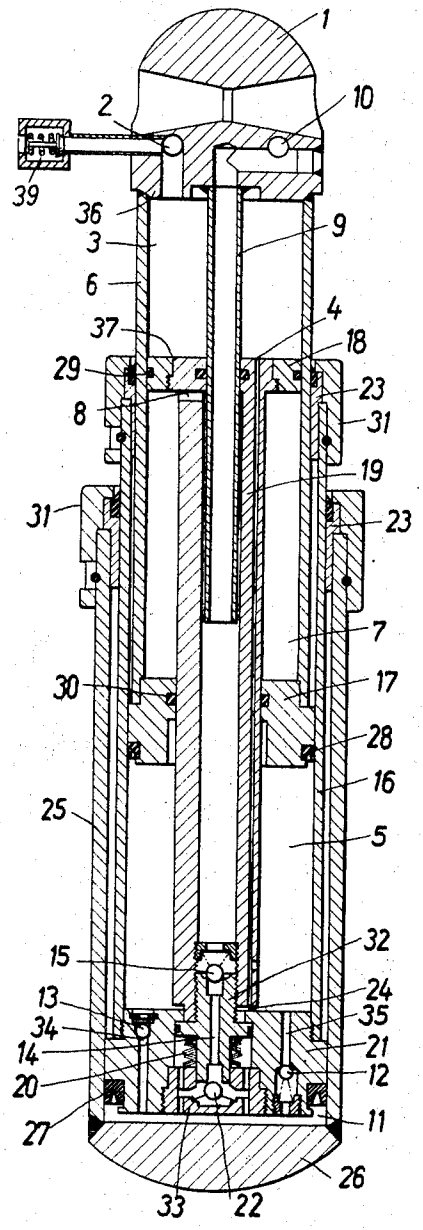
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MULTISTAGE HYDRAULIC MINE PROP

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MULTISTAGE HYDRAULIC MINE PROP

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ABSTRACT OF THE DISCLOSURE

A multistage nine prop comprising at least three telescopically arranged tube sections movable with respect to each other between a collapsible and an extended position, passage means communicating with the interior of the tube sections for feeding pressure fluid into and out of the same to move the section between the positions thereof, and fluid operated means cooperating with the section of smallest diameter for moving the latter prior to the other sections from the collapsed to the extended position during extension of the mine prop, and from the extended to the collapsed position during removal of the prop and for moving the next largest tube section prior to the smallest tube section during partial collapse of the mine props on the load.

The present invention relates to a multistage hydraulic mine prop with at least three telescopic tube sections, in which the tube section with the largest diameter forms the bottom member of the prop, in which the tube section with the smallest diameter is closed at the upper end thereof by a cap member adapted to engage during use of the mine prop the roof of a mine gallery or the like, and in which the various stages of the mine prop are provided respectively with effective surfaces which are acted upon by fluid when the prop is extended in response to admission of hydraulic fluid into the tube sections, the cross sectional areas of the effecting surfaces of the various stages being substantially the same so that the prop offers substantially constant resistance to stresses which tend to contract the same. The mine prop is also provided with cylinder means into which hydraulic fluid under pressure is adapted to be fed from the exterior thereinto in order to cause collapse of the mine prop. Such mine props are known int he art and for instance disclosed in the U.S. Patent 3,241,801 to Wilkenloh et al.

It is an object of the present invention to improve a mine prop of the aforementioned type.

More specifically, it is an object of the present invention to provide a mine prop of the aforementioned type in which during extension of the mine prop, for use of the same for supporting the roof of a mine gallery, the tube section with the smallest diameter is extended under all circumstances first before the tube section with the next largest diameter is extended and that during desired collapse of the mine prop during robbing the same, the tube section with the smallest diameter is positively first withdrawn over its whole length into the tube section of the next largest diameter before the last mentioned tube section is moved to its collapsed position. Furthermore, the mine prop according to the present invention is to be constructed in such a manner that during partial collapse of the mine prop under load, the tube section with the next larger diameter starts to move first to the collapsed position before the tube section with the smallest diameter moves to the collapsed position thereof. This will assure that even if the mine prop is partially collapsed under the influence of the external load, the smallest tube section

can always be withdrawn by the withdrawal cylinder connected thereto when removal of the mine prop is desired.

This sequence of movement of the various tube sections during movement of the mine prop between the collapsed and the extended position thereof is not assured under all circumstances in the above-mentioned mine prop according to the prior art, due to the frictional forces which act on the tube sections during movement thereof relative to each other.

It is therefore the main object of the present invention to overcome this advantage of mine props of the aforementioned construction known in the art.

It is also an object of the present invention to provide for such a mine prop which is simple in construction and which will act trouble-free over an extended period of time.

With these objects in view, the multistage mine prop according to the present invention mainly comprises at least three telescopically arranged tube sections movable with respect to each other between a collapsed and an extended position, passage means communicating with the interior of the tube sections for feeding pressure fluid into and out from the sections so as to move the same between the aforementioned positions thereof, and fluid operated means cooperating with the tube section of smallest diameter and constructed and arranged in such a manner so as to move the tube section of smallest diameter prior to the other sections from the collapsed to the extended position during mounting of the prop in a mine gallery and from the extended to the collapsed position during removal of the prop.

The tube section with the smallest diameter, which during use of the prop is the uppermost section, has preferably a cap member fixed to and closing the upper end of the section and closure means are fixed to the lower end of each section. The closure means of each tube section, except the tube section with the largest diameter, are formed by pistons respectively guided in the tube section of the next largest diameter.

The fluid-operated means connected to the tube section of smallest diameter include preferably a supporting piston in the tube section of smallest diameter between the cap member at the upper end and the piston at the lower end thereof. The supporting piston forms with the tube section of smallest diameter and the cap member a first pressure chamber and between the supporting piston and the piston at the lower end of the tube section of the smallest diameter a second pressure chamber. An intermediate tube section having a diameter larger than that of the smallest diameter tube section forms between the piston connected to its lower end and the piston connected to the tube section of smallest diameter a third pressure chamber and the tube section of the largest diameter forming between its closure means and the piston of the intermediate tube section a fourth pressure chamber. The aforementioned passage means being connected to the pressure chambers for feeding during desired movement of the smallest diameter tube section from the extended to the collapsed position thereof pressure fluid into the second pressure chamber and for discharging pressure fluid from the first and third pressure chamber, and for feeding pressure fluid into the first and third pressure chamber and for discharging pressure fluid from the second pressure chamber during desired movement of the smallest diameter tube section from the collapsed to the extended position thereof. The prop includes further connecting means connecting the supporting piston to the piston of the intermediate tube section and first valve means for automatically separating the fourth pressure chamber from the third pressure chamber during movement of the tube section of smallest diameter

to the collapsed position thereof to prevent outflow of pressure fluid from the fourth pressure chamber.

According to a further feature of the present invention, the prop includes also means cooperating with the aforementioned first valve means for opening the latter to permit outflow of pressure fluid from the fourth pressure chamber after the smallest diameter tube section has moved to its fully collapsed position.

Preferably, the prop includes also second valve means cooperating with the fourth pressure chamber for preventing, during movement of the smallest diameter tube section from the collapsed to the extended position, flow of pressure fluid into the fourth pressure chamber until the tube of smallest diameter has moved to the fully extended position thereof and the second valve means are constructed to open and permit the flow of pressure fluid into the fourth pressure chamber after the tube section of smallest diameter has moved to its fully extended position.

The prop may also include additional valve means cooperating with the fourth pressure chamber and constructed for preventing outflow of pressure fluid therefrom before said second valve means is opened to permit flow of pressure fluid into the fourth pressure chamber and for permitting flow of pressure fluid out of the fourth pressure chamber during movement of the smallest diameter tube section to the collapsed position thereof.

The means connecting the supporting piston to the piston of the intermediate tube section are preferably movable in axial direction with respect to the piston of the intermediate tube section and the connecting means are constructed and cooperate with the additional valve means for controlling the latter.

The aforementioned connecting means preferably include a hollow piston rod and the piston of the tube section of smallest diameter is preferably slidably guided on the hollow piston rod.

The passage means for feeding pressure fluid into and out of the various pressure chambers are preferably formed in part by a tube connected at the upper end thereof to the cap member and telescopically extending into the hollow piston rod. The passage means include further an additional passage extending longitudinally through the piston rod and providing communication between the first and the third pressure chamber.

The first, second and additional valve means are preferably arranged in the piston at the lower end of the intermediate tube section.

The mine proper according to the present invention has not only the advantage of the above-mentioned mine prop according to the prior art, that is that the prop will offer a substantially constant resistance to stresses which tend to contract the same, but the mine prop according to the present invention has also the advantage that, during desired collapse of the mine prop for removing the same from the mine gallery, the tube section of smallest diameter may always be withdrawn into the remaining tube sections, regardless whether the mine prop has already been moved under the load acting thereon to a partially collapsed position.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which the single figure is an axial cross section through the mine prop according to the present invention.

Referring now to the drawing, in which a two-stage telescopic mine prop is illustrated, it will be seen that this mine prop comprises three tube sections **6**, **16** and **25** of successively larger internal diameter which are telescopically arranged with respect to each other. The tube section **25** with the largest diameter forms in use of the mine prop the bottom section. Each of the tube sections is provided at the lower end thereof with closure means and the closure means of the tube section **25** of largest diameter is in the form of a base plate **26** welded to the lower edge of the tube section **25** and having a curved bottom surface, whereas the closure means of the tube sections **16** and **6** are respectively formed by pistons **21** and **17**. The piston **21** fixedly connected to the lower end of the intermediate tube section **16** is provided with an annular sealing means **27** engaging the inner surface of the tube section **25** and the piston **21** is guided in the tube section **25**. The piston **17** connected to the lower end of the tube section **6** of smallest diameter is guided in the tube section **16** and sealed against the inner surface of the latter by means of a sealing ring **28**. A cap member **1** is fixed to the upper end of the tube section **6** of smallest diameter and closes the upper end thereof.

The mine prop according to the present invention includes further a supporting piston **18** arranged between the cap member **1** and the piston **17** in the interior of the tube section **6** and guided on the inner surface of the latter. An annular seal **29** on the supporting piston **18** seals the outer surface of the latter with respect to the inner surface of the tube section **6**. The supporting piston is connected by means of a hollow piston rod **19**, extending centrally through the piston **17**, to the piston **21** of the tube section **16** in such a manner that the piston rod **19** may move to a limited extent in axial direction with respect to the piston **21**. The annular piston **17** is slidably guided on the piston rod **19** and sealed with respect to the latter by an annular seal **30**. A bushing **23** on the upper end of the tube section **16** serves for sealing and guiding the tube section **16** and a corresponding bushing **23** is arranged at the upper end of the tube section **25**. The two bushings **23** are secured in position by cap members **31** respectively connected in any convenient manner to the upper ends of the tube sections **16** and **25**.

The tube section **6** forms between the cap member **1** and the supporting piston **18** a first pressure chamber **3** and between the supporting piston **18** and the piston **17** connected to the lower end of the tube section **6** a second pressure chamber **7**. The tube section **16** forms between the piston **17** and the piston **21** connected to the lower end of the tube section **16** a third pressure chamber **5**, whereas the tube section **25** forms between the piston **21** and the base plate **26** connected to the lower end of the tube section **25** a fourth pressure chamber **11**. The pressure chamber **3** is connected by means of a passage **4** which extends in longitudinal direction through the piston rod **19** with the third pressure chamber **5**.

The pressure chamber **7** between the pistons **17** and **18** forms a withdrawal cylinder cooperating with the tube section **6** of smallest diameter to move the same to the collapsed position when such movement is desired. The pressure chamber **7** communicates by means of a transverse bore **8** through the wall of the hollow piston rod **19** with the interior of the latter. The cap member **1** is provided with bores **2** and **10** for feeding pressure fluid into and out from the aforementioned pressure chambers whereby a tube **9** is fixedly connected to the inner end of the bore **10** and the tube **9** is sealingly guided through the supporting piston **18** and extends with clearance into the interior of the hollow piston rod **19**.

The piston **21** is formed with a pair of bores **34** and **35** extending in axial direction therethrough and flow of fluid through the bores **34** and **35** is controlled by one-way valves **12** and **13** respectively arranged in the aforementioned bores. The one-way valve **12** and **13** are constructed and arranged to respectively open in opposite directions.

The valve **12** controls flow of pressure fluid into the pressure chamber **11** and the valve **12** is constructed and arranged in such a manner that during movement of the prop to the extended position flow of pressure fluid into the pressure chamber **11** is prevented until the tube sec-

tion 6 with the smallest diameter has moved to its fully extended position, whereupon pressure in the pressure chamber 5 increases and the valve 12 is opened when this pressure surpasses the pressure of the spring cooperating with the valve member 12 and tending to hold the latter in the closed position.

The valve 13, on the other hand, is constructed to prevent outflow of pressure fluid from the pressure chamber 11 during desired collapse of the mine prop until the tube section 6 has been moved to the fully collapsed position, after which the valve 13 automatically opens as will be explained later on to permit outflow of pressure fluid from the pressure chamber 11.

Additional valve means in form of a double valve are arranged centrally in the piston 21 and the valve closing members of this double valve comprise the spherical valve members 15 and 22. The seats of the valve members 15 and 22 are formed on opposite ends of a member 32 fixedly connected by means of a screw thread or the like to the lower end of the piston rod 19 and provided with a central bore 14 adapted to communicate with the interior of the hollow piston rod 19. Spring means 20, preferably in the form of a plurality of superimposed spring washers, are arranged between a lower shoulder face of the member 32 and the upper surface of a plug member 33 fixedly connected to the piston 21, by being for instance screwed into a central bore in the piston.

The valve 22 is constructed and arranged to close, during mounting of the mine prop and movement of the tube sections to the extended position, the bore 14 to prevent outflow of pressure fluid from the pressure chamber 11, before the valve 12 opens to permit passage of pressure fluid into the pressure chamber 11 through the bore 35, and the valve 22 is arranged also in such a manner that during desired collapse of the mine prop the valve 22 will automatically open again to permit outflow of pressure fluid from the pressure chamber 11.

The supporting piston 18, which is axially movable relative to the piston 21, serves in a manner as will be explained later on in detail as control member for the valve 22. The hollow piston rod 19 is for this purpose movable against the action of the spring 20 under the influence of the fluid pressure acting on the supporting piston in such a manner that the valve 22 is brought to the closed position thereof, whereas during relief of the spring 20, the valve 22 is maintained in the open position.

The above-described mine prop will operate as follows:

During movement of the mine prop and movement of the tube sections from the collapsed to the extended positions thereof, pressure fluid is fed through the bore 2 in the cap member 1 into the pressure chamber 3 and through the passage 4 also into the pressure chamber 5. Thereby, the tube section 6 is moved to the extended position and during this movement the pressure chamber 7 is connected through the transverse bore 8 and the tube 9 to the bore 10 in the cap member, which during this part of the operation is connected either to the atmosphere or to a reservoir receiving the fluid thus permitted to leave the pressure chamber 7.

During this part of the operation, the pressure chamber 11 is hydraulically separated by the valves 12 and 13 from the pressure chambers 5 and 3 and, through the passage 14 and the one-way valve 15, connected with the return flow bore 10 so that no hydraulic pressure will be developed in the pressure chamber 11 and so that the intermediate tube section 16 will at this time not be moved to the extended position thereof.

After the tube section 6 has been moved to the fully extended position relative to the tube section 16, that is after the piston 17 has engaged the bottom end of the bushing 23, the pressure in the pressure chambers 3 and 5 connected to the pressure fluid feed line will increase to cause thereby movement of the supporting piston 18 in downward direction against the force of the spring 20 so that the ball valve 22 will close. During further increase of the fluid pressure in the pressure chamber 3, the piston rod 19 will engage with its shoulder 24 the upper surface of the piston 21. The pressure chamber 11 is now separated from the bore 10 connected to the return conduit. During further increase of the fluid pressure in the pressure chambers 3 and 5, the ball valve 12 will open against the force of the valve spring connected thereto and liquid will pass from the pressure chamber 5 into the pressure chamber 11 to cause thereby movement of the tube section 16 to the extended position after, as mentioned above, the tube section 6 has already been moved to its fully extended position.

During robbing of the mine prop and movement of the tube sections from the extended to the collapsed positions, the bore 10 in the cap member is connected, by known means not shown in the drawing, to a supply of liquid under pressure so that pressure fluid will pass through the bore 10, the tube 9 and the transverse bore 8 into the pressure chamber 7. At the same time, the bore 2 in the cap member 1 is connected by not shown means to a return flow conduit so that pressure fluid in the pressure chambers 3 and 5 may be discharged from these pressure chambers.

During this part of the operation, the pressure chamber 11 is separated from the return conduit by the closed one-way valves 12, 13 and 15. Due to the pressure in the pressure chamber 7 the tube section 6 will be moved to the collapsed position as long as pressure fluid is fed into the pressure chamber 7, whereby pressure fluid in the pressure chamber 5 will pass through the passage 4 into the pressure chamber 3 and from there through the bore 2 into the return conduit.

When the tube section 6 of smallest diameter has moved to its innermost position while feeding of pressure fluid into the pressure chamber 7 is further maintained, then the valve 13 will open so that pressure fluid in the pressure chamber 11 may pass through the pressure chamber 5 and 3 although in the return conduit. Opening of the valve 13 is accomplished in this case due to the engagement of the bottom face 36 of the cap member 1 with the top face 37 of the supporting piston 18, occurring when the tube section 6 is moved to its fully collapsed position, so that as the pressure in the pressure chamber 7 acts to move the cap member downwardly, the supporting piston 18 and the piston 21 connected thereto are likewise moved downwardly, increasing thereby the fluid pressure in the pressure chamber 11 beyond that in the pressure chamber 5 connected to the return conduit to thereby cause opening of the valve member 13, that is movement of the latter in upward direction relative to its valve seat.

During relief of fluid pressure in the pressure chambers 3 and 5, the force of the spring 20 will cause again upward movement of the piston 18 and the piston rod 19 connected thereto to the position shown in the drawing so that the valve 22 will be reopened for mounting the valve prop again in a mine gallery.

When the mine prop is under axial load, the valve 13 will be held open under the liquid pressure in the pressure chamber 11 so that the pressure chambers 3, 5 and 11 will communicate with each other. A pressure relief valve 39 is arranged in the cap member 1 or, as shown in the drawing, connected outside the cap member with the bore 2, such that the pressure relief valve will open when the prop is subjected to excessive force so that pressure fluid in the pressure chamber 3, 5 and 11 may escape therefrom and so that the prop will move under the load to a partly collapsed position. The surfaces of the pistons of the various stages of the mine prop on which the pressure fluid acts are dimensioned in such a manner that during partial collapse of the prop under load, that is during opening of the pressure relief valve, the intermediate tube section 16 moves first to its collapsed position. Only after the tube section 16 has been moved under

the load to the fully collapsed position, as shown in the drawing, will the tube section 6 start to move inwardly. This will assure that during robbing of the prop, the tube section 16 can still be withdrawn under the influence of pressure fluid fed into the pressure chamber 7.

The pistons 17 and 21 and the fluid responsive elements, that is, valves 12, 13, 15, 22 and present relief valve 39 constitute therefore moving means cooperating with the tube section 6 of smallest diameter for moving the latter prior to the other sections from the collapsed to the extended position during extension of the time prop and from the extended to the collapsed position during removal of the prop, and for moving the next largest tube section, that is, the section 16, prior to the tube section 6 during partial collapse of the mine prop under load.

If, for some reason whatsoever, for instance during assembly of the mine prop, the pressure chamber 11 should be filled with liquid so that during erecting of the mine prop the maximum adjustability of the smallest tube section 6, that is contact of the piston 17 with the bushing 23 should not be present, then the pressure in the pressure chambers 3 and 5 will cause movement of the intermediate tube section 16 in downward direction into the pressure chamber 11, since the pressure chamber is connected via the passage 14 and the one-way valve 15 with the return flow 10 until the piston 17 engages the bottom end of the bushing 23, respectively, until the prop is adjusted for the maximum possible adjustability between the smallest diameter tube section 6 and the intermediate tube section 16.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of multistage hydraulic mine props differing from the types described above.

While the invention has been illustrated and described as embodied in a multistage hydraulic mine prop, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A multistage mine prop, comprising, in combination, at least three telescopically arranged tube sections movable with respect to each other between a collapsed and extended positions; passage means communicating with the interior of said tube sections for feeding pressure fluid into and out from said sections to move the same between said positions thereof; and moving means including fluid responsive elements, said moving means cooperating with the section of smallest diameter for moving the latter prior to the other sections from said collapsed to said extended position during extension of the mine prop and from said extended to said collapsed position during removal of said prop, and for moving the next largest tube section prior to said smallest tube section during partial collapse of said mine prop under load.

2. A multistage mine prop as set forth in claim 1, wherein the tube section with the smallest diameter, which during use of the prop is the uppermost section, has a cap member fixed to and closing the upper end of said section, and including closure means at the lower end of each section, the closure means of each tube section, except the tube section with the largest diameter, being formed by a piston guided in the tube section of the next largest diameter.

3. A multistage mine prop as set forth in claim 2, wherein said fluid-operated means include a supporting piston in the tube section of smallest diameter between said cap member at the upper end and said piston at said lower end thereof, said tube section of smallest diameter forming between said cap member and said supporting piston a first pressure chamber and between said supporting piston and said piston at the lower end of the tube section of smallest diameter a second pressure chamber, an intermediate tube section having a diameter larger than that of the tube section of smallest diameter forming between the piston connected to its lower end and the piston connected to the smallest diameter tube section a third pressure chamber and the tube section of the largest diameter forming between its closure means and the piston of the intermediate tube section a fourth pressure chamber connecting means connecting said supporting piston to the piston of said intermediate tube section, said passage means communicating with said first, second and third pressure chambers, during desired movement of the tube section of smallest diameter from said extended to the collapsed position thereof, for feeding pressure fluid into said second pressure chamber and for discharging pressure fluid from said first and third pressure chambers, and during desired movement of said smallest diameter tube section from said collapsed to said extended position thereof, for feeding pressure fluid into said first and third pressure chambers and for discharging pressure fluid from said second pressure chamber; and first valve means for automatically separating said fourth pressure chamber from said third pressure chamber during movement of said tube section of smallest diameter from the extended to the collapsed position thereof to prevent outflow of pressure fluid from said fourth pressure chamber.

4. A multistage mine prop as set forth in claim 3 and including means cooperating with said first valve means for opening said first valve means to permit outflow of pressure fluid from said fourth pressure chamber after the smallest diameter tube section has moved to its fully collapsed position.

5. A multistage mine prop as set forth in claim 3, and including second valve means cooperating with said fourth pressure chamber for preventing, during movement of said smallest diameter tube section from said collapsed to said extended position, flow of pressure fluid into said fourth pressure chamber until said smallest diameter tube section has moved to the fully extended position thereof, said second valve means being constructed to open and to permit flow of pressure fluid into said fourth pressure chamber after said tube section of smallest diameter has moved to its fully extended position.

6. A multistage mine prop as set forth in claim 5, and including additional valve means cooperating with said fourth pressure chamber and constructed for preventing outflow of pressure fluid therefrom prior to the opening of said second valve means and flow of pressure fluid into said fourth pressure chamber, and for permitting flow of pressure fluid out of said fourth pressure chamber during movement of said smallest diameter tube section to said collapsed position thereof.

7. A multistage mine prop as set forth in claim 6, wherein said connecting means connect said support piston to said piston of said intermediate tube section movable in axial direction, and wherein said connecting means are constructed for controlling said additional valve means.

8. A multistage mine prop as set forth in claim 7, wherein said connecting means include a hollow piston rod, and wherein said piston of the tube section of smallest diameter is slidably guided on said hollow piston rod.

9. A multistage mine prop as set forth in claim 8, wherein said passage means is formed in part by a tube connected at the upper end thereof to said cap member and telescopically extending into said hollow piston rod,

said tube being adapted to be connected through a bore in said cap member alternatively to a source of pressure fluid and to a fluid return conduit.

10. A multistage mine prop as set forth in claim **9**, wherein said passage means include a passage extending longitudinally through the piston rod and providing communication between said first and said third pressure chamber.

11. A multistage mine prop as set forth in claim **9**, and including spring means between said piston rod and said piston connected to said intermediate tube section, said spring means being biased to move said piston in downward direction relative to said piston rod, said additional valve means being arranged at the lower end of said hollow piston rod in such a manner that said additional valve means is closed when fluid pressure acting on said supporting piston is greater than the pressure of said spring means and so that said additional valve means is opened when said fluid pressure is smaller than the pressure of said spring means.

12. A multistage mine prop as set forth in claim **6**, wherein said first, said second, and said additional valve means are arranged in the piston connected to the lower end of said intermediate tube section.

13. A multistage mine prop as set forth in claim **12**, wherein said first and said second valve means are one-way valves means arranged in passages through the piston connected to said intermediate tube section, said one-way valves opening in opposite directions.

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