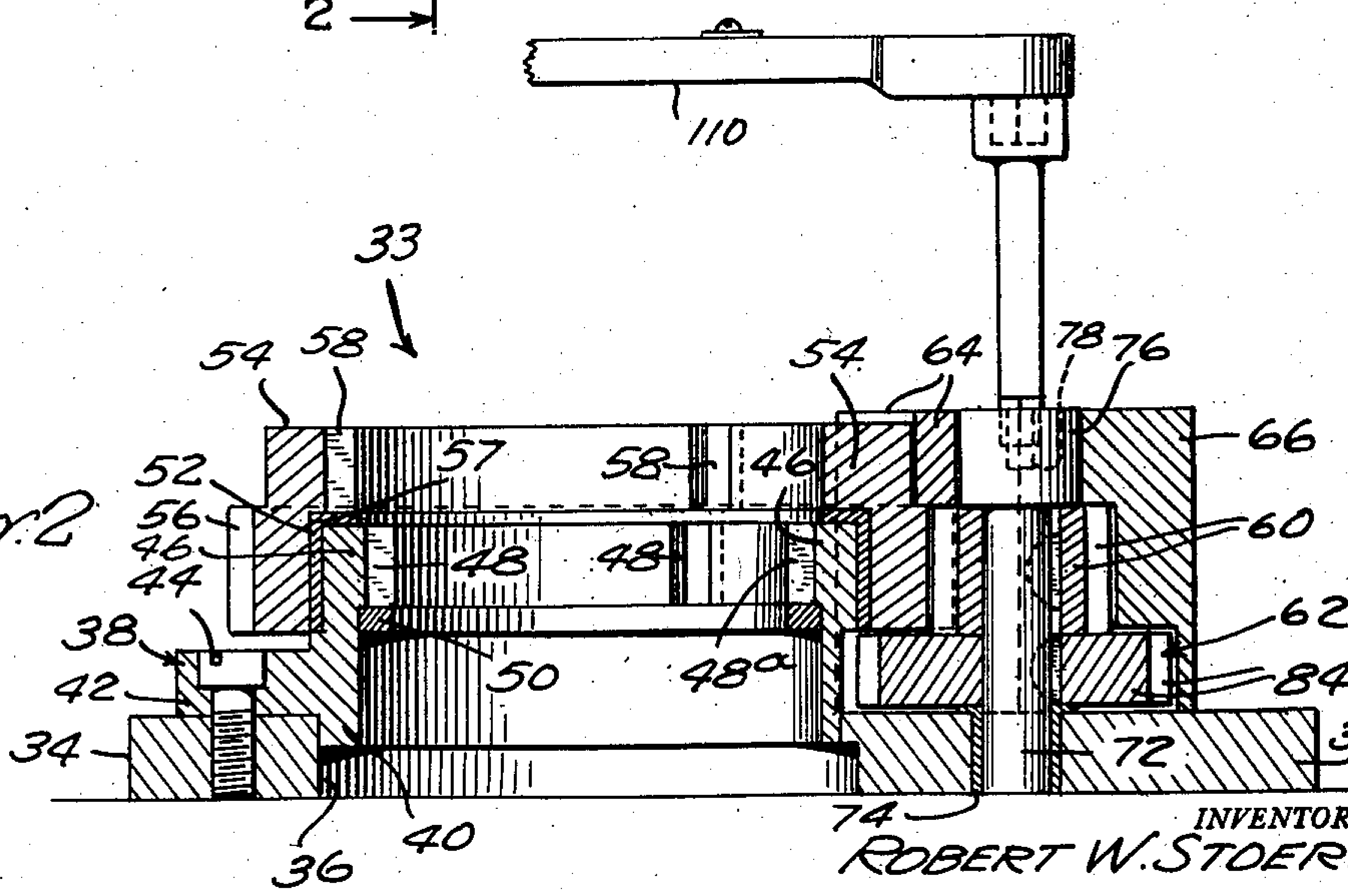

Fig. 2

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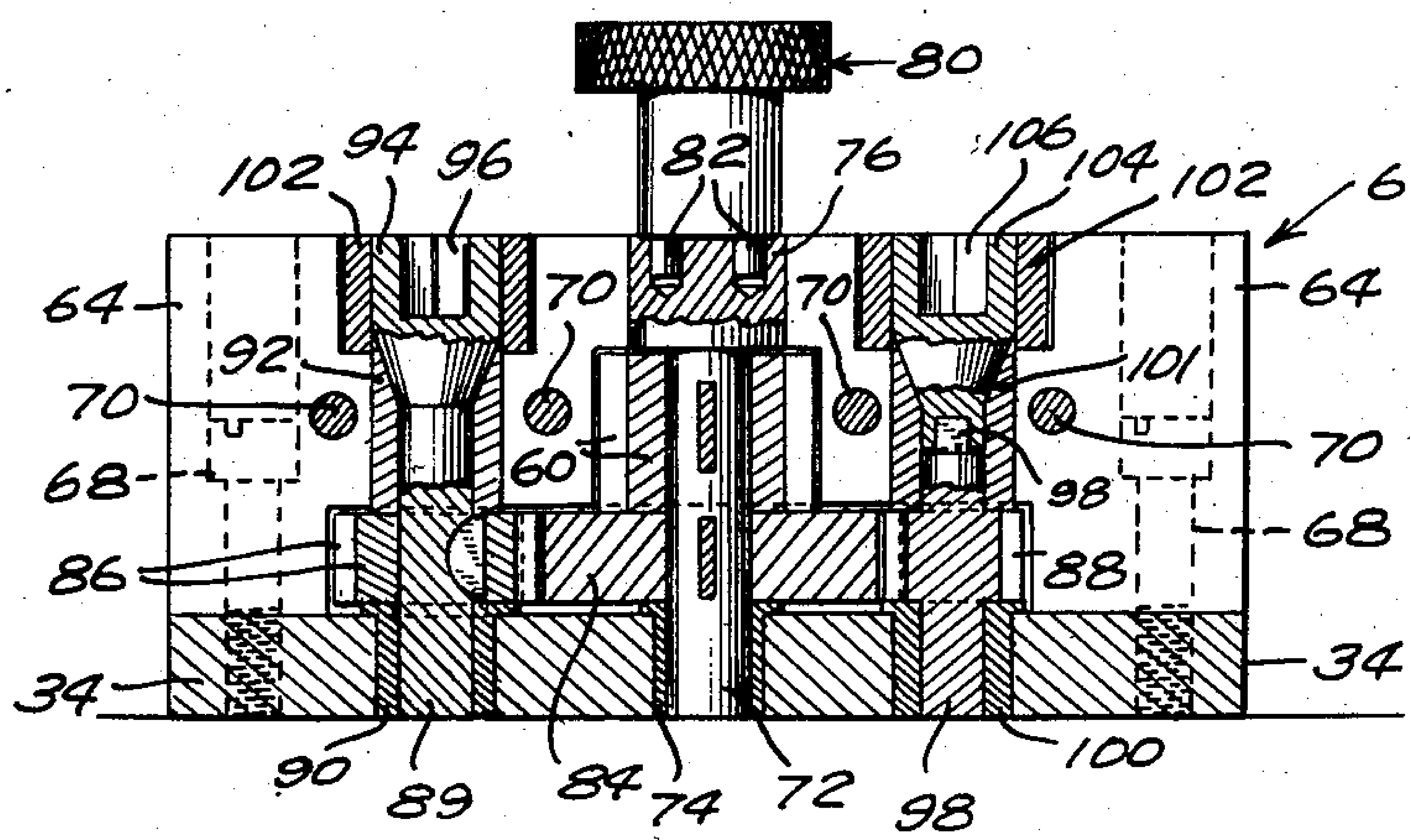

Fig. 4

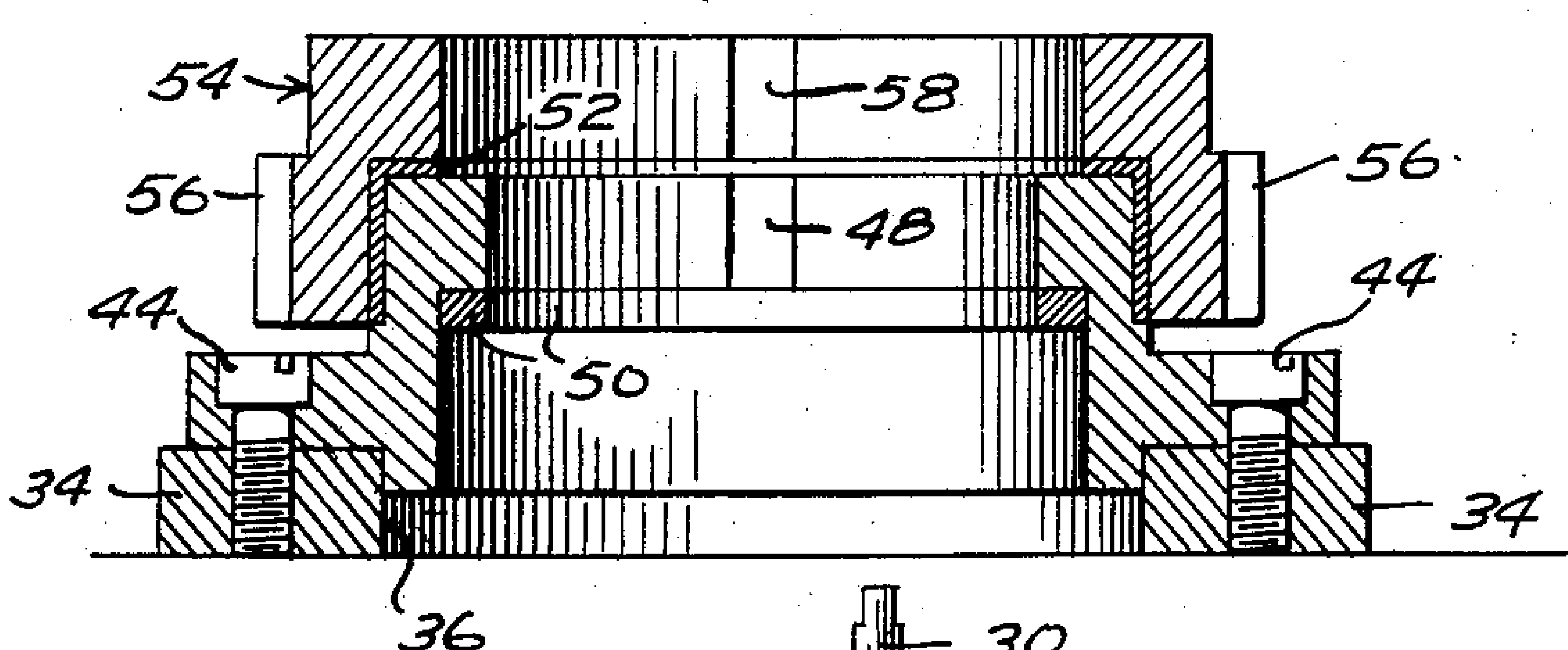

Fig. 5

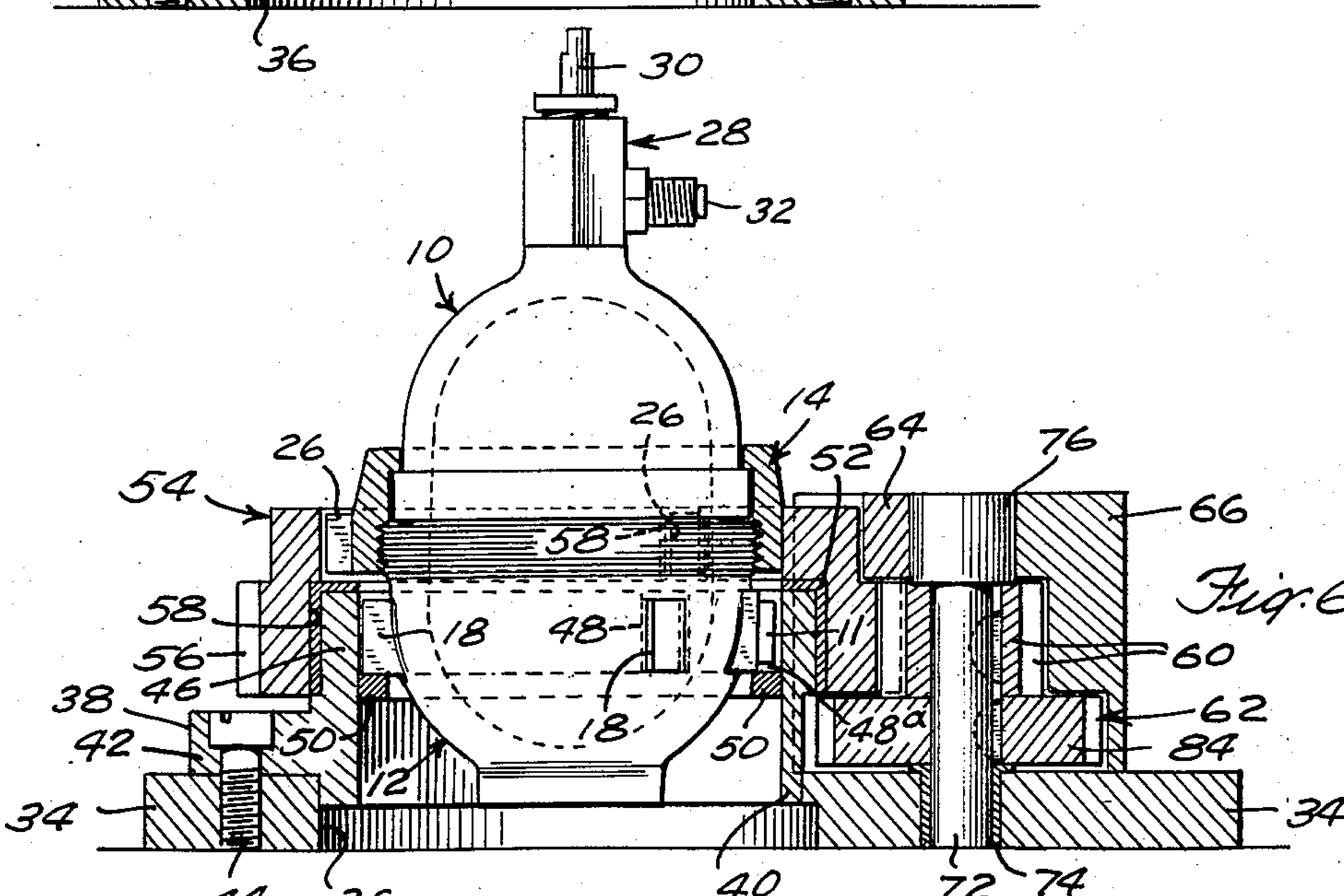

Fig. 6.

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Fig. 7

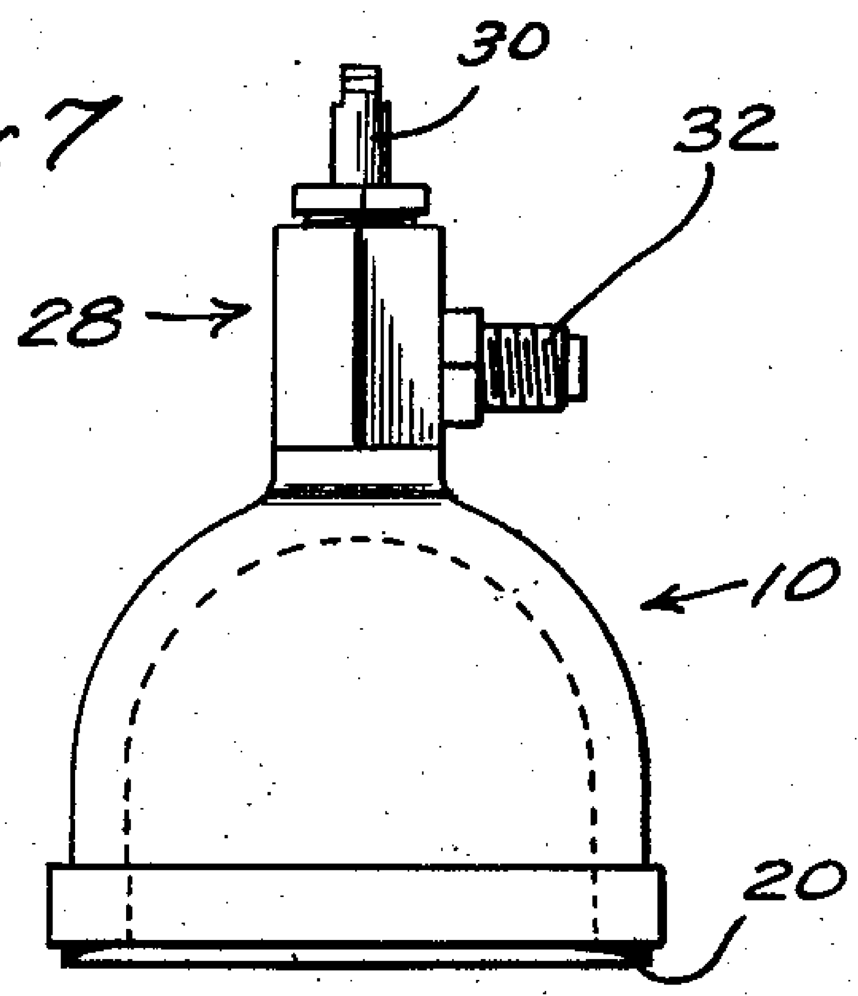


Fig. 8

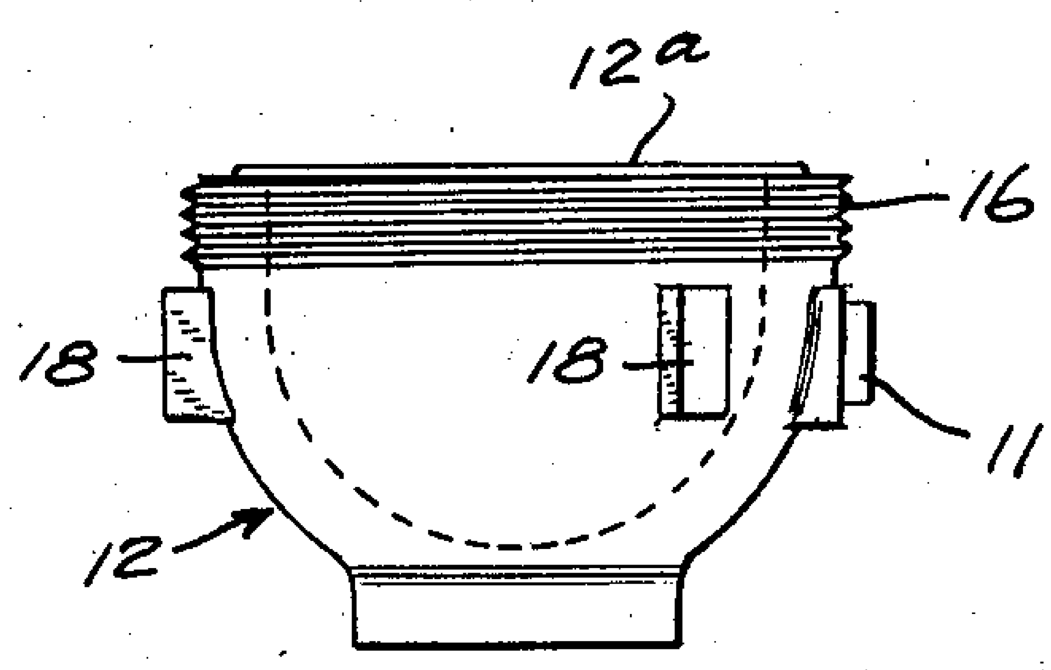


Fig. 9.

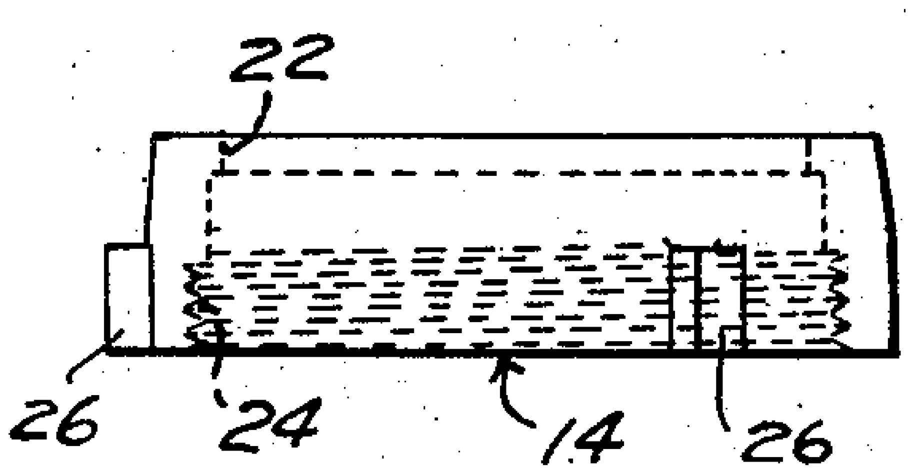


Fig. 10

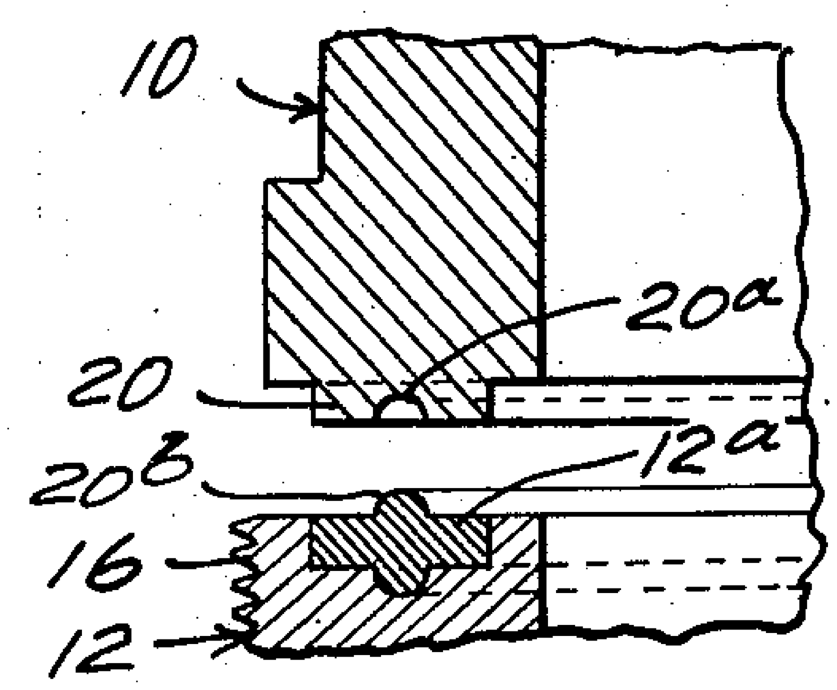


Fig. 12

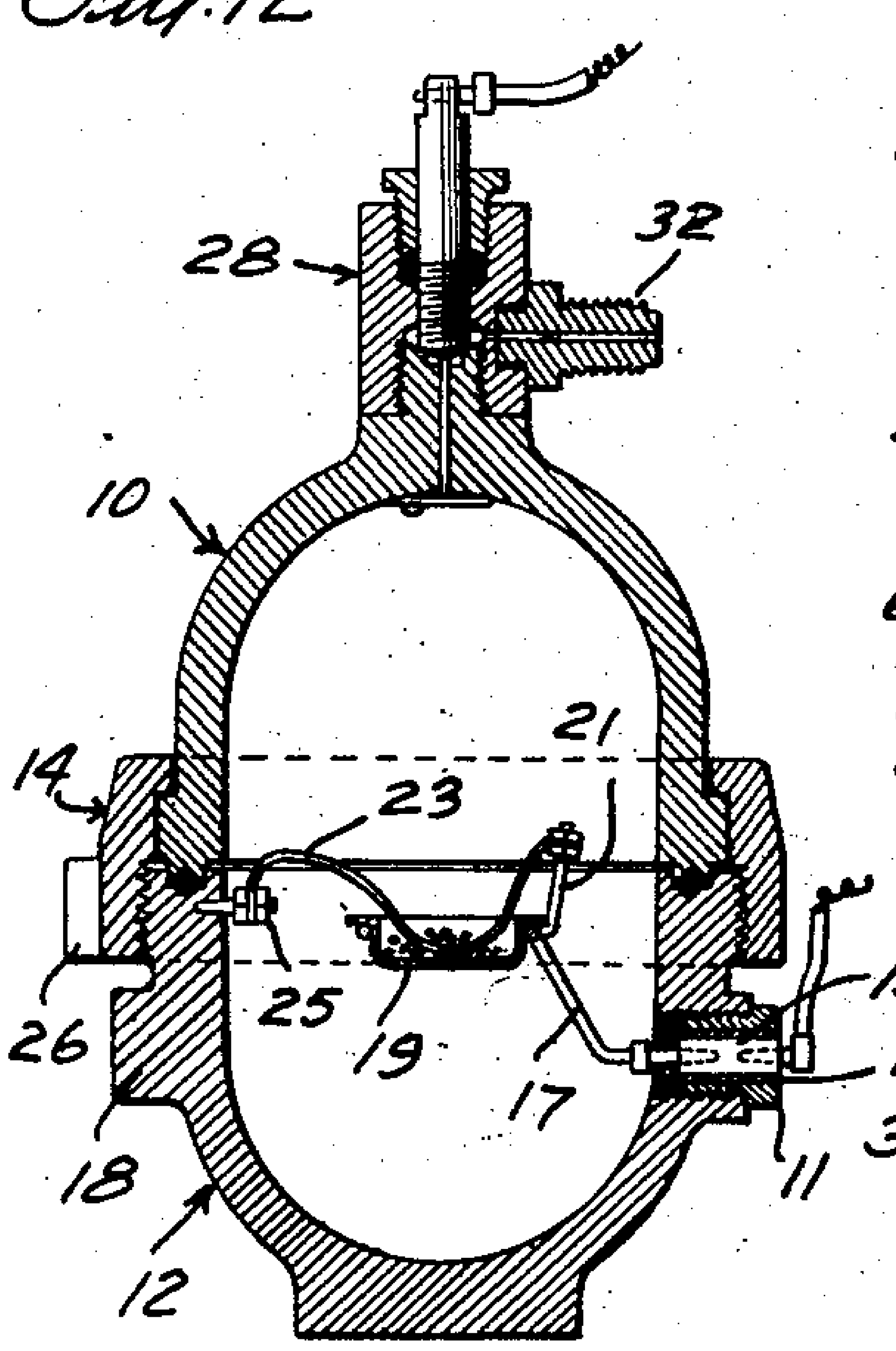
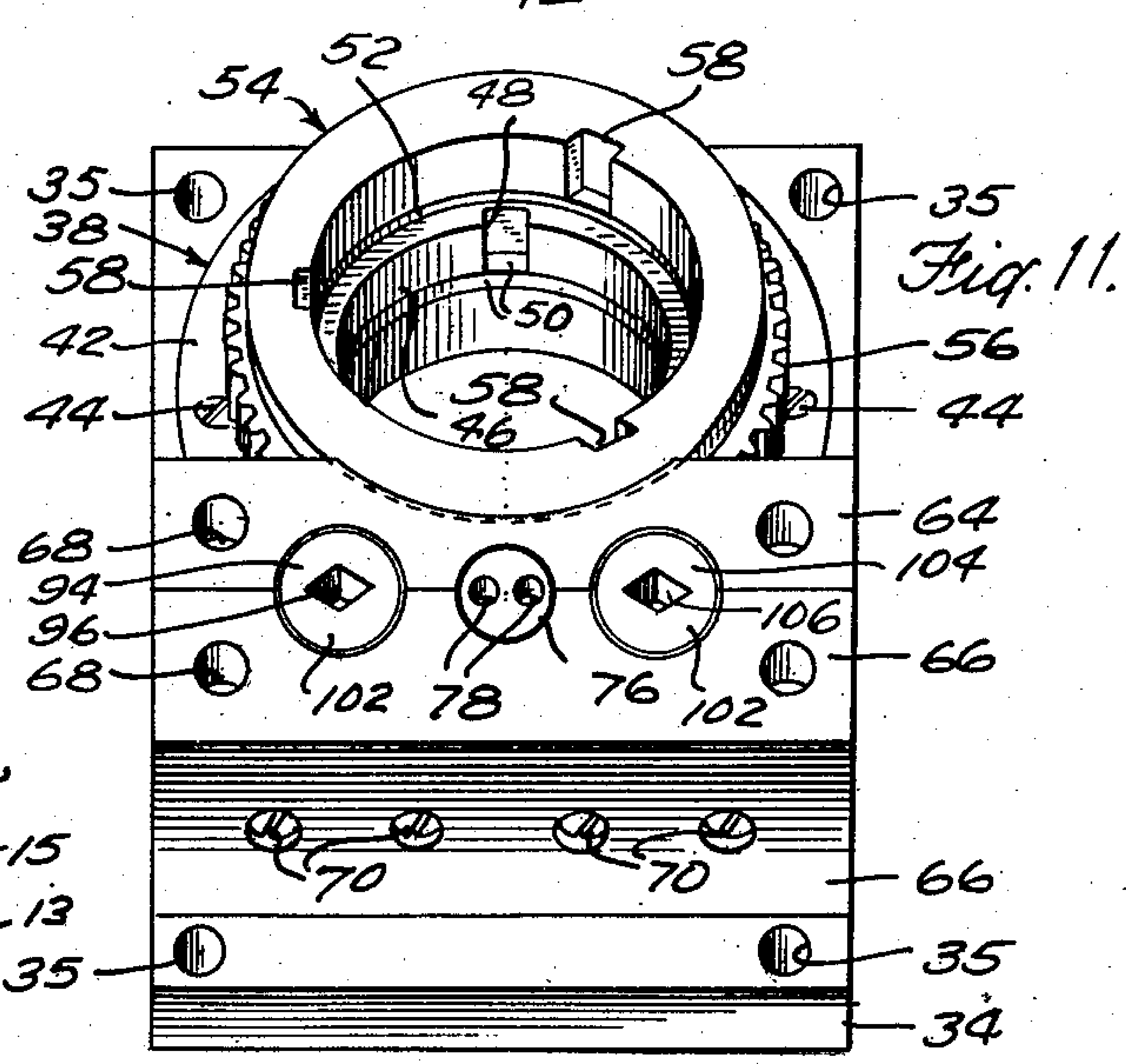


Fig. 11.



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OPERATING JIG FOR CALORIMETER BOMB

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Application December 5, 1952, Serial No. 324,385

2 Claims. (Cl. 29—240)

This invention relates to operating jigs for closing and opening calorimeter bombs. A calorimeter bomb may desirably consist of a stainless steel generally spherical vessel, split horizontally through the middle. To prevent the escape of gases the two halves of the bomb are assembled and sealed by means of a large stainless steel locking nut which also forms a part of the bomb. The bottom half of the bomb is first charged with a measured quantity of combustible material to be tested, and the bomb parts are then assembled. Oxygen is introduced into the bomb, desirably at a pressure of 375 pounds per square inch, after which the material charge is ignited and the heat of combustion determined in the usual calorimeter. The bomb is then vented and disassembled.

According to conventional practice the bomb is made up tight with a three-foot spanner wrench applied to lugs on the nut to very nearly the limit of the operator's strength. Adequate closing has been found difficult, and in some cases impossible, with operators of ordinary strength. To prevent leaking, it is necessary each time to apply a closing torque slightly in excess of the torque applied at the last previous closing—this because of the progressive deterioration of a lead sealing washer which is used. Application of a uniform closing torque is nearly impossible as different operators are not equally strong. Even the strength of the same operator varies from time to time. Opening of the bomb is almost impossible without the use of a sledge hammer to apply an impact along with the torque of the wrench. The use of a large heavy wrench forced very nearly to the limit of the strength of the operator constitutes a safety hazard of some importance.

It is a primary object of the present invention to provide a bomb closing and opening jig in which the lower half of the bomb may be held securely against turning, and in which multiplication gearing is provided for transmitting the torque of a wrench to the closing nut with a high mechanical advantage, to enable the nut to be turned up tight without straining the operator.

It is a further object to provide a jig for the above purpose which gives the user a choice of operating "speeds" or mechanical advantages, so that the preliminary closing and the final opening can be performed rapidly while the final closing and the preliminary opening can be performed powerfully.

It is still another object to provide a jig of the kind referred to which is of compact, simple and inexpensive construction, and which is sturdy, dependable and efficient in service.

Other objects and advantages will hereinafter appear.

In the drawing forming part of this specification,

Figure 1 is a plan view of a novel jig embodying features of the invention;

Figure 2 is a sectional view taken upon the line 2—2 of Figure 1, looking in the direction of the arrows;

Figure 3 is a detail view of an operating knob or finger piece adapted to be applied to one of the available input gears of the jig;

Figure 4 is a sectional view taken upon the line 4—4 of Figure 1, looking in the direction of the arrows;

Figure 5 is a sectional view taken upon the line 5—5 of Figure 1, looking in the direction of the arrows;

Figure 6 is a sectional view similar to Figure 2 but with the bomb in place in the jig;

Figures 7 and 8 are views in elevation, respectively of the upper and lower chamber forming members of the bomb;

Figure 9 is a view in elevation of a clamping nut which also forms part of the bomb;

Figure 10 is an enlarged, detail, fragmentary view showing rims of the upper and lower bomb forming members in opposed but separated relation;

Figure 11 is a view looking obliquely down on the structure shown in Figure 1; and

Figure 12 is a view in vertical section of the assembled bomb removed from the jig.

The illustrative bomb comprises upper and lower complementary metallic chamber forming members **10** and **12**, and a clamping nut **14**. The lower member **12** is in the form of a cup having an external thread **16** on its upper outer margin and a series of equally spaced external lugs **18** (three as shown) disposed around its body below the threaded margin. The upper edge of the member **12** is grooved to receive a lead sealing washer **12*a***. A plug **11** is threaded into the side of the cup **12** and supports, through insulation **13**, a conductive rod **15**. The rod **15**, through a conductive bracket **17**, supports a pan **19** into which a measured fuel charge is placed. A conductive arm **21** of the bracket **17** is connected through a wire **23** with an internal lug **25**. The outer end of the rod **15** is formed to receive removably a tapered conductive terminal pin of a first electrical conductor (not shown).

The upper member **10** is dome-shaped. It is provided with a lower circular rib **20** adapted to fit into the groove of the cup and to bear against the lead washer **12*a***. The rib **20** is formed with a groove **20*a*** for receiving a complementary rib **20*b*** on the washer.

The nut **14** is formed with an internal flange **22** which is adapted to surround the body of the member **10** and to bear downward against the flange **20**. The nut **14** also includes an internal thread **24** at its lower margin for cooperating with the thread **16** of the lower member **12** for pressing the members **10** and **12** forcibly together. Lugs **26** are provided externally on the nut **14**, there being three equally spaced lugs on the illustrative nut. The lugs **18** and **26** are adapted to cooperate with relatively movable parts of the jig.

A fitting **28**, threaded onto the top of the member **10**, has a passage formed through it for the admission of oxygen and the discharge of combustion gases. A needle valve **30**, threaded downward through the fitting **28**, may be turned into position to open or to close the passage. A nipple **32** connects with a side passage of the fitting **28**. The nipple may be connected to a hose for delivering oxygen into the bomb when the needle valve **30** is open, and the needle valve may then be closed and the hose detached from the nipple. The upper end of the needle valve is formed to receive removably a tapered terminal pin of a second electrical conductor. Details of the conductors and the firing circuit are not illustrated, since they form no part of the present invention.

The illustrative bomb operating jig comprises a thick, rectangular base plate **34** which has a large circular opening **36** formed through it. It is provided with bolt holes **35**, through which it may be attached to a board or table. A sleeve **38** is fitted onto the plate **34**. The sleeve **38** has a bottom rim or flange portion **40** received in the opening

36 of the base plate 34, and a circumferential flange 42 disposed to rest upon the plate 34 in the area bordering said opening. The flange 42 is generally circular, but along one side has a straight vertical boundary. The collar 38 is secured to the base plate 34 by headed screws 44 whose shanks pass downward through the flange 42 and into the plate. The sleeve 38 includes at its upper end an internal flange 46 of substantial thickness through which vertical channels 48 are formed, there being three of the channels at equally spaced intervals. The flange is thus divided to form a series of internal abutments or holding segments for cooperating with the lugs 18 of the lower calorimeter member 12. A fourth internal channel 48*a* is provided to accommodate the head of the plug 11. A ring 50, pressed upward into the sleeve 38 against the flange 46, closes the lower ends of the channels 48.

The sleeve 38 is externally rabbeted, and receives in the rabbet the vertical cylindrical wall of a flanged bearing sleeve or bushing 52, desirably of brass. An inturned flange of the bushing 52 rests upon the upper end of the sleeve 38. A gear 54 having external teeth 56 is formed internally with a rabbet 57, which rotatively engages the bearing bushing 52. The upper portion of the gear 54 is formed internally with three equally spaced vertical channels 58. The channels divide the inner portion of the gear into a series of internal driving segments for cooperation with the lugs 26 of the nut 14. The teeth of gear 54 mesh with the teeth of a smaller gear 60, by which the gear 54 is driven. The gear 60 forms part of a gear unit 62.

The unit 62 comprises complementary supporting blocks 64 and 65 which meet in a vertical plane, but which are recessed and grooved to receive between them various gears and shafts of the unit. The blocks 64 and 66, when assembled with one another and with the other parts, are secured to the base plate 34 by vertical headed screws 68, and are secured to one another by horizontal headed screws 70 whose shanks are passed freely through the block 66 and threaded into the block 64. The block 64 engages the flat boundary of the flange 42. It is also cut out to overlie a portion of the gear 54.

The gear 60 is made fast upon a vertical shaft 72 which extends down between the blocks 64 and 66 and into a bearing bushing 74. The bushing 74 is mounted in the base plate 34. The shaft 72 has an enlarged upper end portion 76 formed with a pair of pin receiving bores 78. A knurled knob 80 (Figure 3), having a pair of projecting pins 82 extending from its lower end, may be detachably applied to the upper end of the shaft 72 for turning the shaft and the gear 60.

The shaft 72 also has fast upon it a gear 84 through which the shaft may be operated powerfully from other gearing. The gear 84 is in mesh with smaller driving gears 86 and 88 which are of different sizes.

The gear 86 is made fast upon a vertical shaft 89 which extends downward between the blocks 64 and 66 and into a brass bushing 90 of the base plate 34. The shaft 89 also extends through a brass bearing sleeve 92 which is secured between the blocks 64 and 66. The shaft 89 has an enlarged head 94 in which a wrench socket 96 is formed. When a wrench is applied to the shaft head 94 the drive is from the shaft 89 through gears 86 and 84 to the shaft 72, and thence through gear 60 to gear 54. The mechanical advantage of gear 86 relative to gear 54 in the illustrative jig is 9.5 to 1.

The gear 88 is integral with shaft 98 whose lower end is rotatably received in a brass bearing bushing 100 of the base plate 34. A complementary, co-axial shaft section 101 is made separate from the shaft 98 for assembly purposes, but has tongue and groove connection with the shaft 98 so that these aligned shaft elements operate as one. The shafts 98 and 101 both have bearing in a brass bearing sleeve 102 which is secured between the blocks 64 and 66. The shaft 101 has an enlarged head 104 which is formed with a wrench socket 106 like the socket 96 of the shaft 89. When a wrench is applied to the shaft head 104 the drive is from the shaft 101 through shaft 98 and gears 88 and 84 to the shaft 72, and thence through gear 60 to gear 54. The mechanical advantage of gear 88 relative to gear 54 in the illustrative jig is 14 to 1.

When a test is to be made, a measured quantity of combustible material is placed in the pan 19 of the lower bomb member 12, see Figure 12, the upper bomb member 10 is placed on the lower bomb member with the rib 29 bearing against the lead sealing washer 12*a*, and the nut 14 is then screwed by hand onto the thread 16 of the lower member 12. The bomb is then placed in the jig with the lugs 18 partly entering the channels 48 and with the lugs 26 resting on the gear 54. The knob 80 is then applied to the upper end of the shaft 72 and turned to rotate the gear 54 until the channels 58 come into registration with the lugs 26, whereupon the bomb drops into the position illustrated in Figure 6. The knob may be further turned to tighten the nut 14 on the bomb member 12 so long as the turning is easy. A torque wrench 110 is then applied to the upper end of shaft 101 and turned to screw the nut 14 down onto the member 12 forcibly enough to thoroughly seal the joint between the members 10 and 12.

When this has been done the bomb is lifted freely out of the jig and subsequently charged with oxygen, the needle valve 30 is closed, and the oxygen hose is detached from the nipple 32. Electrical connections from a firing circuit (not shown) to the rod 15 and the valve 30 are established. The bomb is then submerged in a measured quantity of water of known temperature, as is well understood, and the firing circuit is closed to fire the bomb. The hot bomb causes the water temperature to rise until a steady temperature has been attained, whereupon the water temperature is noted and the bomb is withdrawn, dried, and returned to the jig. Here the needle valve may be opened slighly to vent the bomb gradually, after which the wrench 110 is again applied to the shaft 101 and turned to start the opening of the bomb. When the nut 14 has been sufficiently freed to make operation through the knob 80 and the shaft 72 feasible, the latter connection is effected, and the backing off of the nut is continued more rapidly by that means. The nut may be completely detached through operation of the knob, or the bomb may be removed from the jig and the final detachment of the nut may be effected by manual turning.

A schedule for repetitive bomb asesmbly should be worked out for each apparatus. For the bomb illustrated herein only the shaft 101 is utilized in the final closing and preliminary opening operations. After a new lead sealing washer 12*a* has been installed a torque of 55 foot pounds should be applied. This can be determined by using a torque wrench of a known type which embodies means for indicating the torque in foot pounds. At each following assembly the torque should be increased by 2½ foot pounds until a maximum value of 85 foot pounds is reached. At that point the lead washer should be renewed and the sequence repeated, starting again with 55 foot pounds for the first assembly. The torque required to losen the nut after an explosion is usually from 10 to 15 foot pounds greater than the torque employed in effecting the assembly.

Since a power multiplication factor of 14 is introduced by the jig the operation is well within the physical capacity of any operator. No pounding is required, and the operator can watch the wrench indicator and nicely adjust the closing pressure in accordance with his observation.

It will be noted that the shaft 89 is not used at all in connection with the bomb herein illustrated. When a different bomb is to be operated upon requiring less torque than the one herein illustrated, the shaft 89 is useful, since, with its lower mechanical advantage, it is capable of higher speed operation.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. A closing and opening jig for a calorimeter bomb which comprises two relatively rotatable threaded members both formed with external driving lugs, one of said members having an external diameter larger than the other, said jig comprising, in combination, a stationary base, a stationary bomb supporting sleeve rigidly secured to the base and having inwardly facing channels disposed axially of the sleeve upon a comparatively small radius in position to receive the lugs of the smaller diameter relatively rotatable bomber member, and thereby lock said smaller diameter bomb member positively against substantial rotation in either direction, a ring gear co-axial with the stationary sleeve and rotatively mounted thereon, said gear having a shouldered sleeve portion provided with inwardly facing channels disposed above the stationary sleeve and upon a comparatively large radius in position to receive the lugs of the larger diameter relatively rotatable bomb member to force said larger diameter member positively to turn with the gear in either of two opposite directions, means carried by said base and coacting with said shouldered portion for securing said gear and gear sleeve portion on said stationary sleeve against spatial

displacement relative thereto, and operating means for said gear including power multiplying gearing supported from said base and connected to drive said gear rotationally in opposite directions relative to said sleeve.

2. A jig as set forth in claim 1, wherein said operating means gearing comprises a gear train, a first input shaft connected to one gear in said train providing a relatively high speed low power input, and a second input shaft connected to a second gear in said train providing a relatively low speed high power input.

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