March 9, 1965 E. H. BLENKLE 3,172,340

HYDRAULICALLY OPERABLE MINE PROP

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FIG. 1

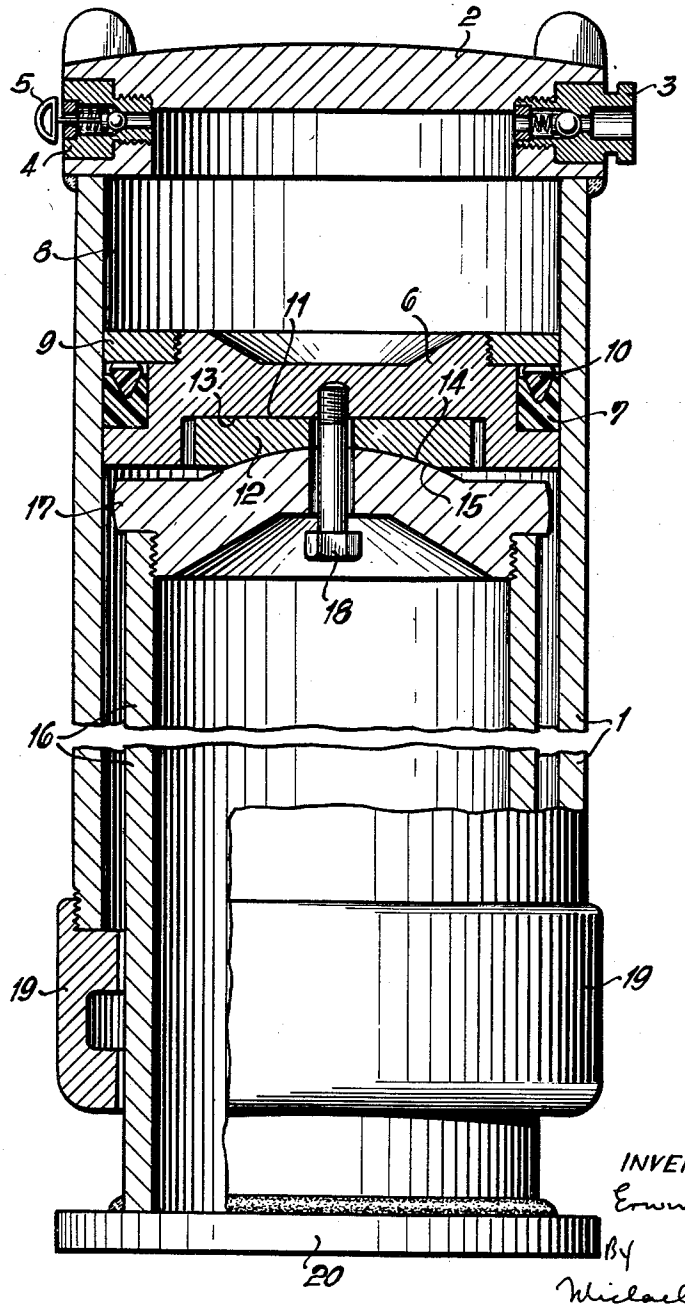

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FIG. 2

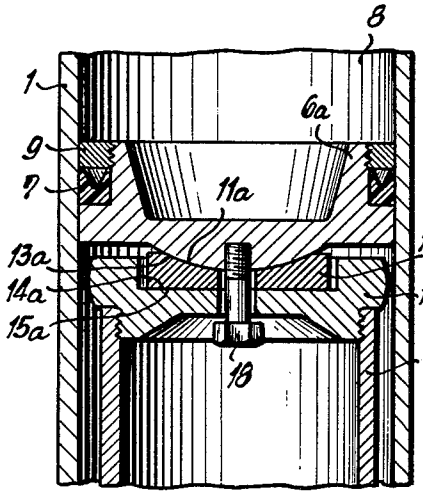

FIG. 3

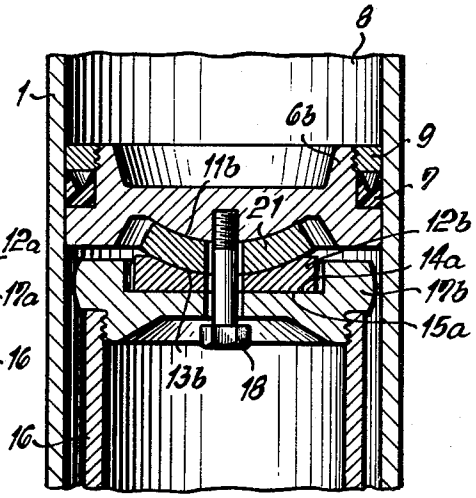

FIG. 4

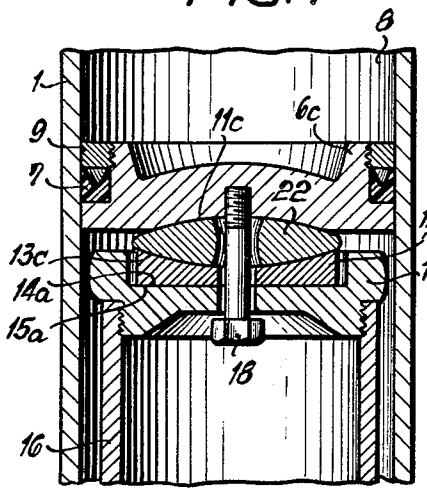

FIG. 5

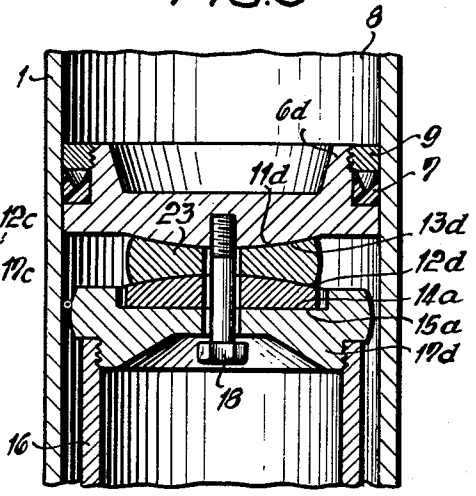

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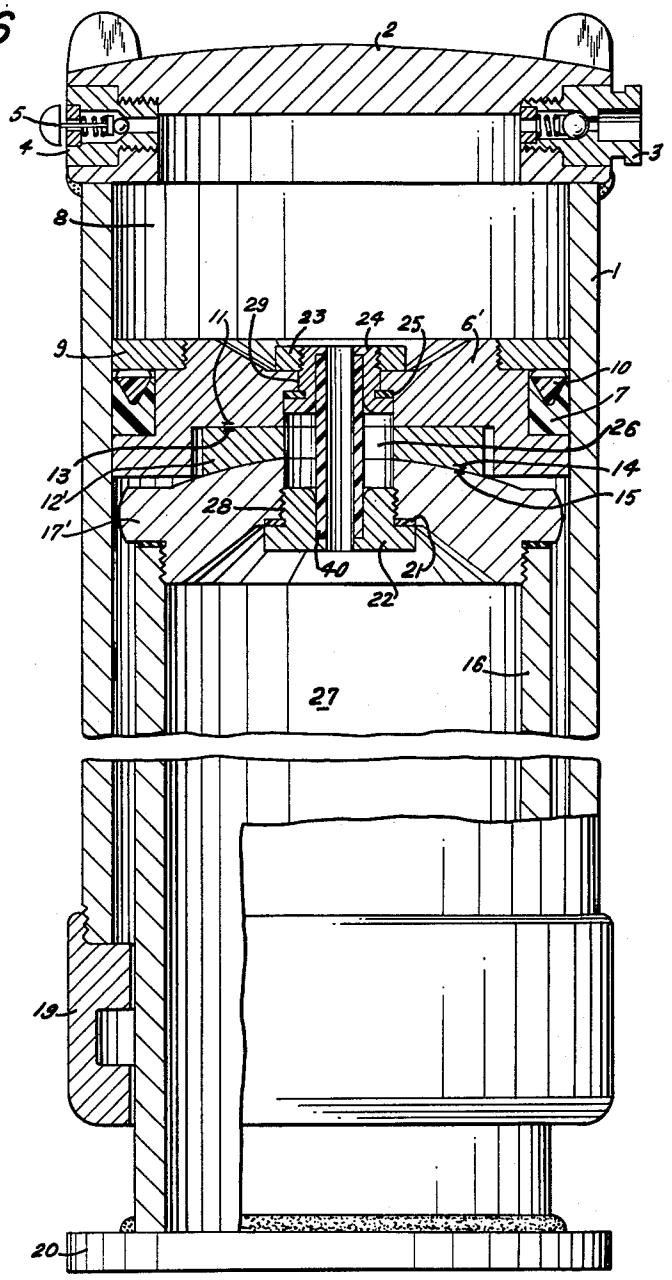
FIG. 6



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HYDRAULICALLY OPERABLE MINE PROP

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FIG. 7

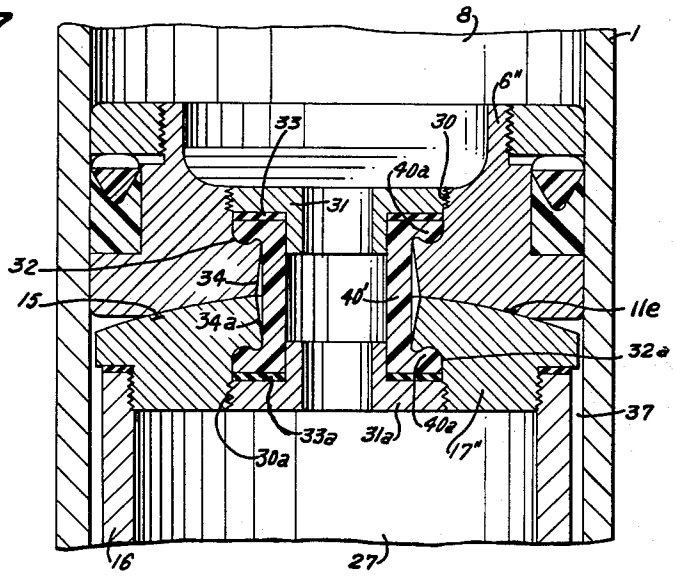
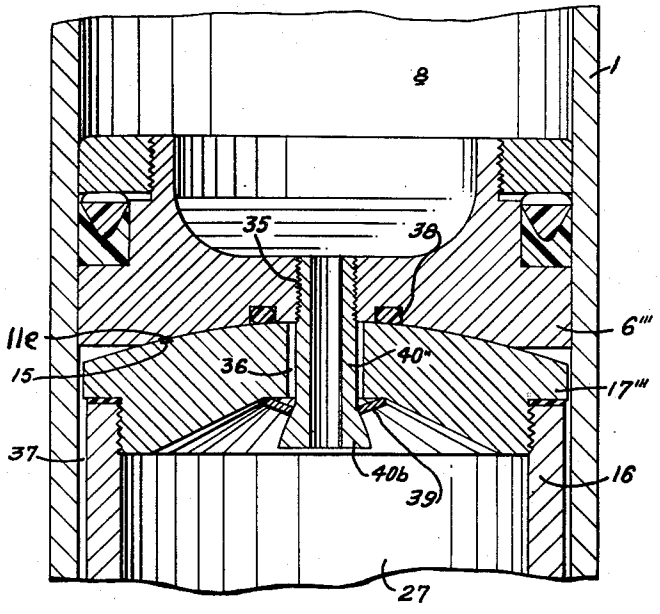


FIG. 8



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3,172,340

HYDRAULICALLY OPERABLE MINE PROP

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Claims priority, application Germany, Feb. 19, 1960, B 56,773
24 Claims. (Cl. 92—117)

This invention relates to mine props, and more specifically to a hydraulically operable mine prop.

The present application is a continuation-in-part application of my copending application Serial No. 88,162, filed February 9, 1961, now abandoned.

In the conventional hydraulically operated mine props, an external prop member serves as a pressure chamber and is longitudinally shiftably guided on an internal prop member closed at its inner end by a piston, said piston engaging the inner wall of the external prop member in sealing relationship. In all hydraulically operated mine props hitherto used in practice, the internal prop member is rigidly connected to the piston.

The conventional mine props of this type have the drawback that, in order to ensure a reliable seal between the external prop member and the internal prop member and to permit an easy slipping of the prop members into and out of each other, six different surfaces of the prop members, partly of considerable dimensions, have to be machined with particular care, and at three places of the mine props the interconnected and telescopically movable prop members must be accurately centered. That is to say, firstly, the piston of the internal prop member must be centered with respect to the inner wall of the external prop member serving as a pressure chamber, and this requires a careful machining of the surfaces of the prop piston and of the inner wall of the external prop member moving on each other. Secondly, the outer wall of the internal prop member must be centered with respect to a guide cap provided at the lower end of the external prop member, and this again requires an accurate machining of the surfaces thereof moving on each other. Thirdly, these known types of props necessitate a careful centering of the prop piston with respect to the inner end of the internal prop member. This means that two further surface portions have to be carefully machined. This treble centering inevitable in the conventional hydraulically operated mine props can only be obtained with the necessary accuracy if precision steel tubes are used which are machine-cut to an accuracy degree of about 5 to 10μ and thus are considerably more expensive than commercial tubes without such a fine machining.

Notwithstanding the double guiding of the telescopically arranged and longitudinally movable prop members by the prop piston and the guide cap provided at the lower end of the external prop member, it cannot be avoided, due to the high ratio of slenderness of the majority of hydraulically operated mine props and their frequently eccentrical stresses, that the internal prop member is canted with respect to the external prop member. Such canting may occur especially when the prop is far extended so that the distance between the places where both these guides are located is correspondingly small. However, the canting of the internal prop member with respect to the external prop member in the known types of props involves the disadvantage that also the prop piston is canted so that the sealing surfaces of the piston are prevented from uniformly engaging the inner wall of the external prop member. This may lead, particularly with the high fluid pressures of, for example, 400 to 500 kg./cm.^{2} prevailing in the pressure chambers of hydraulically operated mine props, to a leakage of the seal between the prop

piston and the inner wall of the external prop member and to a most disadvantageous reduction in the carrying capacity of the props. Moreover, the canting of the internal prop member may entail an irregular wear of the packings provided on the prop piston and a jamming of the latter. Such failure often cannot be remedied in situ, but requires repair in an aboveground or underground repair shop. The relative canting between the external and internal prop members must be apprehended primarily in cases where the prop has to take up—as it is frequently the case in underground mining—not only axial forces, but is also exposed to stresses acting more or less transversely to the longitudinal axis of the mine prop. This is, for example, the case when the prop is employed in a medium steep-angle or steep-angle position and/or serves as an abutment or supporting means for a conveyor or other mining implement.

In literature, proposals have already been made to provide in a hydraulically operable mine prop of particularly large dimensions a support between a piston guided in an external prop member so as to be longitudinally movable therein in sealing relation and a head or foot portion engaging the roof or floor of a seam, which support is mounted in universal joint fashion at both of its ends and is intended to be retained in its axial position with respect to the prop by the force of a resilient restoring element. Due to its particularly high ratio of slenderness, this support serving as an internal prop member has only a very low buckling strength and moreover, has the disadvantage that it is supported but loosely both on the piston of the internal prop member and on the head or foot portion. As the support is connected to the piston of the internal prop member merely by a universal joint and is not laterally displaceable, it will assume, upon a lateral displacement of its outer end connected to the head or foot portion of the prop by the universal joint, a relatively steeply inclined position which results in a correspondingly high buckling stress.

The main disadvantage of this known type of props, however, consists in that the small contact surfaces between the prop piston and the support become increasingly smaller with the increasing inclination angle of the support, so that correspondingly high surface pressures will occur which lead to a permanent deformation of the contact surfaces and destroy the joint connection within a minimum of time, thus rendering the mine prop unserviceable. This prop which has never been used in practice requires, in addition, a resilient mounting and guide for the internal prop member at the lower end of the external prop member, and this adds much to the manufacturing cost. Finally, a prop of this kind is very susceptible to the severe stresses to which it is constantly subjected in underground mining practice.

With respect to the usual hydraulically operated mine props having a rigid connection between the piston and the internal prop member, this known special structure affords, however, the advantage that as compared with the hitherto necessary treble centering, only one centering is required between the inner wall of the external prop member and the prop piston longitudinally movable therein in sealing relationship.

It is the object of the present invention to eliminate the drawbacks of this known hydraulically operable mine prop having its internal prop member connected to the prop piston by means of a universal joint, while retaining all characteristic advantages of this known prop.

This object is achieved by providing a hydraulically operable mine prop which comprises as external prop member closed at one end, an internal prop member projecting into the external prop member, a prop piston supported on the inner end of the internal prop member and sealingly engaging the inner surface of the external prop

member arranged to be longitudinally shiftable on said prop piston and said internal prop member, a plurality of large sliding surfaces provided between said inner end of said internal prop member and said prop piston for connecting said inner end of said internal prop member to said prop piston both in a universal joint fashion and in a laterally displaceable manner to a limited extent, said sliding surfaces contacting each other and said inner end of said internal prop member and said prop piston over an area of substantially constant size irrespective of the inclined position said internal prop member may assume with respect to said prop piston.

It is hereby attained that the internal prop member can be canted with respect to the external prop member as well as laterally displaced to a limited extent, without this relative movement of the internal prop member with respect to the external prop member affecting in any way the position of the prop piston. This important feature affords the advantage that even in cases where the mine prop is subjected to considerable stresses caused by eccentrically acting forces or by forces acting more or less transversely to the longitudinal axis of the prop, the seal between the prop piston and the inner wall of the external prop member is in no way impaired because a canting of the prop piston cannot be effected by such forces. On the contrary, it is achieved that the entire periphery of the prop piston always uniformly sealingly engages the inner surface of the external prop member whereby also irregularities, for example a certain roughness of the inner surface of the external prop member, can be balanced without impairing the seal between the piston and the external prop member. Even if severe mechanical stresses as are inevitable in the rough mining practice have caused a slight permanent deformation of the external prop member, the seal between the external prop member and the piston is practically not affected owing to the connection of the internal prop member to the prop piston as proposed by this invention.

Another advantageous feature afforded by connecting the internal prop member to the prop piston both in a universal joint fashion and in a laterally displaceable manner consists in that even in the case of eccentrically acting forces or forces acting more or less transversely to the longitudinal axis of the prop, the inner prop member will assume a relatively slightly inclined position so that the buckling strength is substantially improved. Of particular importance is the fact that, irrespective of the extent of the actual inclination angle of the internal prop member with respect to the prop piston, these two parts contact each other with permanently equal-sized contact surfaces so that even with a load of, for example 40 to 50 tons, the bearing pressures occurring between the contact surfaces can be kept so small that any permanent deformation of or damage to the contact surfaces is safely prevented.

As in the mine prop proposed by the invention only one centering is required between the inner wall of the external prop member and the prop piston, a much simpler and less expensive manufacture thereof results with respect to the conventional mine props. As, moreover, packings provided on the piston of the internal prop member can compensate any irregularities on the inner wall of the external prop member, the surface thereof need not be finished to such grade as would be required for props having a rigid connection between the prop piston and the internal prop member. Whereas the manufacture of the conventional hydraulically operated mine props is dependent on the use of precision steel tubes having a high-grade smooth surface finish, the mine prop as proposed by the invention can be made of commercially available tubes. Thus, the inner prop member can easily be made of such a commercial tube without any surface machining, whereas the tube used for the external prop member requires but a simple machining of the inner wall in order to ensure a substantially equal inside diameter over the entire length of the tube as well as a fairly smooth surface. To finish

smooth the inner wall of the tube for the external prop member, use may be made, for example, of a mandrel and subsequently, if required, of a plurality of rollers rolling on the inner wall of the external prop tube. A further, particularly cutting machining of the surface of the tube used for the manufacture of the external prop member is not required.

A further advantageous feature of the invention consists in that for the above-mentioned reasons a much less severe standard needs to be applied to the straightness of the tubes used for the manufacture of the internal and external prop members than to that of the tubes of hydraulically operated mine props of conventional type having a rigid connection between the piston and the internal prop member. In the case of the mine prop as proposed by the invention it is possible to accept at a tube length of 1 m. a lateral deviation of, for example, 2 mm. what is within the range of admissible tolerances of commercial tubes, whereas in the past the straightness of the tubes used for hydraulically operated mine props had to meet rather severe requirements, so that these tubes had to be regularly subjected to a refinishing treatment to ensure the maximum possible straightness thereof. Hence it follows that it is necessary for a manufacturer of conventional mine props to furnish himself with tubes having a considerably stronger wall thickness than the final wall thickness actually required in order to make up for the loss in wall thickness caused by the refinishing treatment and to safely ensure a final wall thickness that meets actual stress conditions. As, in the mine prop according to the invention, a metal-cutting refinishing treatment of the tubes can be dispensed with in any case, commercially available tubes may be used the wall thicknesses of which correspond to the final wall thicknesses actually required.

The mine prop as proposed by the invention further contemplates, in contrast to the aforedescribed type of construction, that tubes having a relatively low ratio of slenderness and a sufficient buckling strength may also be used for the internal prop member. Moreover, a guide is provided at the lower end of the external prop member to guide the same on the inner prop member, which guide can be of much simpler construction and can have a correspondingly ampler tolerance. Hereby it is attained that not only an accurate machining of this guide and the outer wall of the internal prop member can be dispensed with but also that even larger permanent deformations of the wall of the internal prop member cannot affect the longitudinal movability of the external prop member.

Suggestions have already been made in literature to connect, in a hydraulically operable mine prop designed for special cases but never put into practice, the inner end of the internal prop member to the prop piston in such a manner that these two parts are allowed to be laterally displaced relatively to each other to an extent lying within the manufacturing tolerances. In this known type of construction, however, a lateral displacement of the internal prop member and the prop piston is intended to be avoided as far as possible by telescopically extensible guide means provided outside the prop tubes. In addition, these telescoped guide means are intended to prevent any canting between the internal prop member and the external prop member. In this construction, the inner end of the internal prop member has a convex configuration and rests on a ball of a relatively small diameter which is mounted in the prop piston so that as a consequence of the very small area of contact between the internal prop member and the piston extremely high bearing pressures will occur which lead within a minimum of time to a permanent deformation of the contact surfaces. This deformation practically eliminates the lateral displaceability of the internal prop member with respect to the prop piston, which displaceability, moreover, is deliberately kept low by the lateral guide means. But even prior to such a permanent deformation of the very small contact surfaces, the lateral displaceability of the internal

prop member with respect to the prop piston is limited by the lateral telescopically extensible guide means to a small extent lying within the manufacturing tolerances of these guide means, and any inclination of the internal prop member with respect to the external prop member is deliberately precluded by these guide means.

In an expedient form of construction of the invention, an intermediate member is mounted for displacement to all sides to a limited extent transversely to the longitudinal axis of the mine prop and connects the inner end of the internal prop member to the prop piston in universal joint fashion.

The use of such an intermediate member enables to construct, in a simple manner a connection both in a universal joint fashion and in a laterally displaceable manner wherein, irrespective of the actual extent of the inclination of the internal prop member with respect to the prop piston, the contact surfaces of the relatively supported parts will remain equal-sized, so that even in the case of particularly severe stresses no permanent deformations of the sliding surfaces can occur.

As a rule, it is recommendable that the intermediate member has an even and a calotte-shaped sliding surface of either convex or concave configuration.

The intermediate member may have an even sliding surface which is laterally shiftable to all sides to a limited extent on a sliding surface of the internal prop member or the prop piston which is disposed transversely to the longitudinal axis of the mine prop.

The intermediate member may have a calotte-shaped sliding surface which is supported on an inversely calotte-shaped sliding surface of the internal prop member, the prop piston or an interposed pressure member.

This pressure member conveniently has on either side calotte-shaped sliding surfaces and may be arranged between the prop piston and the intermediate member or between the inner end of the internal prop member and the intermediate member.

The use of such an intermediate member not only simplifies the manufacture of the fits, but also affords the possibility of making the intermediate member of a material less resistant to compression with respect to the prop piston and the inner end of the internal prop member, so that if the prop should become overloaded with the result of inadmissibly high bearing pressures on the contact surfaces, this material alone will be deformed, without any detrimental effect arising on the sliding surfaces of the internal prop member and the prop piston. Thus, in the case of a possible overloading of the prop, merely the intermediate member needs to be substituted.

The mine prop as proposed by the invention further provides that the sliding surfaces are provided on the internal prop member, the intermediate member, the prop piston, and the pressure member, if any, and, in any inclined position the internal prop member may assume engage each other with substantially equal-sized surface portions corresponding to a substantial portion—for example one half—of the piston diameter. The engaging calotte-shaped sliding surfaces of the intermediate member, of the pressure member, if any, and of the prop piston have, as a rule, equal radii of curvature, so that in any inclined position of the internal prop member with respect to the external prop member and the prop piston guided therein, the contact surfaces between the relatively supported parts will remain of equal size. In this case it is possible to make the calotte-shaped and the even sliding surfaces of such a size that they extend across an essential portion of the piston diameter and no permanent deformations of the contact surfaces can occur even if the prop is subjected to particularly severe strains.

The pressure member which serves to further improve the connection between the prop piston and the internal prop member in a universal joint fashion and in a laterally displaceable manner may have biconvex or double concave sliding surfaces. It is, however, also possible to provide this pressure member with convexo-concave sliding surfaces.

Still another feature of the invention consists in that the prop piston and/or the pressure member and/or the intermediate member and/or the inner end of the internal prop member may be made, entirely or partially, of a synthetic plastic material having a great resistance to compression and a highly smooth surface finish, whereby not only the weight of the prop can be considerably reduced but also the necessity of lubricating the sliding surfaces moving upon each other can be dispensed with.

According to another feature of the present invention, passage means may also be provided between the pressure chamber formed between the piston and the upper closed end of the external prop member and the interior of the internal prop member. In this way substantially the same fluid pressure will be maintained in the pressure chamber and in the interior of the internal prop member, which will act on the upper closed end of the external prop member as well as on the closed bottom end of the internal prop member, so that outside pressures acting on said opposite ends of the mine prop during use of the same in supporting the roof of the mine shaft, will be at least in part taken up directly by the fluid pressure in the interior of the mine prop so that the external as well as the internal prop member will be subjected mainly to bursting pressure. This provides for a considerable improvement over mine props known in the art in which only a small part of the interior of the mine prop is subjected to internal fluid pressure, whereas those parts which are not subjected to internal fluid pressure are subjected to great buckling forces when the mine prop is under load. In such constructions according to the prior art it is necessary to construct at least those parts or portions of the mine prop which are not subjected to internal fluid pressure with cross sections which are relatively large in relation to their length, but mine props according to the present invention may be constructed for the same length and the same load capacity as that of the prior art with smaller cross sectional dimensions, which will result in a lighter construction.

This feature of the present invention in which the pressure chamber and the interior of the internal prop member are connected to each other by passage means, may be used in a mine prop in which the prop piston and the inner end of the internal prop member are connected to each other for limited universal tilting movement relative to each other about a tilting point located at the axis of the internal prop member and for limited movement relative to each other transverse to said axis, as well as in such arrangements in which the prop piston and the inner end of the internal prop member are connected only for universal tilting movement relative to each other. In both arrangements the passage means have to be constructed in such a manner so as not to prevent the aforementioned movements of prop piston and internal prop member relative to each other. Of course, the passage means have also to be constructed in such a manner as to prevent passage of pressure fluid to the exterior of the mine prop.

The passage means according to the present invention preferably include a conduit passing through central bores formed in the prop piston or piston means and through wall means closing the inner end of the internal prop member. The conduit has to be constructed from such material to properly withstand the pressure of the pressure fluid, that is the pressure in the order of 400 to 500 atmospheres, and this conduit has to be arranged with respect to the prop piston and the aforementioned wall means in such a manner as to not prevent the movement of the prop piston relative to the wall means of the internal prop member mentioned above. Preferably the conduit is connected to the prop piston and the aforemen-

tioned wall means in such a manner to assure, even if the arrangement is not under load, that the prop piston will follow any longitudinal movement of the internal prop member when the latter is drawn out of the external prop member.

The conduit means may be made from elastic or flexible material such as rubber or rubber-like plastic and in this case the conduit is preferably armored in known manner to withstand the high pressures it is subjected to. In such construction the flexible or elastic high pressure and armored hose is preferably fluid-tightly connected at opposite ends thereof to the prop piston and the wall means which close the inner end of the external prop member. Preferably the connection is made in such a way that it is releasable and in a preferred construction the conduit and the connecting elements are constructed as a unit and arranged with respect to the other members of the mine prop in such a manner that they can be removed therefrom as a unit when exchange of the conduit means is desired. If a flexible and elastic conduit is used, it is also possible to assemble this conduit with other elements of the arrangement with a certain pretension so that the conduit will tend to press prop piston and the wall means which close the inner end of the internal prop member against each other.

Another advantageous arrangement is to make the conduit from relatively rigid material, preferably from metal or from relatively rigid plastic material. In such an arrangement the rigid conduit has to be arranged and connected to the prop piston and the end wall means at the inner end of the internal prop member in such a manner that the aforementioned relative movement of these members is not impeded, and, of course, the arrangement has to be made in such a manner to prevent undesired escape of pressure fluid from the interior to the exterior of the mine prop. This can be obtained for instance by fluid-tightly connecting the rigid conduit at opposite ends thereof by highly elastic connecting members to the prop piston and to the wall means at the inner end of the internal prop member. In an especially advantageous construction the rigid conduit is rigidly connected at one end thereof either to the piston means or to the aforementioned wall means, whereas the other end portion of this conduit extends with ample clearance through a bore in the other of the means. In this construction it is preferred to provide separate sealing means between the engaging surfaces of the piston means and the wall means which close the inner end of the internal prop member and such sealing means may be in the form of an O-ring located in a groove formed in one of the engaging surfaces. In this arrangement it is also preferred to provide resilient means which press the engaging surfaces of prop piston and the end wall means of the internal prop member against each other to assure a proper seal under all operating conditions that is, also when the mine prop is not under load.

Another possibility to form a proper seal in such an arrangement is to provide sealing bellows from elastically deformable material between that end of the rigid conduit which extends with ample clearance through the prop piston or the aforementioned end wall means bridging the gap between the free end of the rigid conduit and that member through which it extends with ample clearance. It is also possible to form the passage means itself by bellows from elastic material fluid-tightly connected to the prop piston and the end wall means closing the inner end of the internal prop member.

Several preferred embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal section through a hydraulically operated mine prop according to the invention;

FIGS. 2 to 5 are longitudinal sections through four further forms of construction of the mine prop;

FIG. 6 is a longitudinal section through a hydraulically operated mine prop according to the present invention and showing a modification similar to the construction shown in FIG. 1, but differing therefrom by the provision of passage means connecting the interior of the external and the internal prop members;

FIG. 7 is a partial longitudinal section through a different embodiment according to the present invention, likewise showing a passage means connecting the interior of the prop members; and

FIG. 8 is a partial longitudinal section through a further embodiment of such a construction.

With reference now to FIG. 1, an external prop member **1** consisting of a commercial tube is provided at its upper end with a head plate **2** by means of which the upper end of the external prop member **1** is tightly sealed against pressure fluid. In the head plate **2**, on diametrically opposite sides thereof, a fill-up valve **3** and a relief pressure valve **4** are mounted. The relief pressure valve **4** is provided, in addition, with an operating handle **5** with the aid of which it can be opened already before its minimum pressure of response has been reached, so that the relief pressure valve **4** serves at the same time as a pressure-reducing valve.

In the interior of the external prop member **1** a prop piston **6** is arranged and sealingly engages the inner surface of the external prop member. The head plate **2**, the external prop member **1** and the prop piston **6** define a pressure chamber **8** which is sealed by a packing **7** consisting of synthetic plastic material and provided on the prop piston **6**. For adjusting the packing **7**, there serves an adjusting ring **9** threaded on to the prop piston **6**. By means of this adjusting ring a wedge-shaped ring **10** can be forced into the packing **7** whereby to increase the bearing pressure of the packing **7** against the inner wall of the external prop member **1**.

The prop piston **6** is provided on the side remote from the pressure chamber **8** with a recess having a sliding surface **11** which is engaged by the top surface **13** of an intermediate member **12**, this top surface likewise being constructed as a sliding surface. The opposite surface **14** of the intermediate member **12** is calotte-shaped and of concave configuration and has a radius of curvature corresponding to that of the likewise calotte-shaped but convex top surface **15** of an end piece **17** mounted on the inner end of an internal prop member **16** on which the external prop member **1** is longitudinally shiftable.

The end piece **17** is provided with an outer thread and screwed into an inner thread provided at the inner end of the internal prop member **16** and is supported on the latter with its border zones forming a shoulder protruding beyond the internal prop member **16** so that the end piece **17** can transmit compressive forces to the internal prop member **16** substantially without stressing the thread. A screw bolt **18** passing through the end piece **17** and the intermediate member **12** and threaded into the prop piston **6** serves to connect the prop piston **6** with the inner end of the internal prop member **16** with a limited axial and radial play. Onto the lower end of the external prop member **1** there is threaded a guide member **19** which has a tolerance considerably ampler than that of conventional guides of hydraulically operated mine props and can thus surround the internal prop member **16** with a slight radial play.

The internal prop member **16** has at its lower end a prop base **20** welded thereto.

In the form of construction illustrated in FIG. 2, a prop piston **6***a* has a convex sliding surface **11***a* facing the internal prop member **16**. An intermediate member **12***a* having a calotte-shaped concave sliding surface **13***a* of like radius of curvature engages therewith the sliding surface **11***a*, whereas, on the side facing the internal prop member **16**, it has an even sliding surface

14*a* which in turn bears against a likewise even sliding surface 15*a* provided in a recess of an end piece 17*a*. The internal prop member 16 is detachably coupled to the prop piston 6*a* by means of the screw bolt 18 with a slight axial and radial play. The screw bolt 18 passes through bores provided in the end piece 17*a* and the intermediate member 12*a*, the diameter of these bores being greater than the diameter of the screw bolt 18.

The form of construction illustrated in FIG. 3 shows a pressure member 21 which is disposed between a sliding surface 11*b*, provided in a recess of a prop piston 6*b*, and a concave sliding surface 13*b* provided on an intermediate member 12*b*. This pressure member 21 has on one side a convex sliding surface and on the other side a concave sliding surface, the radii of curvature of both sliding surfaces being conformed to the countersurfaces of the prop piston 6*b* and the intermediate member 12*b*, respectively.

In the form of construction illustrated in FIG. 4, a prop piston 6*c* has a concave sliding surface 11*c* facing the internal prop member 16. An intermediate member 12*c* also has a concave sliding surface 13*c* facing the prop piston 6*c*. Between these two sliding surfaces 11*c* and 13*c* there is disposed a pressure member 22 having biconvex sliding surfaces.

The form of construction illustrated in FIG. 5 shows convex sliding surfaces 11*d* and 13*d* of a prop piston 6*d* and an intermediate member 12*d*, respectively, which bear against double concave sliding surfaces of an interposed pressure member 23.

As shown in the forms of construction illustrated in FIGS. 3, 4 and 5 each of the prop pistons 6*b*, 6*c* and 6*d* is detachably coupled to an end piece 17*b*, 17*c* and 17*d*, respectively, of the internal prop member 16 with a limited axial and radial play. To this end, in all forms of construction shown, the screw bolt 18 is screwed into the prop piston in such a manner that both the end piece and the intermediate member as well as the pressure member, if any, are guided by the screw bolt with a limited radial play.

In all cases where, contrary to the embodiment shown in FIG. 1, the pressure fluid is fed into the pressure chamber 8 of the mine prop not from outside, but from a reservoir provided in the interior of the internal prop member 16, the screw bolt 18 may serve as a pressure fluid conduit connecting the pressure chamber 8 with the interior of the internal prop member 16 constructed as a reservoir. To this end, the screw bolt 18 may, for example, be constructed as a tube and connect the pressure chamber 8 with the interior of the internal prop member 16, suitable valves being incorporated in the tube.

The guide member 19 mounted on the lower end of the external prop member 1 to guide the same on the internal prop member 16 has so ample a tolerance that the internal prop member 16 can be canted by at least about 2 to 3°, but preferably more degrees, in relation to the longitudinal axis of the external prop member 1, and this will cause the calotte-shaped sliding surfaces provided between each of the prop pistons 6, 6*a*, 6*b*, 6*c* and 6*d* and the internal prop member 16 to be displaced relatively to each other. The ample tolerance of the guide member 19 also permits a transverse displacement of the internal prop member 16 parallel to the longitudinal axis of the mine prop. This lateral displacement is limited by the play of the intermediate member 12 in the recess of the prop piston 6 or of the intermediate members 12*a*, 12*b*, 12*c* and 12*d* in the recesses of the end pieces 17*a*, 17*b*, 17*c* and 17*d*. The lateral displaceability of the intermediate members and of the pressure members, if any, can be limited by the limitation of the radial play thereof on the screw bolt 18. The lateral displaceability may, for instance, amount to 2 to 3 mm. to all sides and is so chosen that it is in any case greater than the lateral distance between the end pieces 17, 17*a*, 17*b*, 17*c* or 17*d* and the inner surface of the external prop member 1.

The intermediate members 12, 12*a* 12*b*, 12*c* and 12*d* and the pressure members 21, 22 and 23 may consist of synthetic plastic materials having a high resistance to compression and a high-grade smooth surface finish. Use may be made particularly of thermoplastic or thermoelastic hard synthetic materials having a low elastic deformability, a high resistance to wear and good anti-friction properties, i.e. a low coefficient of friction. Typical representatives of this kind of synthetic plastic materials are the hard polyamides. Such hard synthetic plastic materials have a high resistance to compression, a high modulus of elasticity and a high softening or fusing temperature. Principally, all synthetic plastic materials may be used which are employed in the manufacture of bearing bushings and gear wheels.

It is also possible to make the whole prop piston of a synthetic plastic material having a high resistance to compresison and a high-grade smooth surface finish, whereas the packing 7 is made of a synthetic plastic material hava greater capacity for elastic deformation and, nevertheless, good wear properties. The end pieces 17, 17*a*, 17*b*, 17*c* and 17*d* of the internal prop member 16 may also be made of such a synthetic plastic material having a high resistance to wear and a high-grade smooth surface finish.

FIG.6 shows an arrangement similar to that shown in FIG. 1 and differing therefrom only in that the connecting means which connect the prop piston with the inner end of the external prop member include passage means providing communication between the pressure chamber formed in the external prop member above the prop piston and the interior of the internal prop member. The general arrangement of the mine prop shown in FIG. 6 has been described before in connection with FIG. 1 and repetition of this description seems therefore superfluous. It is mentioned that such parts or elements of the arrangement shown in FIG. 6 which are identical with those shown in FIG. 1 have been provided with the same reference numerals whereas such parts which have been slightly modified in the arrangement shown in FIG. 6 have been provided with reference numerals which are the same as used in FIG. 1 to which, however, a prime has has been added.

In the construction shown in FIG. 6 the piston means 6′, 12′ are universally tiltable about a pivot point located at the axis of the internal prop member 16 and also shiftable to a limited extent in a direction transverse to this axis with respect to the end wall means 17′ which close the inner end of the internal prop member 16 in the same manner as the arrangement shown in FIG. 1. The connecting means shown in FIG. 6, which connect the piston means 6′, 12′ to the end wall means 17′ for simultaneous movement in axial direction with each other include passage means which provide communication between the pressure chamber 8 formed in the external prop member 1 above the piston means and the interior of the internal prop member 16.

The passage means are provided by a conduit 40, constructed as an elastic high pressure hose formed from rubber or rubber-like plastic material and preferably armored to withstand the high pressure the arrangement is subjected to, which extend through axially aligned bores 29, 26, 28 respectively formed in the prop piston 6′, the intermediate member 12′, and the end wall 17′ closing the inner end of the internal prop member 16. The outer diameter of the conduit 40 is considerably smaller than the diameter of the aforementioned bores and the upper end of the conduit 40 is held in the bore of the prop piston 6′ by a substantially tubular connecting member 24 provided at its upper end with an external screw thread engaged by a nut member 23, which when tightened will press the radially extending flange at the lower end of the connecting member 24 against a shoulder formed in the stepped bore 29 through the piston 6′. Preferably, a

sealing member 25 is sandwiched between the upper face of the radially extending flange on the member 24 and the shoulder face on the prop piston 6'. The lower end of the conduit 40 is connected to the end wall 17' by a substantially tubular connecting member 22 provided at its inner end with an external screw thread screwed into a corresponding internal screw thread formed in the surface of the bore 28 extending axially through the end wall 17'. The connecting member 22 is preferably formed at its lower end with a radially outwardly projecting flange having an upper annular surface facing a corresponding annular surface on the end wall 17' and a sealing member 21 is preferably sandwiched between these two annular surfaces. The upper and lower ends of the conduit 40 are fluid-tightly connected to the tubular connecting member 24 and 22, respectively, by cementing or by vulcanizing. Conduit 40 and connecting members 22 and 24 thus form a single unit and since the diameters of the bores 26, 28 through members 12' and 17' are made to the same size as the maximum diameter of the connecting member 24 this unit may be removed without disassembly from the arrangement by simply unscrewing the nut member 23.

The arrangement shown in FIG. 7 differs from all of the previously described arrangements in that in this modification the prop piston 6'' directly engages the end wall 17'' which closes the inner end of the internal prop member 16. Piston 6'' and end wall 17'' engage each other along spherical faces 6*a* and 15 respectively formed on the prop piston 6'' and the end wall 17''. These spherical faces are of equal radical curvature which is considerably greater than half the diameter of the piston 6'' and these spherical surfaces 11*e* and 15 extend in a direction transverse to the longitudinal axis of the internal prop member a distance at least half of the diameter of the prop piston 6'' so that the prop piston 6'' and the end wall 17'' abut against each other along relatively very great faces extending substantially transverse to the axis of the prop so that the specific surface pressure on these faces when the prop is used to support the roof of a mine shaft are relatively small, while the prop piston 6'' and the end wall 17'' on the inner end of the internal prop member 16 may universally tilt with respect to each other to a limited extent. The construction shown in FIG. 7 provides also for communication between the pressure chamber 8 above the prop piston 6'' and the interior 27 of the internal prop member 16.

The elastic high pressure hose 40', which may be made from the same material as described in connection with the embodiment shown in FIG. 6, is formed in the modification shown in FIG. 7 at opposite ends thereof with radially outwardly extending beads 40*a* which are respectively fluid-tightly connected to the prop piston 6'' and the end wall 17''. For this purpose serve tubular connecting members 31 and 31*a* provided at flange portions thereof with outer screw threads and respectively engaging with internal screw threads formed in bores 30 and 30*a* respectively formed through the prop piston 6'' and the end wall 17'' so as to press the beads 40*a* of the conduit or high pressure hose 40 against annular surfaces 32 and 32*a* formed according to the form of the beads 40*a* in the prop piston 6'' and the end wall 17''. Preferably, annular sealing members 33 and 33*a* are sandwiched between the beads 40*a* and the engaging flange portions of the connecting members 31 and 31*a*. The portions 34 and 34*a* of the bores through the prop piston 6'' and the end wall 17'', which surrounds the portion of the conduit 40' between the beads thereof are conically enlarged toward the surfaces 11*e* and 15, respectively, to permit universal tilting movement of prop piston 6'' relative to end wall 17'' and relative shifting of these two members with respect to each other during such tilting movement without impediment of such movement by the conduit 40'. The prop piston 6'' and the end wall 17'' of the internal prop member are thus connected for limited universal tilting movement and for simultaneous movement in longitudinal direction, while the pressure chamber 8 and the interior 27 of the internal prop member communicate with each other and while escape of pressure fluid from the pressure chamber 8 or the interior 27 of the internal prop member into the space 37 between the outer surface of the internal prop member and the inner surface of the external prop member 1 is positively prevented. While FIG. 7 shows only a part of the mine prop, it is understood that the external prop member 1 is closed at the upper end as shown in FIGS. 1 and 6 and provided at its lower end with a guide member 19, whereas the lower end of the external prop member is closed by a plate 20 as likewise shown in the aforementioned figures.

The modification shown in FIG. 8 is similar to the modification shown in FIG. 7 in that in the modification illustrated in FIG. 8 the prop piston 6''' engages with the end wall 17''' on the inner end of the internal prop member 16 along spherically curved faces 11*e* and 15 which are constructed in the same manner as the corresponding spherical faces described in connection with FIG. 7, but the modification shown in FIG. 8 differs from that shown in FIG. 7 in that the conduit 40'' which provides communication between the pressure chamber 8 above the prop piston 6''' and the interior 27 of the internal prop member 16 is in the form of a rigid conduit 40'' which is preferably made from metal. In order not to impede universal tilting movement of prop piston 6''' and end wall 17''' relative to each other, the rigid conduit 40'' is screwed at its upper end into a threaded bore 35 formed through the prop piston 6''' whereas the lower portion of the conduit 40'' extends with ample all around clearance through a bore 36 formed through the end wall 17'''. Escape of pressure fluid through bore 36 in the end wall 17''' and between the spherical surface 11*e* and 15 into the annular space 37 between the outer surface of the internal prop member 16 and theinner surface of the external prop member 1 is prevented by annular sealing means 38 between the spherical surfaces 11*e* and 15. The annular sealing means 38 is preferably formed as an O-ring inserted in an annular groove formed as shown in the prop member 6'''. Of course it is also possible to arrange the annular sealing means 38 in a groove extending from the spherical surface 15 into the end wall 17'''.

The embodiment shown in FIG. 8 preferably includes also a resilient means for pressing the spherical faces 11*e* and 15 against each other and to compress thereby the O-ring 38 in the groove formed in the prop piston 6'' or in the end wall 17'''. In the construction illustrated in FIG. 8 the resilient means are in the form of a spring washer 39 which is slightly cupped and which engages with the outer peripheral edge the bottom face of the end wall 17''' around the bore 36 therethrough, whereas the inner peripheral edge of the spring washer 39 engages a head 40*b* formed on the bottom end of the conduit 40'' which extends beyond the bore 36. In the assembled arrangement the spring washer 39 is under tension to press thereby the spherical surfaces 11*e* and 15 against each other, to assure a proper seal and prevention of escape of pressure fluid from the pressure chamber 8 or the interior 27 of the external prop member in the annular space 37 between the outer surface of the internal prop member 16 and the inner surface of the external prop member 1.

Of course, the arrangement shown in FIG. 8 may also be reversed and the conduit 40'' could be screwed with a lower end thereof into a corresponding threaded bore formed in the end wall 17''', in which case the upper portion of the conduit would have to extend with clearance through an enlarged bore formed in the prop piston 6''', whereas the spring washer 39 would be located between the enlarged head 40*b*, extending in this case upwardly beyond the prop piston 6''' and the latter.

The prop pistons and the end walls at the inner end

of the external prop member in the embodiment shown in the FIGS. 6–8 may be formed from steel or any appropriate plastic material which combines great mechanical strength with small elastic deformability with resistance against oil, acid and aging. Plastic materials of such characteristics can for instance be found in the plastic materials of the polyamide group.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. Thus, the conduit means shown in FIG. 6 may also be used in the general arrangement illustrated in FIGS. 7 and 8 in which the intermediate member **12'** shown in FIG. 6 is omitted and which the prop piston and the end wall on the inner end of the internal prop member directly engage each other along spherically curved surfaces. Correspondingly, the conduit means as illustrated in FIGS. 7 and 8 may also be used in the general arrangement as shown in FIG. 6. In the constructions shown in FIGS. 1–5 a spring washer, as shown in FIG. 8, may be located between the head of the screw **18** and the bottom face of the end wall closing the inner end of the internal prop member. The thus modified constructions illustrated in FIGS. 1–5 would provide a resilient connection between prop piston and internal prop member. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

I claim:

1. A hydraulic mine prop comprising, in combination, an external tubular prop member having an axis and being closed at one end; an internal prop member having an end portion projecting with clearance into said external prop member and being movable towards and away from said closed end of said external prop member; a prop piston at the inner end of said internal prop member and sealingly engaging the inner surface of said external prop member to form therewith between said piston and said closed end a pressure chamber; connecting means for connecting said piston and said inner end of said internal prop member for simultaneous movement toward and away from said closed end and for limited universal tilting movement relative to each other; and means for feeding pressure fluid into and out of said pressure chamber.

2. A hydraulic mine prop comprising, in combination, an external tubular prop member having an axis and being closed at one end; an internal tubular prop member closed at opposite ends and having an end portion projecting with clearance into said external prop member and being movable towards and away from said closed end of said external prop member; a prop piston at the inner end of said internal prop member and sealingly engaging the inner surface of said external prop member to form therewith between said piston and said closed end a pressure chamber; connecting means for connecting said piston and said inner end of said internal prop member for simultaneous movement toward and away from said closed end and for limited universal tilting movement relative to each other about a tilting point located at said axis and including passage means for connecting said pressure chamber with the interior of said internal prop member; and means for feeding pressure fluid into and out of said pressure chamber.

3. A hydraulic mine prop comprising, in combination, an external tubular prop member having an axis and being closed at one end; an internal prop member having an end portion projecting with clearance into said external prop member and being movable towards and away from said closed end of said external prop member, said internal prop member including at said end portion end wall means facing said closed end of said external tubular prop member; piston means supported on said end wall means of said internal prop member and sealingly engaging the inner surface of said external prop member to form therewith between said piston means and said closed end of said external prop member a pressure chamber, said end wall means and said piston means engaging each other along spherical surfaces so that said internal prop member may universally tilt to a limited extent with respect to said piston and with respect to said external prop member, said spherical surfaces having equal radii of curvature greater than the radius of the peripheral surface of said piston means and at least one of said spherical surfaces extending in direction transverse to said axis a distance greater than half of the diameter of said piston means; connecting means for connecting said piston means and said end wall means for simultaneous movement toward and away from said closed end of said external prop member while permitting limited universal tilting movement of said piston means and said end wall means relative to each other about a tilting point located at said axis; and means for feeding pressure fluid into and out of said pressure chamber.

4. A hydraulic mine prop comprising, in combination, an external tubular prop member having an axis and being closed at one end; an internal prop member having an end portion projecting with clearance into said external prop member and being movable toward and away from said closed end of said external prop member; a prop piston at the inner end of said internal prop member and sealingly engaging the inner surface of said external prop member to form therewith between said piston and said closed end a pressure chamber; connecting means for connecting said piston and said inner end of said internal prop member for simultaneous movement toward and away from said closed end and for universal tilting movement relative to each other about a pivot point located at said axis as well as for limited movement relative to each other transverse to said axis; and means for feeding pressure fluid into and out of said pressure chamber.

5. A hydraulic mine prop comprising, in combination, an external tubular prop member having an axis and being closed at one end; an internal prop member having an end portion projecting with clearance into said external prop member and being movable toward and away from said closed end of said external prop member; a prop piston at the inner end of said internal prop member and sealingly engaging the inner surface of said external prop member to form therewith between said piston and said closed end a pressure chamber; connecting means for connecting said piston and said inner end of said internal prop member for simultaneous movement toward and away from said closed end and for universal tilting movement relative to each other about a pivot point located at said axis as well as for limited movement relative to each other transverse to said axis; guide means at the other end of said external prop member for guiding said other end on the outer surface of said internal prop member, said guide means surrounding said internal prop member with clearance; and means for feeding pressure fluid into and out of said pressure chamber.

6. A hydraulic mine prop comprising, in combination, an external tubular prop element having an axis and being closed at one end; an internal prop member having an end portion projecting with clearance into said external tubular prop element and being movable toward and away from said closed end of the latter; a piston member located adjacent the inner end of said internal prop member and sealingly engaging the inner surface of said internal prop element to form therewith between said piston member and said closed end a pressure chamber; at least one abutment plate sandwiched between said internal prop member and said piston member and having a substantially plane surface extending transverse to said axis and a spherically curved surface extending transverse to said axis and one of said members being formed with a plane surface engaging said plane surface of said abutment plate

and the other of said members having a spherically curved surface engaging said spherically curved surface of said abutment plate; means connecting said members and said abutment plate for simultaneous movement toward and away from said closed end while permitting limiting sliding movement of said surfaces relative to each other in direction transverse to said axis so that said internal prop member may tilt and may move transversely to a limited extent with respect to the axis of said external tubular prop element; and means for feeding pressure fluid into and out of said pressure chamber.

7. An arrangement as defined in claim 6 in which said abutment plate is at least in a portion thereof engaging one of said members formed of a synthetic plastic material having a great resistance to compression and a high-grade smooth surface finish.

8. An arrangement as defined in claim 6 in which at least one of said members is at least in a portion thereof engaging said abutment plate formed of a synthetic plastic material having a great resistance to compression and a high-grade smooth surface finish.

9. A hydraulic mine prop comprising, in combination, an external tubular prop element having an axis and being closed at one end; an internal prop member having an end portion projecting with clearance into said external tubular prop element and being movable toward and away from said closed end of the latter; a piston member located adjacent the inner end of said internal prop member and sealingly engaging the inner surface of said external prop element to form therewith between said piston member and said closed end a pressure chamber, one of said members being formed at a portion thereof facing the other of said members with a cavity having a plane end surface transverse to said axis and a peripheral surface; at least one abutment plate sandwiched between said internal prop member and said piston member and being located in said cavity, said abutment plate having a plane surface engaging said plane end surface of said cavity and having opposite said plane surface a spherically curved surface extending transverse to said axis and the other of said members having a spherically curved surface engaging said spherically curved surface of said abutment plate, said abutment plate having a peripheral surface spaced from said peripheral surface of said cavity; means connecting said members and said abutment plate for simultaneous movement toward and away from said closed end while permitting limiting sliding movement of said surfaces relative to each other in direction transverse to said axis so that said internal prop member may tilt and may move transversely to a limited extent with respect to the axis of said external tubular prop element; and means for feeding pressure fluid into and out of said pressure chamber.

10. A hydraulic mine prop comprising, in combination, an external tubular prop element having an axis and being closed at one end; an internal prop member having an end portion projecting with clearance into said external tubular prop element and being movable toward and away from said closed end of the latter; a piston member located adjacent the inner end of said internal prop member and sealingly engaging the inner surface of said external prop element to form therewith a pressure chamber, one of said members being formed at a portion thereof facing the other of said members with a cavity having a plane end surface transverse to said axis and a peripheral surface; a first abutment plate located in said cavity and having a plane surface engaging said plane end surface of said cavity and having opposite said plane surface a spherically curved surface and a peripheral surface spaced from said peripheral surface of said cavity; a second abutment plate sandwiched between said first abutment plate and the other of said members, said second abutment plate having a pair of spherically curved surfaces extending transverse to said axis, one of which engages said spherically curved surface of said first abutment plate and the other of said members being formed with a spherically curved surface extending transverse to said axis and engaging the other spherically curved surface of said second abutment plate; means connecting said members and said abutment plates for simultaneous movement toward and away from said closed end while permitting limiting sliding movement of said surfaces relative to each other in direction transverse to said axis so that said internal prop member may tilt and may move transversely to a limited extent with respect to the axis of said external prop element; and means for feeding pressure fluid into and out of said pressure chamber.

11. An arrangement as defined in claim 10 in which both of said spherically curved surfaces of said second abutment plate are curved in the same direction.

12. An arrangement as defined in claim 10 in which said spherically curved surfaces of said second abutment plate are both convexly curved.

13. An arangement as defined in claim 10 in which said spherically curved surfaces of said second abutment plate are both concavely curved.

14. A hydraulic mine prop comprising, in combination, an external tubular prop member having an axis and being closed at one end; an internal tubular prop member having an end portion projecting with clearance into said external prop member and being movable toward and away from said closed end of said external prop member, said internal prop member including end wall means fixed to said end portion thereof and being closed at the end opposite said end portion; piston means supported on said end wall means of said internal prop member and sealingly engaging the inner surface of said external prop member to form therewith between said piston means and said closed end of said external prop member a pressure chamber; connecting means for connecting said piston means and said end wall means of said internal prop member for simultaneous movement toward and away from the closed end of said external prop member and for limited universal tilting movement relative to each other, said connecting means including passage means for providing communication between said pressure chamber and the interior of said internal prop member; and means for feeding pressure fluid in and out of said space formed by the communicating pressure chamber and the interior of said internal prop member.

15. An arrangement as defined in claim 14 in which said passage means include conduit means fluid-tightly connected at opposite ends thereof to said end wall means and to said piston means.

16. An arrangement as defined in claim 15 in which said conduit means are made from elastic material.

17. An arrangement as defined in claim 14 in which said passage means include an elastic high pressure hose formed at opposite ends thereof with beads fluid-tightly connected to said piston and said end wall means, respectively.

18. An arrangement as defined in claim 14 in which said piston and said end wall means are formed with stepped axial bores therethrough forming in said bores shoulders respectively facing away from each other, in which said passage means include an elastic high pressure hose formed at opposite ends thereof with beads projecting radially outwardly and abutting against said shoulders, respectively, and including pressure means releasably connected to said piston and said end wall means, respectively, for fluid-tightly pressing said beads against said shoulders.

19. An arrangement as defined in claim 14 in which said passage means include a substantially rigid tube, preferably formed from metal.

20. An arrangement as defined in claim 19 and including sealing means cooperating with said piston means and said end wall means for preventing escape of pressure fluid through any space between said last mentioned means.

21. An arrangement as defined in claim 19 in which said piston means and said end wall means engage each other along spherical surfaces and including annular sealing means coaxial with said rigid tube and located between said surfaces.

22. An arrangement as defined in claim 21 and including resilient means for pressing said spherical surfaces against each other.

23. An arrangement as defined in claim 1 in which said

connecting means connects said piston and said inner end of said internal prop member detachable from each other.

24. An ararngement as defined in claim 4 in which said connecting means include passage means for providing communication between said pressure chamber and the interior of the internal prop member.

No references cited.