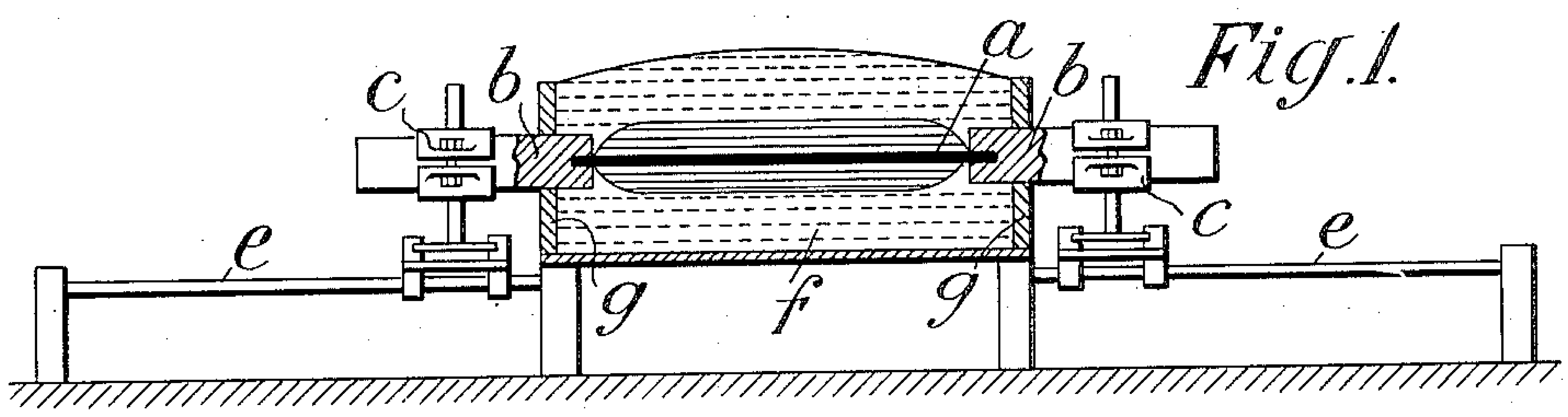
No. 822,424. PATENTED JUNE 5, 1906.

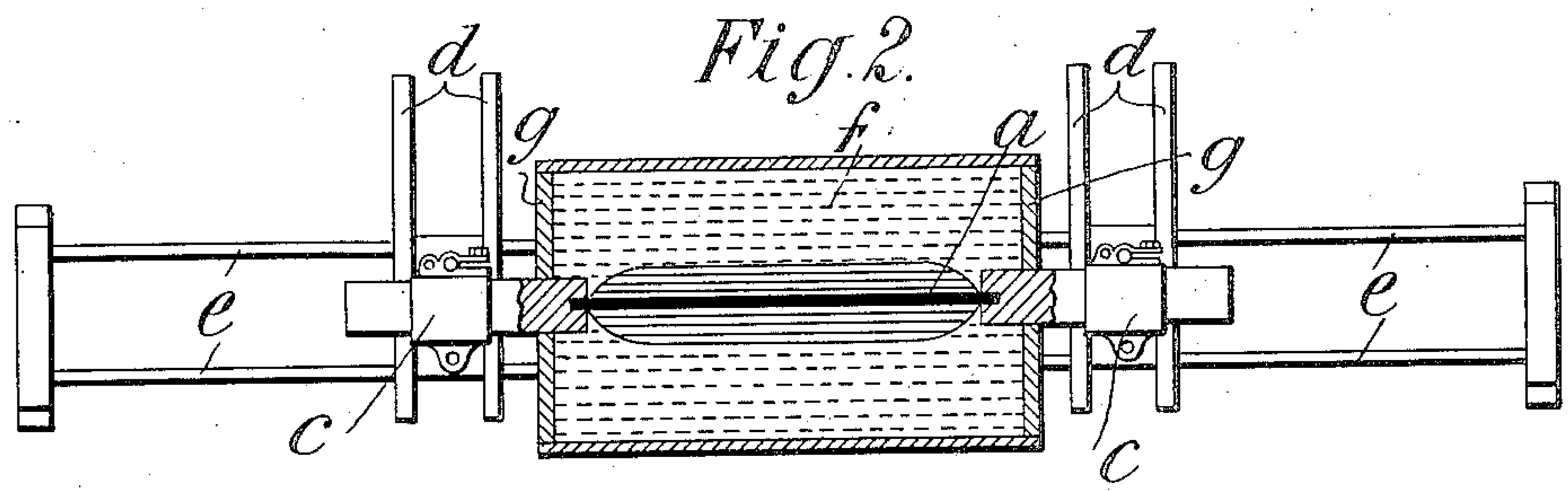
J. F. BOTTOMLEY & A. PAGET.

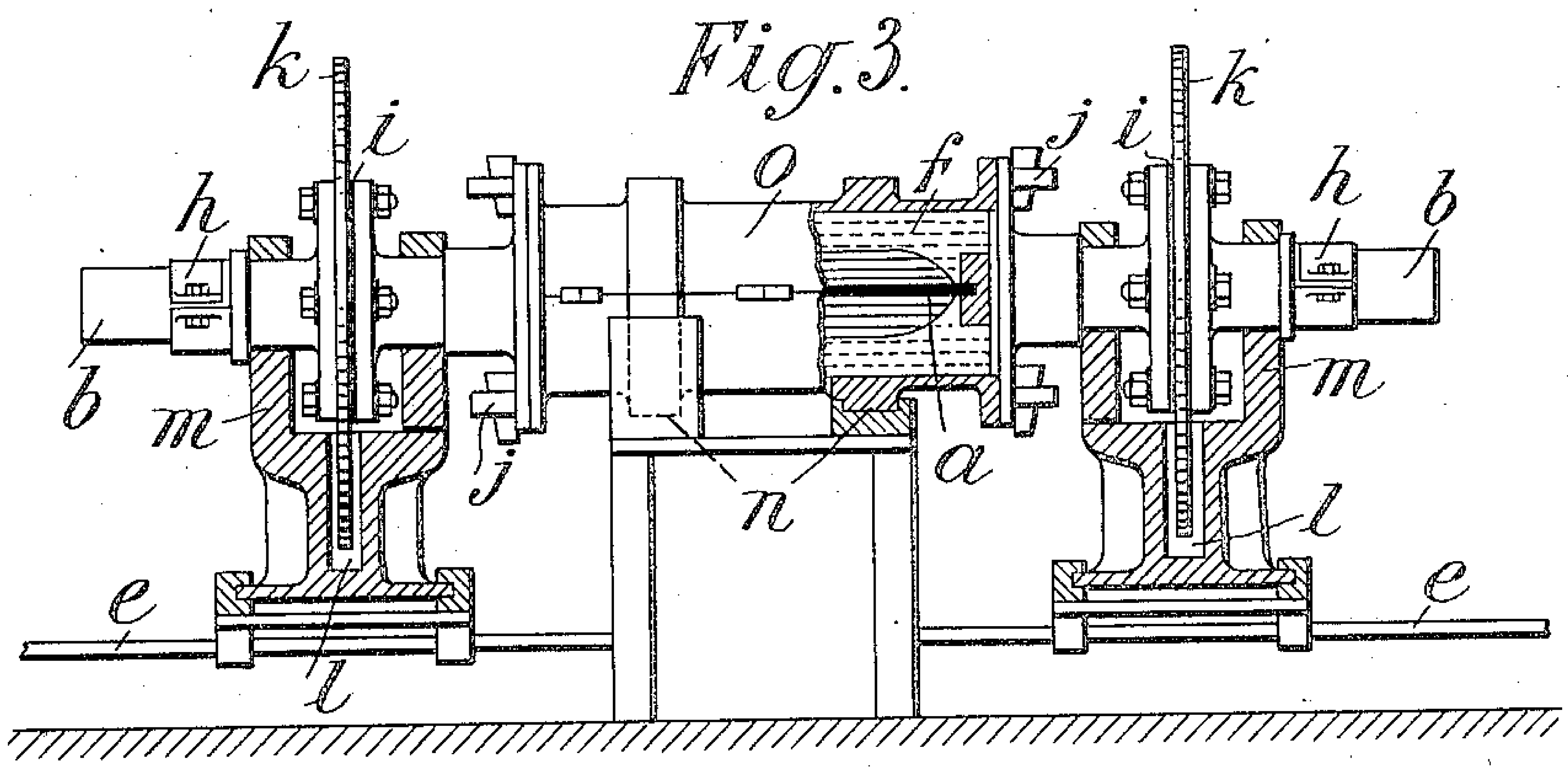
PROCESS FOR FUSING SILICA AND FOR SHAPING THE MASS WHILE PLASTIC.

APPLICATION FILED JUNE 9, 1905.

3 SHEETS—SHEET 1







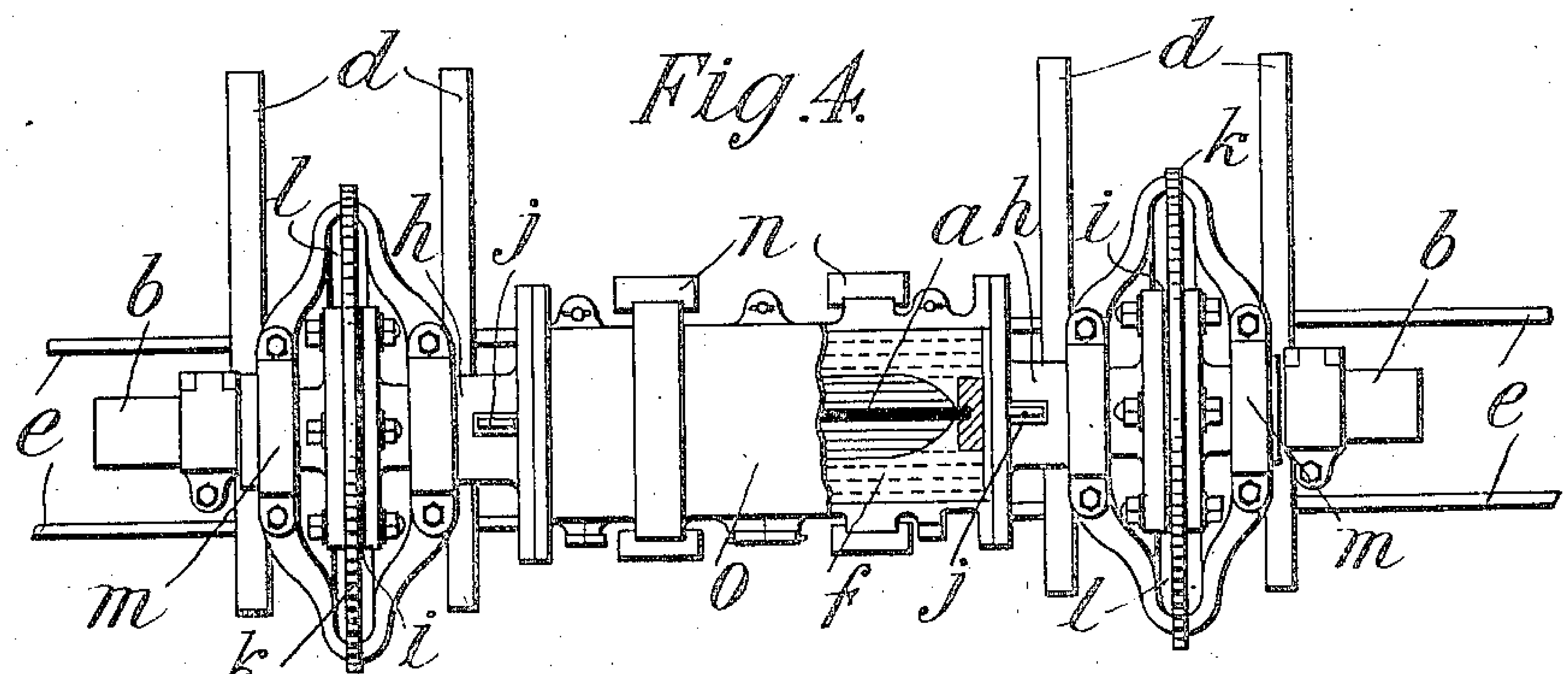


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Fig. 5.

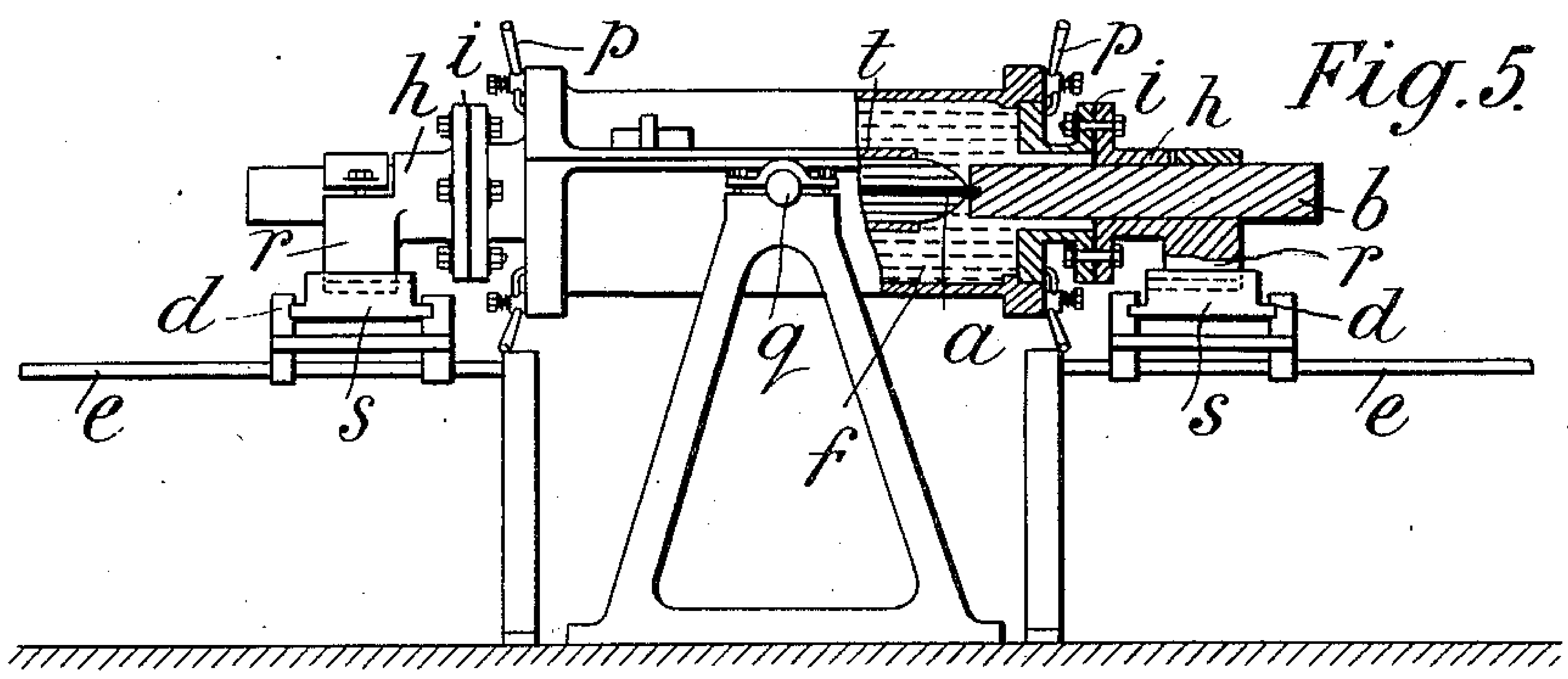


Fig. 6.

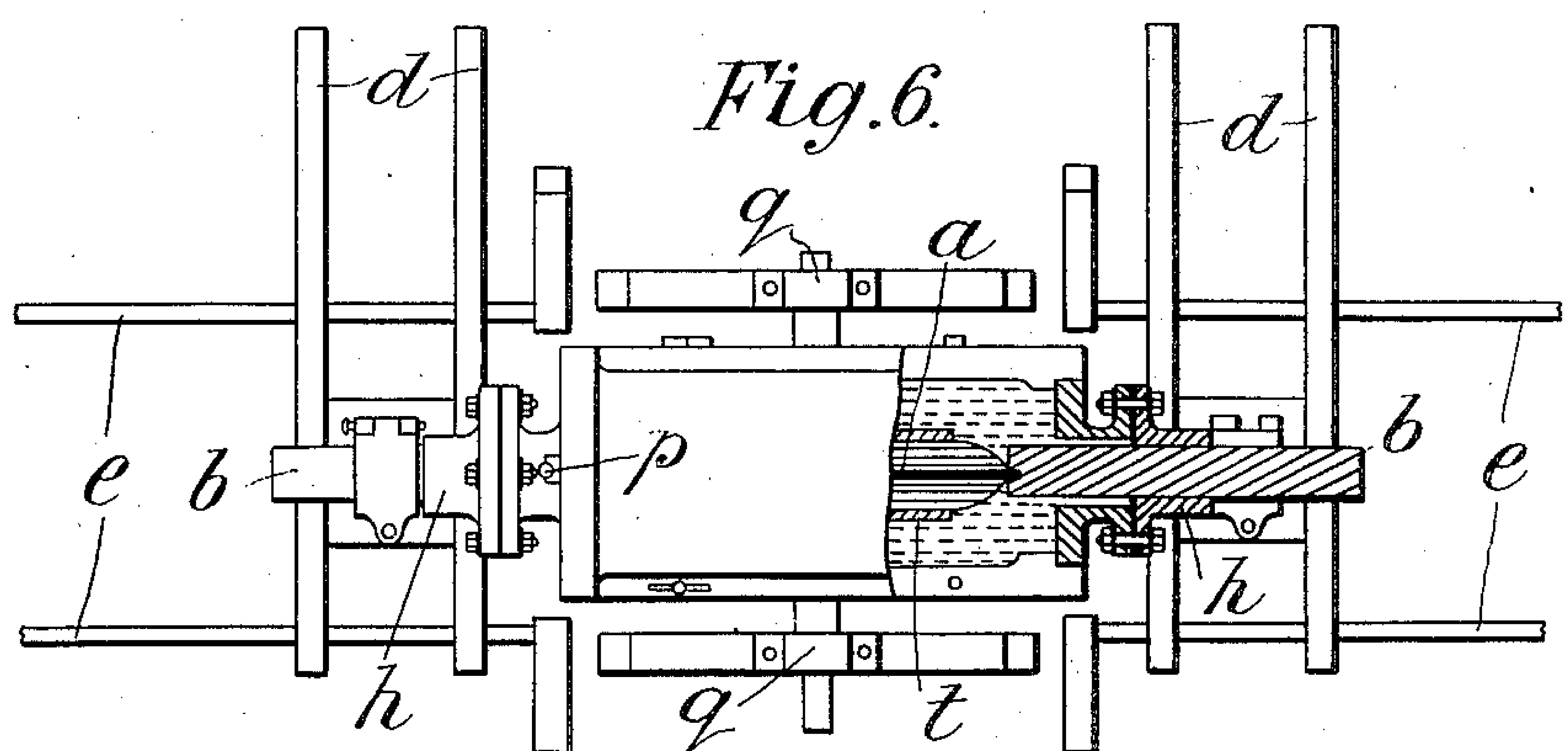
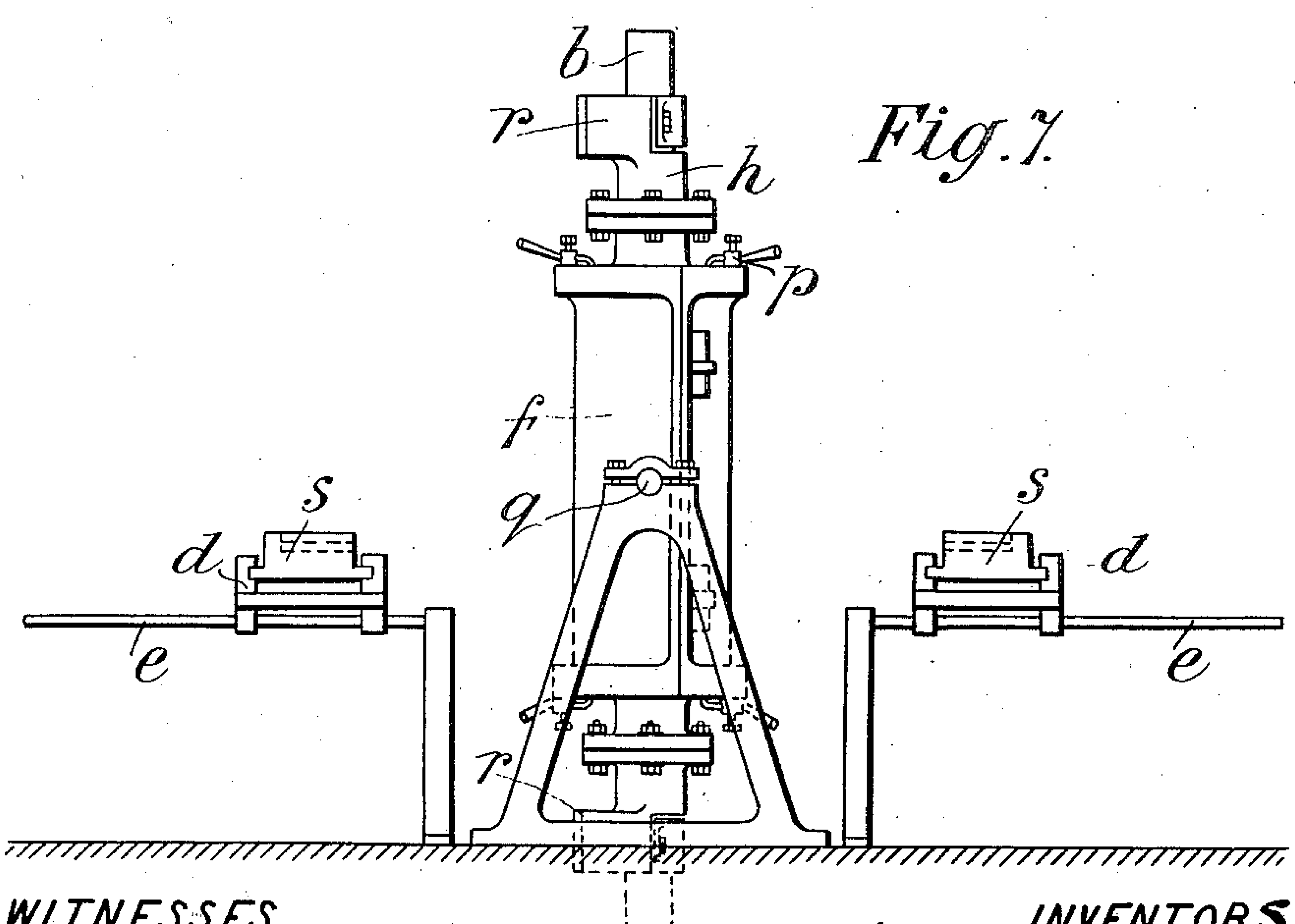


Fig. 7.



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3 SHEETS—SHEET 3.

Fig.8.

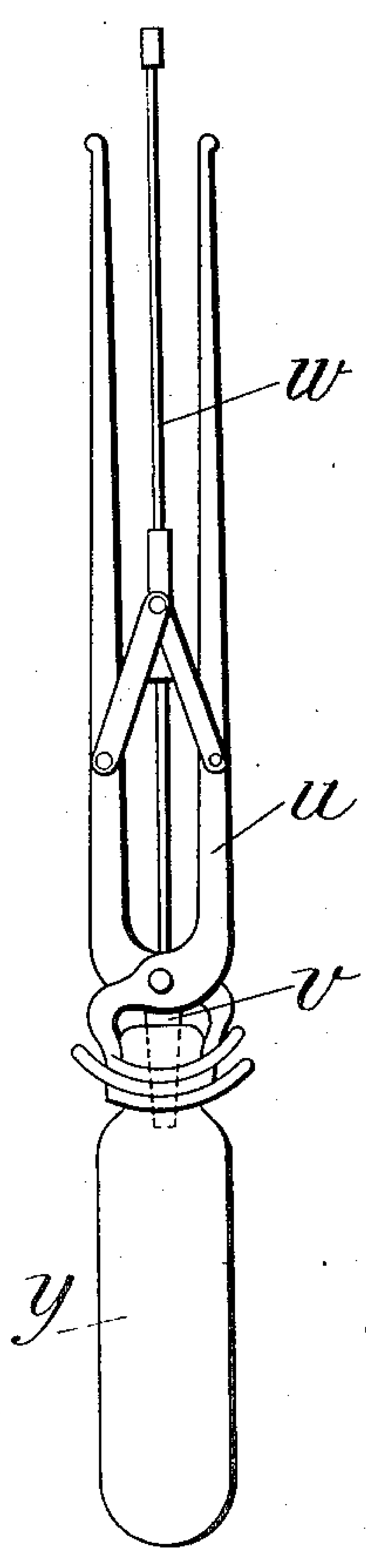


Fig.9.

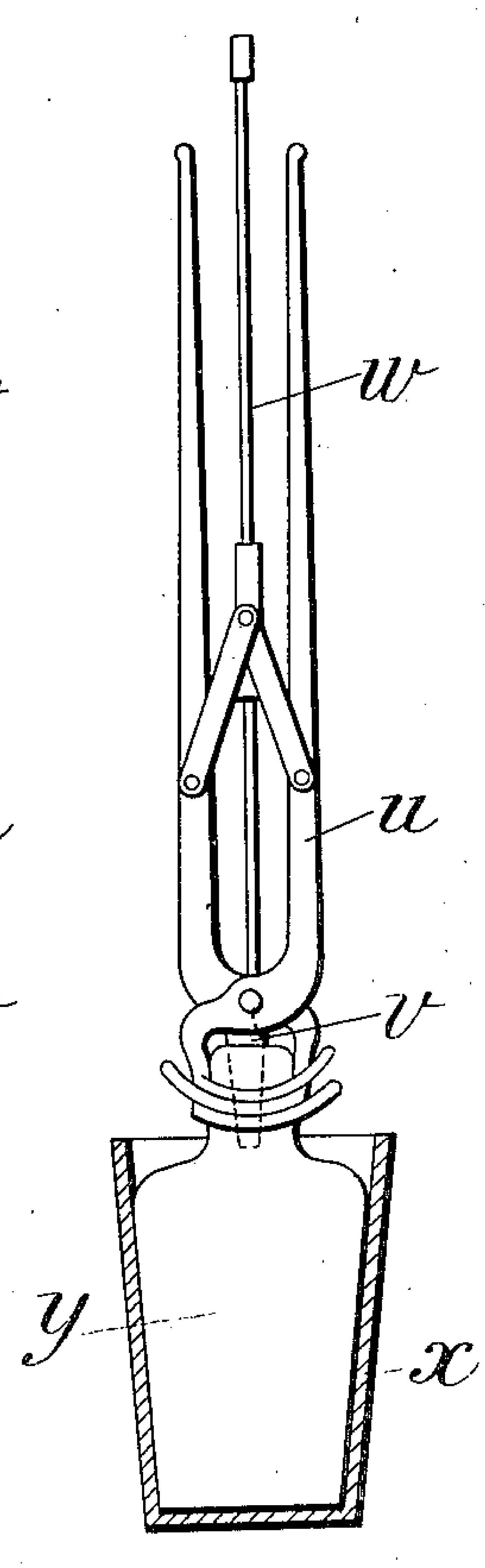
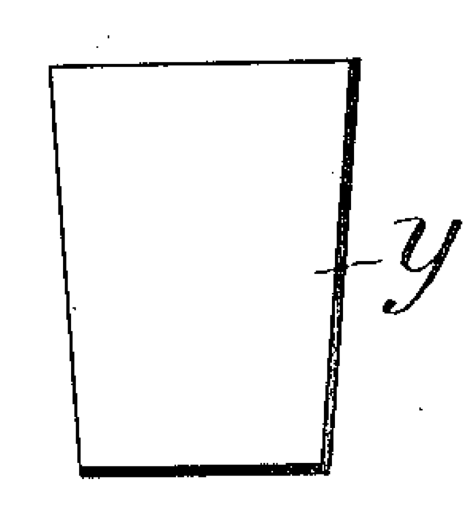


Fig.10.



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UNITED STATES PATENT OFFICE.

JAMES FRANCIS BOTTOMLEY, OF WELLSEND-ON-TYNE, AND ARTHUR PAGET, OF NORTH CRAY, ENGLAND.

PROCESS FOR FUSING SILICA AND FOR SHAPING THE MASS WHILE PLASTIC.

No. 822,424. Specification of Letters Patent. Patented June 5, 1906.

Application filed June 9, 1905. Serial No. 264,429.

To all whom it may concern:

Be it known that we, JAMES FRANCIS BOTTOMLEY, residing at Wellsend-on-Tyne, in the county of Northumberland, and ARTHUR PAGET, residing at North Cray, in the county of Kent, England, subjects of His Majesty the King of Great Britain, have invented a certain new and useful Improved Process for Fusing Silica and for Shaping the Mass While Plastic, of which the following is a specification.

This invention relates to improvements in and connected with the working of fused silica by drawing, blowing, or pressing a plastic cylinder of fused silica formed by fusion of sand or other suitable form of silica round a central core heated by the passage of an electric current.

To form the cylinder of plastic silica, we make use of a furnace so constructed as to allow of a separation of the electrodes from the heating-core after the completion of the fusion, so that the plastic silica may be removed and the heating-core withdrawn from the cylinder either before or after its removal from the furnace. The heating-core is preferably formed of carbon or graphite and may be either solid or hollow and of any desired cross-section, according to the size and nature of the product required.

In order to allow of the ready withdrawal of the heating-core in the case of a carbon or graphite core, the heating is continued sufficiently to allow of an initial separation between the core and the inner surface of the plastic cylinder, which takes place on account of the formation of a small quantity of gas on the surface of the core.

In case the product is to take the formation of a true cylinder special precautions are necessary in order to avoid the tendency to the formation of a D-section. This difficulty may be met by inclosing the material to be heated in such a way as to give uniform support to the plastic cylinder by preventing any displacement of the material round the core. The amount of current and length of heating may also be regulated so as to prevent the cylinder from becoming too plastic, or the furnace may be rotated on a horizontal axis during fusion.

In the alternative the heating-core may be placed vertically and the furnace may be mounted so as to be reversible. The cylinder and, in consequence, the products formed therefrom are usually rough on the exterior, owing to the imperfect fusion of the outer layer of silica. In order to produce an externally-glazed product, means may be provided either for limiting the amount of material surrounding the core, so that the whole of it is fused, or the rough cylinder may be subsequently treated in a separate furnace, as described hereinafter.

In order to limit the amount of material around the heated core, we may provide a jacket of carbon or other sufficiently refractory material—as, for example, metals of the platinum group—this jacket being further protected on the outside against heat losses by additional sand or other heat-insulating material. The jacket may be made in two parts, so as to be more easily removable.

Where a cylindrical product is required and a jacket is employed, the vertical form of furnace is preferable, as it facilitates the feeding in of the sand or other form of silica to compensate for the shrinkage in volume during fusion. When the fusion is complete, the plastic cylinder is ready for removal and subsequent treatment. For this purpose the electrodes at either end of the heating-core are drawn apart, so as to free the core from the furnace, and one or both ends of the cylinder are clasped by tongs, so that the cylinder may be drawn out and released (if desired) from the jacket or freed from the surrounding sand, the heating-core being withdrawn either before or after the removal of the plastic cylinder from the furnace.

The second furnace may consist, for example, of a tube of carbon or other suitable resistance material fixed between two electrodes and heated by the passage of an electric current. The tube is covered with a suitable insulating material to prevent heat losses. For some purposes this may conveniently be of sand, which owing to the fact that it fuses round the tube and forms a gas-tight covering for it affords a good protection against corrosion of the outside of the heating-tube through contact with the air. Nitrogen or other inert gas may be led into the interior of the furnaces for the same purpose.

The second furnace may be either vertical or horizontal and open at one or both ends, according to the purpose for which it is required, the vertical arrangement being preferable where a cylindrical product is required, so as to take advantage of gravity. The rotation of the cylinder of plastic material may be employed to insure uniformity of heating and also to help in producing a cylindrical product. The manipulation of the plastic cylinder varies with the product required; but in every case in which expansion of the plastic mass is required it is necessary to apply sufficient initial force to overcome the external resistance due to external chilling. Where the initial resistance has been overcome, the mass becomes more plastic, so as to be easily expanded.

First. To draw the cylinder, (without blowing,) the cylinder is clasped at both ends by tongs and drawn out. Rotation of the cylinder during drawing may be employed to maintain the cylindrical form and, if desired, the external jacket, if any, need not be removed prior to the drawing operation.

Second. For blowing the cylinder a nozzle constructed of a material capable of withstanding the high temperature or cooled by some device is inserted in one end of the plastic cylinder after withdrawing the heated core and the plastic mass pressed round this nozzle by some suitable means, so as to make a gas-tight joint at this point—*e. g.*, the pressing may be done by means of tongs which may be conveniently in one piece with the nozzle and so constructed that by closing the jaws a uniform pressure is exerted on the plastic cylinder round the nozzle. The opposite open end of the cylinder is simultaneously closed by pressure, either by suitably-constructed tongs which may, if desired, be made to shear off the irregular end produced or by the end pressure of a suitably-formed die, or both. The cylinder is then removed from the melting-furnace and where necessary freed from the surrounding sand and where desirable glazed in the tubular or second furnace before mentioned. Compressed air or other gas may be admitted into the plastic mass, which may then be blown out either freely or into a surrounding mold. If desired, the plastic cylinder may be simultaneously drawn while gas-pressure is admitted to the interior of the plastic mass, so as to produce tubing of larger internal diameter or to insure its cylindrical form.

Third. The plastic cylinder may further be compressed between suitable rollers or dies, so as entirely to weld up the interior cavity and produce a homogeneous mass of any desired form.

Referring now to the drawings, which illustrate an effective construction of apparatus and which form the subject-matter of a divisional application, Serial No. 303,551, Figures 1 and 2 are longitudinal elevation and plan, respectively, of a furnace in part section, exemplifying a method of forming the cylinder of plastic silica and means for separating the electrodes and the heating-core from the product after completion of the fusion. Figs. 3 and 4 are longitudinal elevation and plan, respectively, of a furnace in part section capable of being rotated, with means for separating the electrodes from the fused material when required. Figs. 5 and 6 are longitudinal elevation and plan, respectively, of a furnace in part section capable of being rotated on a horizontal transverse axis into a vertical or horizontal position or of completely reversing, with means for separating the electrodes from the fused material and also exemplifying the method of limiting the amount of material by surrounding it with a jacket to produce fusion throughout. Fig. 7 is a longitudinal elevation showing the same furnace rotated into a vertical position. Figs. 8 and 9 exemplify the method of manipulating a cylinder of plastic silica, so as to shape it by blowing in a mold. Fig. 10 shows the molded article after it has been finished off.

In Figs. 1 and 2 the heating-core *a* consists of a rod of graphite or hard carbon which fits between the terminals or electrodes *b*, of graphite or carbon. In order to insure the heated core being removed at one end along with the electrode, the rod may be screwed into the electrode at that end and mortised into the other. The electrodes are held in metal holders *c*, supported on metal stands, to which the current may be led by flexible leads. (Not shown.) The stands are made to slide in insulated transverse guides *d*, while the transverse guides themselves can slide along longitudinal guides *e*. A trough *f* serves as a containing vessel for the material to be fused and may be of any convenient material. The ends *g* of the trough may be made removable, so as to facilitate the manipulation of the plastic cylinder when required.

The following is an example of a method of operation: A graphite rod twenty-four inches long and one inch in diameter is fixed between the electrodes in the manner described and covered with glass-makers' sand. About one thousand amperes at fifteen volts are passed through the rod for half an hour, when a cylinder of fused silica forms round the core. The fusion being effected, the current is cut off and the electrodes drawn back along the longitudinal guides, the graphite core coming out along with the electrode into which it had been screwed. When the electrodes and core are conveniently clear of the furnace, they are pushed along the transverse guides, and the plastic cylinder is ready for subsequent manipulation. The above figures for current, voltage, and length of heating can only be taken as a rough approximation and would vary according to the material of which the heating-core is composed. In order to effect the withdrawal of the heating-core, it is necessary, however, to carry on the heating sufficiently long to effect the initial separation between the heating-core and fused material by internal generation of gas or to bring about this separation by the introduction of gas or air between the heating-core and the fused material by some device—such as, for example, by using a hollow and perforated core and passing the required quantity of gas through it into the middle of the fused mass, as described in application filed March 21, 1905, Serial No. 251,321.

In Fig. 3 the heating-core *a*, embedded in the material to be fused, is fixed between the electrodes *b* in the manner described above. *h* represents metal sleeves through which the electrodes pass. The sleeves are made in two parts with insulating material *i* between. The flanges on the sleeves form the ends of the chamber *f*, in which the fusion is carried out, and are held in position by the wedges *j*. *k* represents metal disks, which dip into the mercury-troughs *l*, to which the current is led by means of flexible leads, (not shown,) and convey the current to the electrodes. *m* represents the bearings on which the furnace rotates. By means of the longitudinal and transverse guides *e* the electrodes can be drawn clear of the furnaces when required. The chamber *f* itself rotates in the bearings *m*, which support it when the electrodes are drawn apart. It is fitted with a cover *o*, which opens on hinges.

The method of operation is similar to that described above. For example, current is passed through a heating-core fixed between the electrodes until a cylinder of plastic silica of the required dimensions has been formed. During the heating the furnace is kept in slow rotation or rotated from time to time, as desired. The fusion being complete, the current is cut off and the wedges *j* removed, so that the electrodes are free. The electrodes and heating-core are then separated from the fused material in the manner described above, and after opening up the chamber the plastic silica is ready for further manipulation.

In Fig. 5, *f* is a metal chamber made in two parts. The electrodes *b* pass through metal sleeves *h*, which are made in two parts with insulating material *i* between. The flanges on the sleeves form the ends of the chamber and are held in position by the clips *p*. *q* represents trunnions on which the furnace rotates. The sleeves have extension-pieces *r*, which are arranged so that they can engage with the blocks *s*, which run on the transverse guides *d*. Longitudinal guides *e* are also provided as before. Current is led to the sleeves by means of flexible leads, (not shown;) but if the furnace has to rotate completely brushes or some similar device for conveying the current to the sleeve may be employed.

The method of operation is similar to that described above. The heating is carried out with the furnace in the vertical position, and when complete the furnace is rotated to the horizontal and the extension on the sleeves *h* made to engage with the blocks. The clips *p*, holding the sleeve-flanges at the end of the furnace-casing, are then opened and the electrodes drawn apart.

If a material glazed throughout is required, a jacket of carbon or other sufficiently refractory material may be made to surround the core, so as to limit the amount of material to be fused. The jacket may be used with any of the types of furnace and is shown at *t* in Figs. 5 and 6. The ends of the heating-core may be left unjacketed, if desired, as shown on the right of Figs. 5 and 6, in order to facilitate the manipulation of the plastic cylinder, or in order to prevent the material within the jacket from being blown out at the unjacketed ends the ends of the core may be surrounded with a jacket of slightly larger diameter, so that fusion of the outer layer of the contained material does not take place during the main fusion, so that the end jackets are easily removed. One of the extension-jackets may be made funnel-shaped to enable fresh material to be fed in. The jacket may be made in two halves to facilitate its removal afterward, in which case the material surrounding the jacket on the outside, which serves as heat-insulator, may be of some refractory material which does not melt at the required temperature—as, for example, magnesia, carborundum, or the like. In using a jacket it may be advantageous to use a hollow heating-core and electrode and to provide means for regulating the amount of gas given off during the heating. As an example of the method of limiting the amount of material around the heating-core a graphite rod twenty-four inches long and one inch diameter is fixed in position between electrodes with a cylinder of agglomerated carbon three inches internal diameter supported centrally round it and the whole of the furnace filled with pure glass-makers' sand. One thousand amperes at fifteen volts are passed through until the sand on the exterior of the jacket begins to agglomerate, which occupies about three-quarters of an hour. The furnace is then rotated into a horizontal position and connection made with the arrangement for separating the electrodes. The body of the furnace is opened, and after cutting off the current the electrodes are separated and the plastic cylinder contained in the jacket is ready for subsequent manipulation.

According to the alternative method of producing a material glazed throughout the plastic cylinder after removal from the furnace is immediately transferred to an electrically-heated chamber—as, for example, the tubular furnace before mentioned—where it is subjected to radiant heat sufficient to melt the exterior layer of agglomerated material. As soon as the glazing has been effected the plastic cylinder is ready for subsequent manipulation.

In order to produce tubing, the nozzle *v* of the tongs *u* (shown in Fig. 9) may be inserted in one end of the plastic cylinder *y* and the plastic material pressed round it by means of the jaws. The other end of the cylinder is simultaneously closed by the pressure of a suitable pair of tongs. The cylinder is then removed from the furnace and drawn out, compressed air being admitted through the pipe *w*, so as to produce cylindrical tubing of any desired diameter. When the cylinder is removed from the furnace, the outside is hard, and before it can be drawn considerable force has to be employed to overcome the external chilling. When this has been done, the mass becomes much more plastic and can be easily drawn out. For example, in drawing tubing from a plastic cylinder unglazed on the outside to overcome the initial resistance a pull of fifty-five pounds was required, which fell as soon as the material began to draw to twenty-five pounds.

If the plastic cylinder has to be molded, the manipulation is similar; but the nozzle of the tongs is inserted in one end of the cylinder and the plastic material pressed round it as before. The other end may be closed by means of a suitable pair of tongs which may simultaneously shear off the irregular end. The cylinder is lifted into the mold—as, for example, that shown at *x* in Fig. 9—which may be of any suitable material capable of withstanding the temperature of the exterior of the fusion. Compressed air is then admitted, so as to force the plastic material *y* to take the shape of the mold.

When the material to be molded is rough on the outside, the mold may be pierced with a number of perforations to allow the loose sand to pass through.

Instead of the above the plastic cylinder may be shaped by pressing it between dies of any desired shape.

By this invention, therefore, we provide a means whereby fused silica, which on account of its high melting-point cannot be worked by the usual processes common to glassmaking, (namely, of melting in a receptacle and gathering portions of fused material on a blowing-tube,) is brought to such a condition that it can be worked into various articles with comparative ease by the methods indicated. Further, the process is one of high thermal efficiency, because, in the first place, practically only the exact amount of material required need be fused, and, secondly, because the heat is applied directly to the center of the material to be fused, so that (except in the subsidiary process of glazing) practically no heat is lost in heating the containing vessel.

What is claimed is—

1. In the working of silica, fusing same by means of an internal-resistance core, then initially separating the fused material from the core by a layer of gas and then removing the core from the plastic mass for the purposes described.

2. In the working of silica, fusing same by means of an internal-resistance core, heating the core sufficiently to effect the formation of a small quantity of gas on the surface thereof, separating the fused material from the core by means of such gas and then withdrawing the core while the mass is still plastic, substantially as and for the purposes described.

3. In the working of silica, fusing same by means of an internal-resistance core, separating the core from one of the electrodes, withdrawing the core from the plastic mass and shaping such mass while still plastic, substantially as and for the purposes described.

4. In the working of silica, fusing same by means of an internal-resistance core, separating the core from one of the electrodes, withdrawing the core from the plastic mass, removing said plastic mass from the furnace, further heating same within an electrically-heated chamber so as to glaze the exterior of the mass and shaping said mass during plasticity, substantially as and for the purposes described.

5. In the working of silica, fusing same by means of an internal-resistance core, withdrawing the core from the plastic mass, closing one end of the mass, pressing the other end around a nozzle and then introducing air under pressure therethrough, substantially as and for the purposes described.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

JAMES FRANCIS BOTTOMLEY.
ARTHUR PAGET.

Witnesses:
PHILIP M. JUSTICE,
A. KNIGHT CROAD.