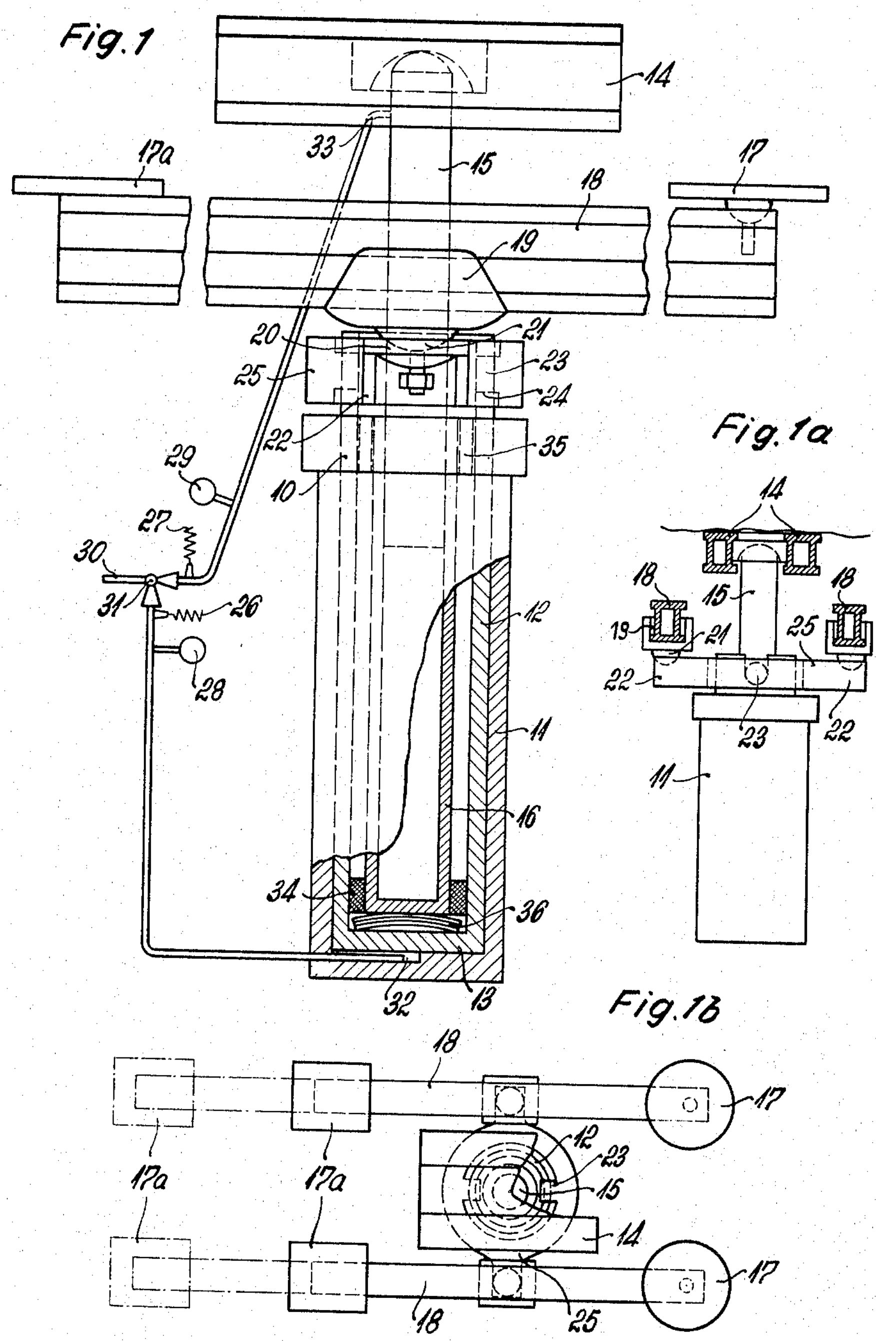
March 5, 1968 K. M. GROETSCHEL 3,371,901

SUPPORT

Filed Aug. 25, 1964 5 Sheets-Sheet 1



INVENTOR:
Karl Maria Groetschel
By: Spencer & Kaye
Attorneys

March 5, 1968 K. M. GROETSCHEL 3,371,901

SUPPORT

Filed Aug. 25, 1964 5 Sheets-Sheet 2

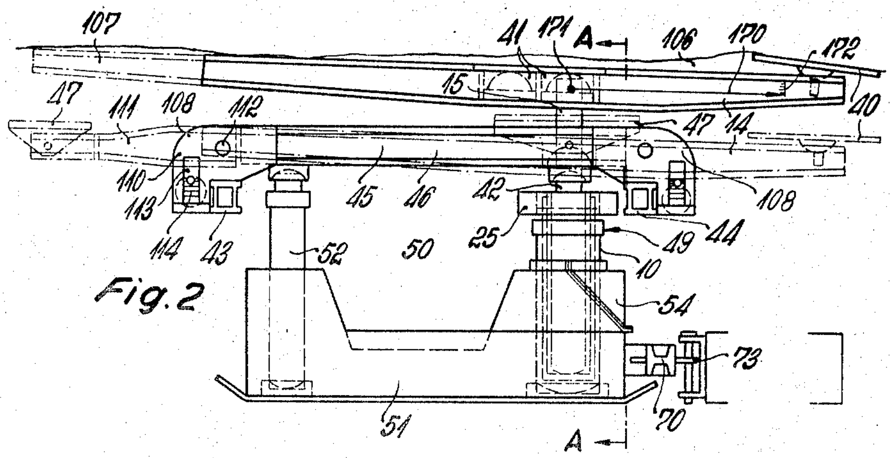


Fig.2

Fig.2b

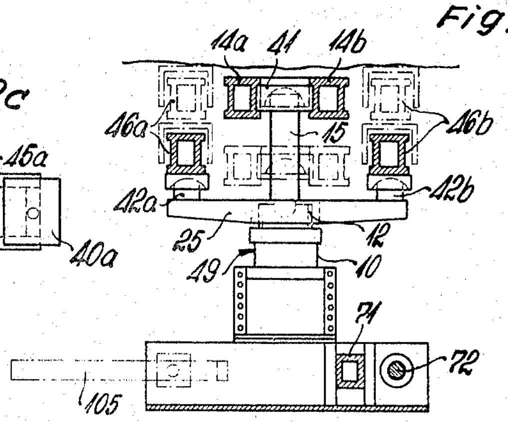


Fig.2c

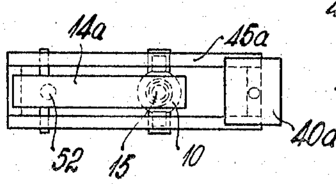
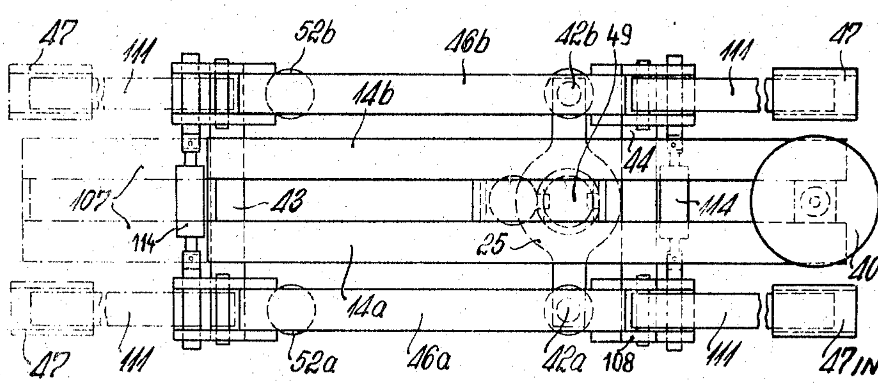


Fig.2a



INVENTOR:
Karl Maria Groetschel
By: Spencer & Kaye
Attorneys

SUPPORT

Filed Aug. 25, 1964

Fig. 3

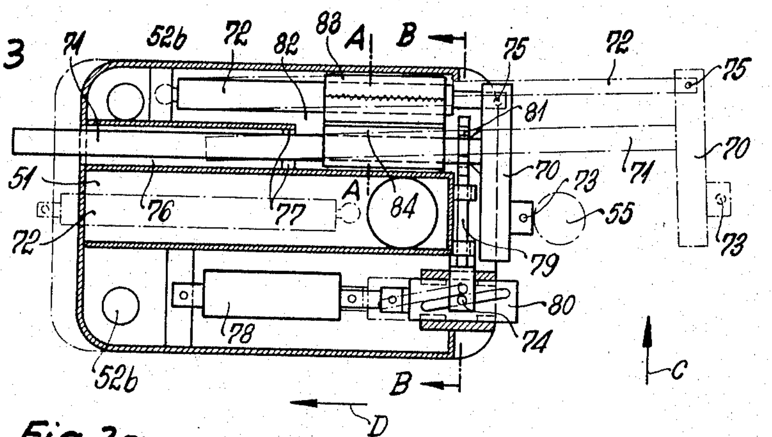


Fig. 3a

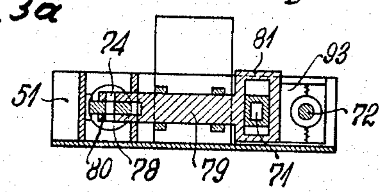


Fig. 4a

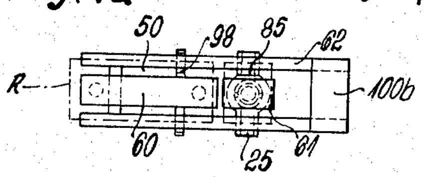


Fig. 4b

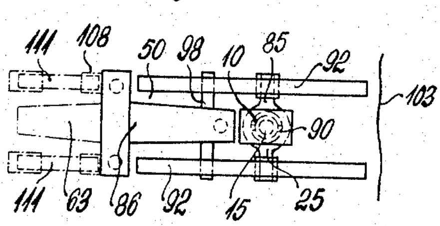


Fig. 4c

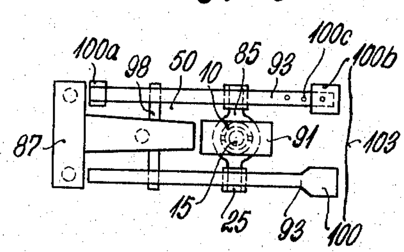


Fig. 4d

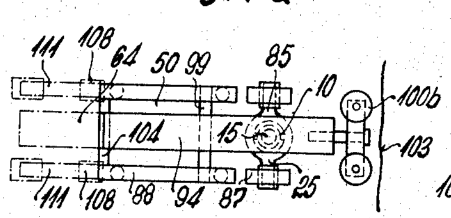
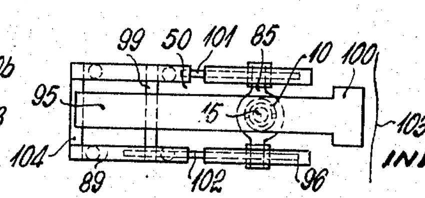


Fig. 4e



INVENTOR:

Karl Maria Groetschel

By: Spencer & Kaye

Attorneys

Fig. 5

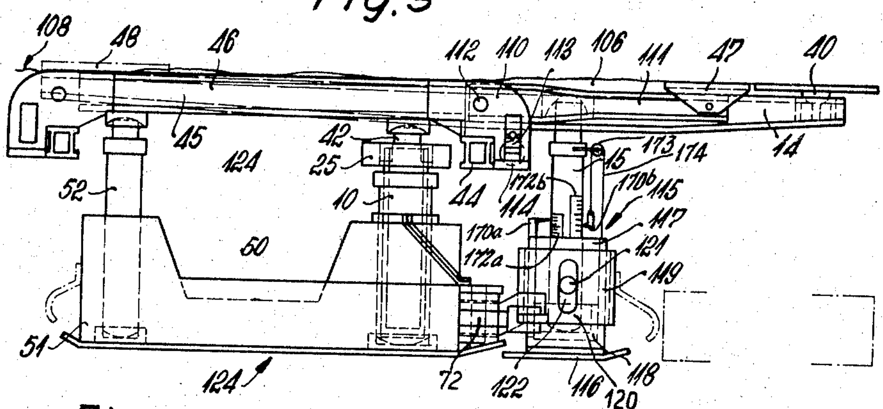


Fig. 5a

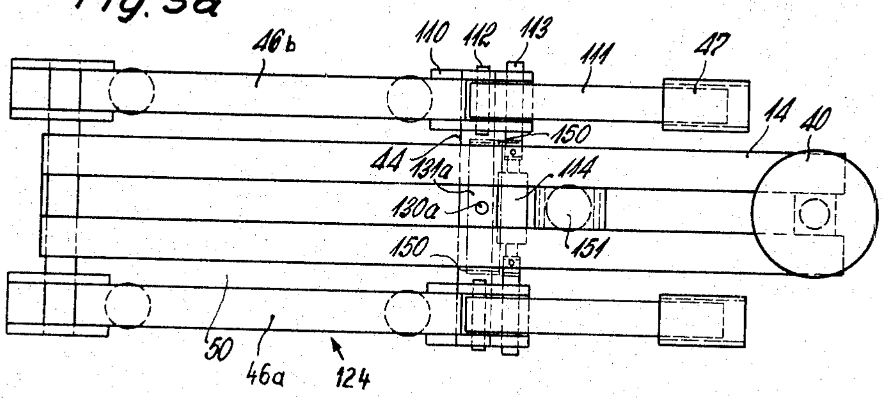
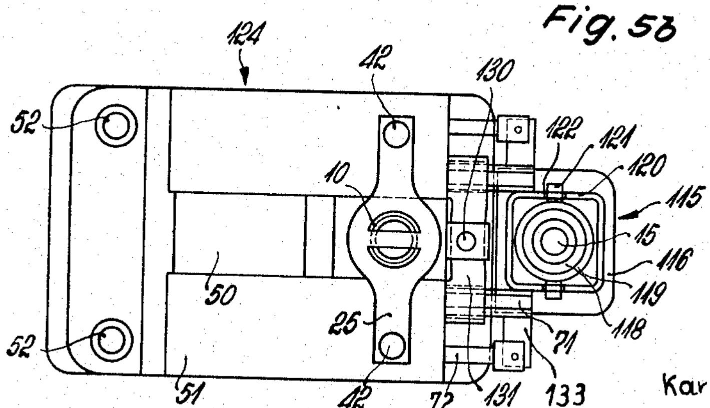


Fig. 5b



INVENTOR:
Karl Maria Groetschel
By: Spencer & Kaye
Attorneys

March 5, 1968 K. M. GROETSCHEL 3,371,901

SUPPORT

Filed Aug. 25, 1964 5 Sheets-Sheet 5

Fig. 5c

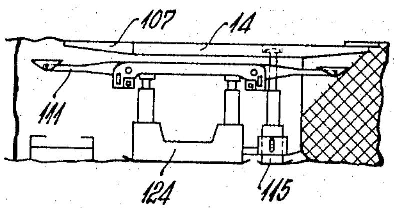


Fig. 5d

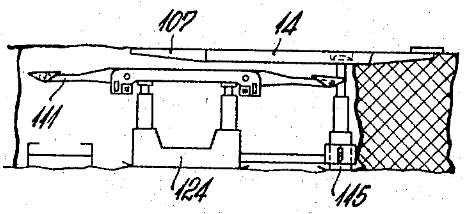


Fig. 5e

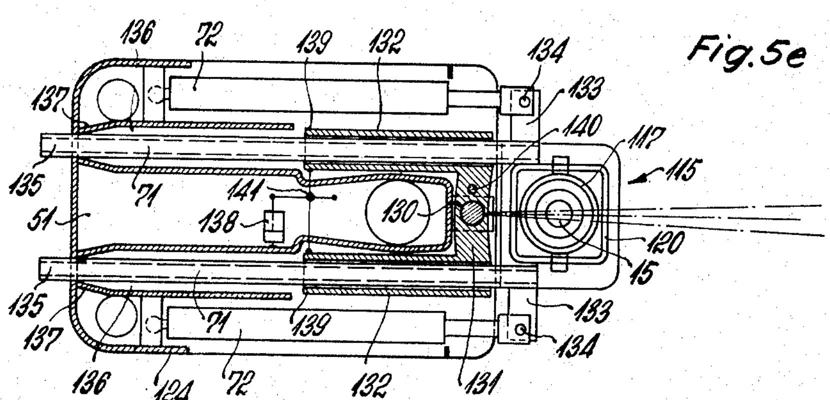
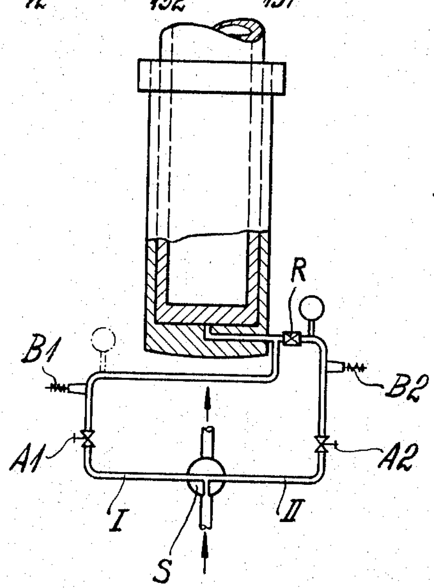


Fig. 6



INVENTOR:
Karl Maria Groetschel
By: Spencer & Kaye
Attorneys

# United States Patent Office

3,371,901

Patented Mar. 5, 1968

1

3,371,901
SUPPORT

Karl M. Groetschel, Stolzestrasse 44, Bochum, Germany

Continuation-in-part of application Ser. No. 322,606, Nov. 12, 1963. This application Aug. 25, 1964, Ser. No. 392,002

Claims priority, application Germany, Aug. 29, 1963, G 38,575; June 29, 1964, G 40,953; Austria, May 14, 1964, A 4,234/64

31 Claims. (Cl. 248—354)

TABLE OF CONTENTS

This application is a continuation-in-part of my application Serial No. 322,606, filed Nov. 12, 1963.

INTRODUCTION

The present invention relates generally to the support art, and, more particularly, to a method as well as to devices for supporting the roof of a mine in underground mining operations.

It is a main object of the invention to provide supporting possibilities for supporting the roof above the area of a mining operation under all imaginable conditions and in a manner basically improved over previous methods and supporting devices.

Another object of the invention is to provide for support of a mine roof under unfavorable rock and mountain conditions and to control the roof under those conditions which exist in connection with the caving system of mining as well as under those conditions which exist when mining with artificial gobbing.

A further object of the invention is to provide for the support of a mine roof in which adjustment can be made not only to those roof conditions which generally change from seam to seam but also to those roof conditions which occur more or less strongly differentiated during one mining operation and which often change in a surprising manner.

Still a further object of the invention is to provide for the above-noted adjustment in a simple manner which can be carried out at the same place and which, if at all possible, is sensitive.

These objects and others ancillary thereto are accomplished in accordance with preferred embodiments of the invention wherein the supporting power of a supporting element which forms a component of the support assembly made up of several such elements is arranged to be made effective upon a roof in a locally and/or timewise differentiated manner to correspond with the differences in roof conditions. This can be accomplished by selecting one or several arrangements which are combined.

One of these means which the operator can use and which shall be referred to as "means I" in the following is a hydraulic support which is capable of being effective upon the roof chronologically as well as locally and with a setting load distribution which is variable and selectively different to a large extent. This can be accomplished because the support includes two coaxially arranged hydraulic props which are telescoped with respect to each other. The piston of an external prop of an open hollow piston has a weaker internal prop inserted into it and concentrically therewith. Each of the two props is provided with a girder frame of its own. The two telescoped props can have pressure exerted thereupon, first one, then the other, and the succession can be varied and is capable of being selected at will. The pressure medium which is used has the same inlet pressure, and the two props can be effective upon the roof with different setting load distributions.

2

Another means which can be used by itself or in conjunction with means I will be designated "means II" below. Means II includes a roof support which can be a single prop and which is preferably a section of an assembly of props, is adjusted or set to a high setting load which preferably extends up to its normal load. The roof support is first set with a setting load which is indicated by a stationary pressure gauge provided at this roof support. This setting load is disposed below its maximum setting load at a suitable instant which can be selected as desired, and with a further step-wise adjustment corrections with respect to the initial setting load can be made, these corrections being necessary considering roof conditions.

In this latter case, there is also provided a device which can be a spring element for delaying or retarding the pressure build-up in the prop cylinder. Such a device would be used in the case of firm or solidly reacting rock. In addition or in combination with the above-mentioned retarding element an arresting device can be used which is adjustable to a certain pressure in the prop cylinder and which becomes effective when this pressure is attained. This device can also be turned off and it influences the supply of pressure medium and can be of any suitable construction, and will be referred to as a setting load limiting device.

BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects and advantages of the present invention will become apparent upon consideration of the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a diagrammatic side elevational view partly in section of a coaxial support.

FIGURE 1*a* is a diagrammatic front view of the device of FIGURE 1, also partly in section.

FIGURE 1*b* is a schematic plan view of the device illustrated in FIGURE 1.

FIGURE 2 is a side diagrammatic sectional view of a three-leg support assembly including the coaxial support illustrated in FIGURE 1.

FIGURE 2*a* is a plan view of the structure illustrated in FIGURE 2.

FIGURE 2*b* is a view partly in section, taken substantially along the plane defined by reference A—A of FIGURE 2.

FIGURE 2*c* is a plan view on a reduced scale of an embodiment of a support assembly which is somewhat modified with respect to that of FIGURE 2.

FIGURE 3 is a horizontal sectional view of a three-leg support assembly of the type illustrated in FIGURE 2 and having an advancing device and a direction control device.

FIGURE 3*a* is a sectional view taken substantially along the plane defined by reference line B—B of FIGURE 3.

FIGURE 4*a* is a diagrammatic plan view of an embodiment of a two-section support assembly.

FIGURE 4*b* is a diagrammatic plan view of a further embodiment of a two-section support assembly.

FIGURE 4*c* is a diagrammatic plan view of a support assembly embodiment somewhat modified from that illustrated in FIGURE 5*b*.

FIGURE 4*d* is a plan view of a similar assembly which can be moved in a dragging or pendulous manner.

FIGURE 4*e* is a schematic plan view of a similar embodiment which is somewhat modified with respect to FIGURE 4*d*.

FIGURE 5 is a schematic side elevational view of a further embodiment of an assembly which can be moved in a pendulous manner.

FIGURE 5*a* is a plan view in which only the upper structural elements of the entire assembly of FIGURE 5 are shown.

FIGURE 5*b* is a plan view of the assembly illustrated in FIGURE 5 but with the upper structural elements removed.

FIGURES 5*c* and 5*d* are reduced side elevational views of the assembly of FIGURE 5 illustrating it in two different phases of use.

FIGURE 5*e* is a plan view partly in section of a somewhat modified embodiment and illustrating the advancing and direction control assemblies.

FIGURE 6 is a schematic view of an embodiment of the automatic setting load limiting device.

GENERAL CONSIDERATION OF THE INVENTION

Before considering the drawings in detail, it should be noted that the support which can be employed by itself as well as in conjunction with an identical device or with other hydraulic supports and/or support assemblies and which comprises the two coaxially telescoped hydraulic props can, if desired, also be used individually. They are generally of approximately the same length. The external prop will be designated as the "E-prop" in the following. It can be set to have a setting load which surpasses the hydraulic normal load of the inner prop which hereinafter will be designated as the "I-prop." This "I-prop" is carried in the cup-shaped hollow piston of the "E-prop." Each one of the two props, which are combined in as narrow a space as possible because of their coaxial arrangement, is effective against the roof together with its assigned girder element which is independent from the girder element of the other prop, and thus each has a range of effectiveness all its own which is demarcated with respect to the effective range of the other prop.

Preferably, at least one of the girder elements of the two props, be it the one for the I-prop or the one for the E-prop, is constructed to be a single or double longitudinal girder extending in the direction of the strike. While the girder element of the I-prop will generally be of one piece, it is possible when using the coaxial support as single support to make the girder element of the E-prop likewise of one piece. In this case it encompasses the girder element of the I-prop with a certain amount of play. It is also possible to fashion this E-prop girder element of two portions which are independent of each other. This latter arrangement has the special advantage that the supporting effect of the total support system is extended still further. In the latter case, each partial girder rests, suitably via a cup-shaped socket, on one of the two arms of a yoke-like intermediate girder. This intermediate girder is shaped, in its center portion, like a frame or a ring and is provided with a free space or perforated at that center portion. This yoke, in turn, is pivotably mounted on the upper edge of the hollow piston of the E-prop at right angles to the longitudinal direction of the girder elements. This mounting is accomplished by means of internally projecting lugs or pins which are rotatable in recesses at the E-prop and which do not prevent the I-prop, which is erected within the E-prop, from extending through the above-mentioned free space in the yoke-shaped intermediate girder.

The new coaxial prop support provides a supporting device which can be adjusted to a supporting capacity which corresponds to the total supporting capacity of a plurality of hydraulic props having conventional supporting effect. Without requiring substantially more space than such a hydraulic individual support, the novel "compact support" can, however, make this supporting power which is concentrated in this compact support effective upon the roof in such a manner that the supporting power is distributed in almost the same manner as if individual girder elements were supported by respectively one of several individual props of average capacity which are distributed over a larger area. This can be done via the independently operating girder elements of the two props combined in this support.

The solution of the problem to effect a differentiated use of the supporting power of the new support is provided by the selectively usable modes of operating the two coaxial props explained in the following. These modes of operation can, as such, be further varied.

The operating modes are:

(A) first the I-prop, which has the smaller piston area, may be put under pressure by the pressure medium, and then at a desired instant, the E-prop, which has the larger piston area, which is preferably a multiple of the piston area of the I-prop, can be put under pressure by the pressure medium (supply sequence A); and

(B) the two props can be set in the reversed sequence (supply sequence B).

In the case of supply sequence A, at first the I-prop is extended and completely set with its normal setting load (determined by the maximum pressure of the medium supplied) under its girder element. Then, the I-prop is put under load by the force of the subsequently pressurized piston which carries the I-prop, this piston pertaining to the E-prop. The E-prop acts in the manner of a hydraulic press upon the I-prop, and the I-prop is put under load by the action of the piston of the E-prop until its high-pressure relief valve is actuated, i.e., until its normal load or load capacity is reached. Finally, the I-prop is pushed, overcoming this hydraulic resistance, until the girder element of the E-prop has found firm contact with the roof, and, additionally, the pressure for the excess setting force has built up in the E-prop cylinder. This excess setting force can be supplied by the E-prop until it reaches its maximal setting load. This portion of the produced total setting load of the prop combination which is effective via the girder element or elements of the E-prop upon the roof thus corresponds to the difference between the values of the maximal setting load of the E-prop and the normal load of the I-prop.

In case the supply sequence B is employed, i.e., in case the two props are put under pressure by the pressure medium in the reverse sequence, the I-prop reduces the portion of the produced total setting load of the E-prop, which is effective upon the roof via the girder element of the E-prop, only by the amount of the normal setting load.

A further feature which is modified with respect to the above-discussed feature is to start with telescoping the I-prop not after the setting of the E-prop has been completed, but to close the supply valve of the I-prop only after the setting of the E-prop has been completed if this I-prop is telescoped together with the E-prop or, chronologically, before the E-prop. Under certain circumstances and in some cases, this affords a more suitable operation. This setting method ends up with having the same pressure distribution upon the roof as that of supply sequence B, but does not at first make the total setting force of the E-prop effective upon the roof—as is the case in supply sequence B.

As can be easily understood, the effects of the supply sequence A are more different from those of the supply sequence B, as well as its mentioned modification, the larger or smaller the roof areas are which are defined by the dimensions of the girder elements, upon which areas, on the one hand, the I-prop is effective and, on the other hand, the E-prop is effective.

As can be seen from the above explanations, the props combined to form the coaxial prop, i.e., the E-prop and the I-prop, are actually independently operating supporting devices whose hydraulic systems are separate from each other. However, there is a dependency of one prop upon the other with regard to their effectiveness because the E-prop carries the I-prop in its hollow piston and thus the supporting power of the I-prop is dependent upon the pressure which is ambient in the cylinder chamber of the E-prop. Any release of pressure—whether on purpose or inadvertent—in the cylinder chamber of the E-prop and/or any lowering of the piston of the E-prop thus triggers a simultaneous release of pressure and/or lowering of the I-prop. This dependency of the supporting effects of the E-prop and the I-prop with respect to each other can have disadvantageous effects if the E-prop, for some reason, for example on account of a fault at the sealing collar or sleeve, is deprived of its pressure and then simulaneously the supporting effect of the E-prop as well as of the I-prop is lost.

On the other hand, when rendering the E-prop pressure-less on purpose, the lowering of the piston of the E-prop in some cases does not take place quickly enough because of the relatively large diameter of the E-prop. Thus, the instant at which the moving of the entire support device is possible, may be delayed in an undesirable manner.

In order to meet these circumstances, the following is done according to a special feature of the invention: A check valve or non-return valve is inserted in the pressure medium supply line of the I-prop. This valve prevents reflux from the pressure chamber, the shut-off valve of this supply line being constantly opened. On the other hand, at each instant at which the pressure in the chamber of the I-prop has only minutely fallen below the value of the medium pressure in the supply line—which can happen as a consequence of the the fact that the I-prop is lowered together with the pressure piston of the E-prop when the latter is without pressure—pressure medium is anew supplied from the line to the I-prop pressure chamber, in such a quantity as is necessary for pressure equalization between the two chambers of liquid. Consequently, the piston of the I-prop is continuously raised or telescoped to that extent at which the cylinder of the I-prop is lowered on account of the resilient lowering of the piston of the E-prop. Consequently, the I-prop does not lose contact with the roof in this case either, i.e., even though the E-prop is yielding, this contact with the roof exists via the girder element supported by the I-prop. The I-prop remains effective with an active supporting pressure which, if desired, extends up to its normal setting load and, additionally, it is capable of immediately carrying new loads caused by the rock pressure.

Conversely, the proposed check valve arrangement also furthers the lowering operation of the E-prop piston, which is advantageous in case the E-prop unintentionally yields. In this case, the arrangement can be particularly coupled with an acoustic or other type of signal generator. It is of particular advantage for the intended lowering of the E-prop piston which is induced by the opening of the outlet valve of the E-prop.

In the latter case—unless the check valve is deactuated by closing the supply line and the outlet line of the I-prop is opened—the I-prop no longer exerts a pressure upon the E-prop piston which corresponds to its weight and to the weight of its cap when the outlet valve of the E-prop is opened, but the I-prop presses the E-prop piston downwardly, with practically the same force with which it is effective upon the roof. Thus, in a manner which is intended, the downward motion of the E-prop piston is accelerated. The I-prop extends because of the supply of pressure medium which is automatically fed via the check valve.

The arrangement of the described check valve does not require anything else but constructing the valve in the pressure medium supply line of the I-prop which serves otherwise as blocking valve and is in operating relationship with the check valve, as a two-way cock or bypass valve or providing a second blocking valve. In both cases, the arrangement must be done such that, when the I-prop has been set, the pressure chamber thereof remains continuously connected with the pressure medium supply line and can be connected with an outlet line—for the purpose of relieving the pressure after the supply line has been blocked or simultaneously with the blocking of the supply line. The outlet or discharge line may, for example, again lead into the feed line at a location which lies beyond the check valve, via which line the pressure medium can be discharged during the pressure relief phase in which no pressure medium is fed.

When two individual valves are used, which is in some cases more suitable for safety reasons, one of them serves for actuating and deactuating the check valve and the other serves for discharging the pressure medium and, if desired, for feeding the prop with the pressure medium. These valves can be coupled with each other by mechanical means. In the event that poppet or spindle valves are used, this can be accomplished by a preferably disconnectible coupling of the poppets or spindles thereof with each other. For example, this can be done by meshing toothed rims which are effective in an oppositely oriented manner and which are also vertically displaceable relative to each other. This valve coupling is done such that, by the closing of one valve and subsequent blocking of the feed of pressure medium possible via the check valve into the pressure chamber of the I-prop, the other valve with the feed line is opened, be it for discharging the medium or feeding the medium.

In case the coaxial support is employed as the second support device of a roof girder carried by two supports, it is suitable to connect the portions carried by the I-prop and the E-prop by means of a non-rigid device (chain or the like) in order to prevent the girder or the like carried by the E-prop from being lowered by too large an extent, which may conceivably occur if the lowering path of the E-prop piston becomes too large.

Under certain circumstances, it is possible, within the scope of the present invention, to provide the described coaxial prop with one or two additional, external props. The arrangement remains basically the same, so that a prop assembly results which comprises three and, if desired, even four coaxial props.

The second of the above-mentioned means (means II) for making pressure effective upon the roof in a differentiated manner provides the operator, the "wagon master" of such a support assembly, with the possibility of terminating the pressure buildup within a comparatively large and therefore advantageous range. This can be done already when a selectively determinable value of the setting force has been reached which lies below the maximal setting load, instead, of setting the prop, as previously done, only with its maximal setting load (whatever size it may have). This latter possibility has already been described above. In this manner, i.e., by prematurely terminating the pressure build-up, step-wise corrections can be carried out at a suitable instant and, with each forward motion and re-setting of the support device, the prop setting load can be varied at will below its uppermost limit, taking the respective roof conditions into consideration.

The automatically operating setting load limiting device becomes effective when a predetermined pressure has been reached, but it is also deactuatable. It is connected with the support assembly and/or the inventive controllable props thereof, if desired, so that the operator does not have to carry out manually again and again a measure which constantly repeats itself at each advancing and re-setting of the support devices in case newly determined roof conditions for which the setting load value has been calculated by the operator to control the same will in all likelihood remain the same for a longer period of time. Rather, the limiting of the setting load can be left to such an automatic device.

In the following, for the purpose of explaining the possibilities offered by the invention, for controlling the roof by using the two means I and II, even more completely, several practical examples of applying the same are disclosed, as follows:

(a) In case both coaxial props are fed from the same feed line, the pressure in the line amounts to 100 kp./cm.^{2} (kiloponds per square centimeter), and the piston area of the I-prop—which is set to an assumed normal load of 25,000 kp.—is 50 cm.^{2}, and the piston area of the E-prop is 400 cm.^{2}. The operator can achieve the following two final results by supplying both props by themselves with pressure, in the manner previously customary for props of assemblies, i.e., up to the build-up of the normal setting pressure:

(1) If the supply sequence A is chosen to feed the coaxial props with pressure medium, an effect is exerted upon the roof, in the region of the girder element of the E-prop which prop reaches a total setting load of (400 cm.$^2\times$100 kp./cm.^{2}=) 40,000 kp., of which, however, a component of the amount of the previously mentioned 25,000 kp. has been transferred to the I-prop carried by the E-prop, which effect has a value of (40,000−25,000) 15,000 kp.

(2) When choosing the supply sequence B for the coaxial props, in which from the setting load (40,000 kp.) of the E-prop first supplied with the medium only a proportion is transferred upon the I-prop which corresponds to the inherent setting load of the I-prop which is subsequently supplied with pressure medium, only (50 cm.$^2\times$100 kp./cm.^{2}) 5,000 kp. are effective upon the roof region assigned to the girder element of the I-prop, and (40,000−5,000 kp.) 35,000 kp. are effective upon the region assigned to the girder element of the E-prop.

(b) As, when using means II, the pressure build-up in the cylinder of the E-prop can be stopped at a selectively determinable stage below the pressure of the medium supply line, any desired setting force, lying below the 15,000 kp. mentioned under (a), (1), when using the way of setting the two coaxial props in the supply sequence A, and any desired setting force, lying below the 35,000 kp. mentioned under (a), (2), can be made effective upon the roof via the girder element of the E-prop.

(c) If, in contradistinction thereto, the E-prop, as is also possible, is set by itself, i.e., only like a conventional hydraulic prop with the same maximal setting load of 40,000 kp., the upper limit of the range for employing means II lies at these 40,000 kp. because an I-prop is not participating.

(d) In case the coaxial support is supplied with pressure in accordance with sequence B and a predetermined maximal setting load of, for example, 15,000 kp. is provided for the I-prop, it is possible that, at such a setting load, for operating the support at pressure stages which lie below the pressure of the supply line, an amount of play must be provided in the cylinder of the I-prop which makes it possible to achieve suitable distributions of the entire assembly effect upon the roof.

(e) If, now, a stationary pressure gauge is assigned to a prop—such as a prop of Examples *b*, *c* and *d*—and the prop is furthermore equipped with a cylinder piston unit having a press-like effect upon the prop, such a unit being represented by the E-prop, the operator can also adjust the adjustable pressure relief valve of the prop to another pressure by means of this E-prop under the control of the presure gauge, if such an adjustment is required. In other words, the prop can be set to any desired new normal load lying below the maximal normal load. The use of this additional feature of the invention will always be of advantage for controlling particularly those roof conditions which change substantially from location to location. The use of this feature in connection with the I-prop of a coaxial support is of even further importance because, if the supply sequence A is chosen for the two coaxial props, the distribution of the total setting force of the support can be influenced to a substantial extent by varying the normal load of the I-prop.

If it is desired, for example, to make the possible total setting load of the support effective in equal parts upon the girder element of the I-prop and that of the E-prop, this is now possible without difficulty—under the above-mentioned prerequisites—by lowering the normal load of the I-prop, for example, from previously 25,000 kp. to 20,000 kp. Then, the supply sequence A causes the increase of the proportion of the E-prop setting load pertaing to the girder element of the E-prop to those 5,000 kp. by which the I-prop normal load was decreased, i.e., it also reaches the amount of (15,000+5,000) 20,000 kp.

It is possible in the same manner to distribute the setting load of the E-prop, which is transferred partially to the I-prop and partially is effective upon the girder of the E-prop, in any other desired proportion.

Within the scope of the above-described possibilities, it is of particular advantage to use the natural or a systematically increased elasticity of girder elements of the coaxial support for realizing the inventive setting load variation and pressure distribution.

For this purpose, a zone is created—preferably by means of spacer elements provided on the girder elements and if desired being displaceable—in the region of the supporting point of the girder elements, this zone being more or less extended, depending upon suitability. Within this zone, such a girder element bends, with increasing resistance, under the effect of the pressure building up in the prop supporting this girder element, before the latter contacts the roof—if it contacts the roof at all in this zone. By displacing the spacer elements along the girder element, the operator can, if required, vary the extension of the girder zone which is to be kept out of contact with the roof and thus can vary the course of the elastic resistance of this girder, i.e., the operator can thereby influence, in a controlled manner, the attenuating or damping effect of the girder upon the pressure build-up in the prop.

It has already been noted above that any imaginable embodiment of the support forming the means I is usable by itself, as well as in the various combinations with the same or any other support elements or assemblies. If only a single prop in a multi-prop support assembly has features of the invention, substantial advantages along the lines of the purpose of the invention are already achieved. A maximum of advantages of the invention is obtained when using the invention in connection with support assemblies which have at least one coaxial support which is constructed in the manner described.

In order to be able to satisfy, with one and the same such support assembly, the basically different roof conditions which are ambient when mining in accordance with the caving system and when mining under artificial gobbing, these assemblies are suitably constructed, with regard to the arrangement of the support, as well as with regard to the accessories (advancing device, etc.), so that they are usable for their second purposes solely by turning the total assembly by 180°. This is also possible if the supports of the assembly form a unitary structure above a common bottom structure, such as in the case in which the support which is the strongest within the support assembly and which is constructed to be particularly a coaxial support in the manner described above, is placed on an independent bottom plate and is thereby movable by itself with respect to the remaining supports which are themselves combined by a common bottom structure to form a second partial assembly.

DETAILED DESCRIPTION OF THE DRAWINGS

The invention will now be considered in more detail with particular reference to the drawings.

FIGURES 1, 1a, and 1b

In this embodiment of the novel coaxial support, an outer cylinder **11** is provided with a pot-like piston **12** disposed internally thereof. These are the components of the external prop **10** or the E-prop. The inner prop **15** or the I-prop has its cylinder **16** at the bottom **13** of piston **12** and the inner prop **15** is provided with a relatively short girder element or cap **14**. The girders **18** of the E-prop **10** are provided with pressure shifting or pressure transfer means which may also be considered as load bearing plates **17** and **17***a*. These girders **18** have their edges resting on the ends **22** of a yoke **25** by means of bearing bodies **21** which have semi-spherical shaped bottoms and which partially encompass the girders by means of jaws or claws **19**. The yoke **25** is provided with pivots **23** which are disposed in dished recesses **24** on the rim of the hollow piston **12** of the E-prop **10** and this provides the mounting for the yoke **25**. The rim of piston **12** is suitably reinforced and the yoke surrounds the I-prop **15** annularly and with a certain amount of play.

In this embodiment, props **10** and **15** are provided with pressure relief valves and valve **26** is provided for prop **10** while valve **27** is provided for prop **15**. The props **10** and **15** are also provided with stationary pressure gauges **28** and **29**, respectively. The props are supplied with pressure medium from a common feed line **30** by means of the multi-way cock **31** and the pressure medium is introduced to the props at ports **32** and **33**. Resilient holding rings **34** and **35** are provided for the I-prop and they are disposed interiorly of hollow piston **12** of the E-prop. A spring assembly **36** is provided at the bottom **13** of piston **12** and is thus disposed below the internal prop cylinder **16**, in order to slow down the pressure build-up in cylinder **16** when the I-prop **15** is set. This spring assembly is in this event compressed by the I-prop almost to that point at which the available portion of its elastic resistance has been exhausted.

FIGURE 1 illustrates the support arrangement in which the I-prop **15** has first been placed under pressure and been completely set with its normal setting load (supply sequence A). If then the substantially larger hollow piston **12** of the E-prop **10** is placed under pressure by the pressure medium, the hollow piston is raised upwardly. As it moves upwardly, it carries the I-prop **15** along with it. However, this is only possible by overcoming the further increasing pressure which rises in the I-prop **15** until its normal load has been reached and until the relief pressure valve **27** which has been set to a desired value is actuated. When the two girders **18** which are raised together with the piston **12** of the E-prop have arrived at and contact the roof, they, too, are subjected to a setting pressure. In the illustrated arrangement, each girder is subjected to half the setting pressure which results from that portion of the pressure which is not required for lifting the I-prop, and thus the pressure which is ambient in the E-prop cylinder **11** until the pressure of the feed line has been attained.

FIGURES 2, 2a, 2b, and 2c

A three-leg trestle is illustrated and can be seen particularly from FIGURES 2 and 2*a*. The two single props are indicated as **52** in FIGURE 2 and **52***a* and **52***b* in FIGURE 2*a* and they are provided in the rear of the device with respect to the conveying means, and the forward prop **49** is constructed as a coaxial support. A transport path **50** is formed between the forward prop **49** and the rear props **52**. The coaxial support **49** has a yoke **25** on its E-prop **10** and rounded heads **42** in FIGURE 2 and **42***a* and **42***b* in FIGURE 2*a* are disposed on the yoke and support one forward end respectively of longitudinal caps **46**, shown in FIGURE 2, and **46***a* and **46***b* in FIGURE 2*a*. These caps are connected to form a frame **45** and the connection is accomplished by means of downwardly turned or bent traverse members **43** and **44**, which are connected between the longitudinal

caps. The longitudinal caps are supported by the props **49**, **52***a*, and **52***b*, which are mounted on a common bottom structure **51** which is rectangular in configuration despite the fact that the props are arranged in triangular fashion. The bottom structure is in the form of a housing and assures stability of the assembly in conjunction with the coaxial support **49**. A detachable portion **54** of the bottom structure makes it possible to exchange the support **49**. This rectangular form of the bottom structure is of particular advantage as the bottom support of the stronger and forwardly placed prop and furthermore offers the advantage of providing chambers on both sides rather than beneath the prop for housing guiding elements, direction control devices, etc.

In this embodiment the I-prop **15** carries a longitudinally extending girder **14**. Coupling bodies **108** are provided on both ends of the frame **45** and thus on the longitudinal caps **46***a* and **46***b* and these are used for connecting fore-poling element **111** or pairs of such fore-poling elements. These fore-poling elements can be hydraulically pressed against the roof and lowered away from the roof and they are preferably provided with tiltable pressure transfer means or load bearing plates **47**. These coupling bodies are constructed of a fork member **110** and coupling bolts **112** actuated by transverse wedge assembly **13** which is itself actuated by means of a cylinder piston unit **114** to which it is connected. The arrangement provides the possibility of utilizing pairs of fore-poling elements on both ends of the trestle and this is due solely to the fact that the upper structural frame is also of rectangular configuration despite the fact that the prop arrangement is triangular.

In order to provide for moving the trestle by means of the same advancing device when the trestle is used in one position or in another position which is rotated by 180° with respect to the first position, two possibilities are provided by the present invention. One possibility is that a stationary abutment can be provided on the side which faces the mine filling. This is provided for the advancing device which has been detached from the mining machine and which now faces the mine filling. The assembly is supported against this abutment when it travels and the advancing device, in the position of the trestle which is illustrated, drags the trestle with it by engaging the mining machine. Such an abutment can be, for example, as indicated in dot-dash lines in FIGURE 2*b*, a pivotable or telescopable traverse **105** which is suitably mounted at a neighbouring trestle. The abutment could also be provided by the face of the filling or gobbing itself. In addition, there is the possibility which is indicated in FIGURE 3 which is to change the position of the advancing device at the assembly from the one to the opposite side of the assembly.

In the embodiment of the support assembly illustrated in FIGURES 2 and 2*a*, the longitudinal frame **14** of the I-prop **15** is constructed to be a narrow frame constructed of two longitudinal caps **14***a* and **14***b* which are connected with each other by two socket bearings **41** which form two transverse struts. In accordance with one sequence of movement of the support, the longitudinal inner frame **14** is the first one to be raised to the roof. These socket bearings **41** make it possible to longitudinally displace the girder frame **14** selectively in a longitudinal direction on the I-prop and by this means effect a change in length of its lever arms. Pressure transfer means in the form of a pressure plate **40** which is connected to be universally mounted thereto is connected on the shorter and forwardly positioned lever arm of the frame. This universal mounting means that relative rotative movement in all directions, within limits, can take place. This pressure plate **40** transfers a predominant portion of the supporting effect of the I-prop into the winning area of the mine or working face of the mine and at the same time creates a zone **106** (see FIGURE 2) at the girder frame **14** and which has no contact with the roof. If desired, tiltable plates 47 can be provided in the forward region of the longitudinal caps 46*a* and 46*b* of the frame 45 and this forward region is supported on the E-prop 10.

In should be noted that although in FIGURES 2 and 2*b*, the frame 45 appears to be spaced some distance from the roof of the mine, this has been over-emphasized for purposes of clarity and the outer frame 45 in practice is only spaced a few centimeters from the roof.

FIGURE 2 shows in dot-dash lines the longitudinal caps 46*a*, 46*b*, of the outer frame 45 after it is raised to the roof and placed under setting load. The I-prop 15 is at first brought to its normal setting load and is then pressed against the roof by means of the raised piston 12 of the E-prop 10 until the normal load of the I-prop has been reached. If this normal load of the I-prop amounts, for example, to 30,000 kp., then 18,000 kp. are effective upon the roof via pressure plate 40 and inner frame 14 and this latter pressure is in the region of the working area of the mine. If the girder is extended by using section 107, then approximately 21,000 kp. become effective upon the roof via the pressure plate 40.

The props 52*a* and 52*b* which carry the rear portion of the frame must also be raised approximately parallel with the raising of the E-prop 10 which carries the forward portion of the frame 45. These props 52 must be placed under their setting force at the time that the setting force is applied to the frame 45 by means of the forward prop. This is the A-sequence for placing the coaxial prop and its support members under setting load. In a similar manner, the B-sequence can be carried out in which first the E-prop 10 and only after termination of this, the I-prop 15 with its normal setting load are to be set. Or, in case the I-prop 15 was already subjected to the raising operation which can be done if desired, then it must be terminated at this point by closing its valve.

Means II can be used in connection with such a support assembly and it is advantageous to use such means. It can be realized that the possibilities of adjusting the total support assembly to the requirement of varied roof conditions either in successive stages or in a finer adjustment are multiplied if the coaxial support 49 is equipped with this means II which are not shown in this figure of the drawing but which will be explained in more detail below. The two single props 52*a*, 52*b*, due to their relatively large piston area, already have a suitable range for the use of this means at a pressure in the pressure medium supply of, for example, only 100 kp./cm.^{2}. Then it is also possible to subject the two single props 52*a*, 52*b*, to pressure in continuous adjustment to the respective pressure medium supply to the two props 10, 15 of the coaxial support.

After termination of each advancing step of the support assembly, there is only a single manipulation which is required to again raise the I-prop 15 and its longitudinal frame to provide immediately an initial effective support for the free face area of the mine along its entire extension, that is, as shown in FIGURE 2, practically from the working face of the mine to the rear end of the assembly. When this is done, the operator, who can then be at ease since the mine is supported, can take his time to set the further supporting elements into operation in a sequence which he deems correct for existing conditions.

In the support frame of FIGURE 2*c*, a coaxial support 49 is provided with a conventional single hydraulic prop 52. This frame is a "compact frame" and has a broad bottom structure which is not shown in this figure and the girder 14*a* is carried by the I-prop 15 and prop 52. An extended girder frame 45*a* is arranged with the E-prop 10 and this frame is provided with a pressure transfer plate 40*a* on its front transverse strut.

FIGURES 3 and 3a

FIGURE 3 is a sectional view through the bottom structure 51. This bottom structure is also rectangular and is associated with a three-leg support trestle which has a transport path. The advancing device including a direction control device is disposed in the bottom structure and the direction control device is a special feature of the present invention. A transverse yoke 70 is provided which can be connected with the conveying device or mining machine via the eye 73. This yoke 70 is rigidly connected at a right angle with the guide rod 71. Guide rod 71 is mounted to be pivotable in both lateral directions about a fulcrum defined by projections 77 and the guide rod is located in a channel 76 of bottom structure 51.

A piston cylinder unit 72 engages the yoke 70 at 75 in order to effect advancing of the guiding element 71 and/or to provide advancing of the assembly of the previously extended guiding construction which is connected with the conveying means at 73 and this latter advancing is carried out along guide rod 71.

The direction control device is provided for allowing there to be variations in the travelling direction of the assembly since these variations may become necessary under certain circumstances. This assembly includes a longitudinal cam link 80 which is actuated by piston cylinder unit 78 and the oblique slot of this longitudinal cam link guides the pin 74 of a transverse link 79. These elements which are disposed in the bottom structure 51 are also shown in FIGURE 3*a* from which it can be seen that the transverse link 79 engages the guide rod 71 by means of a frame body 81 which provides free play for the rod in the upward and downward direction.

In the drawing, the direction control device is illustrated in its neutral position which means that movement of the assembly will be in the prescribed direction. If the assembly should assume an angle in the travelling or advancing direction, for example this may occur because of sliding on a floor which is too steeply inclined, then during the advancing step it is returned to the travelling direction again. This is accomplished by first decoupling from the conveyor before the conveyor again advances the assembly which is still stationary or which has already been set anew. Then, the guiding elements 70, 71 and the connecting eye 73 are pivoted by means of the rocker arm steering arrangements 78, 80, 74, 79, 81 and this pivoting takes place about the abutment pins 77 in the channel 76 and is accomplished by actuating the piston cylinder unit 78. If the cylinder 78 is moved in the direction of arrow D then the guiding element 70, 71 is moved in the lateral direction indicated by arrow C. The movement of guide element 70, 71 into the position indicated in dot-dash lines is carried out and subsequently the eye 73 is connected to the mining machine and then the assembly can be turned. For this purpose, the assembly had been lowered and can be turned into the new direction by actuating the piston cylinder unit 78 in the rearward direction and finally the assembly is again moved forward to the mining machine by corresponding actuation of the piston cylinder unit 72.

In the case a two-support assembly is used, which can be formed by supplementing the three-leg trestle shown in FIGURE 3 by placing a partial assembly in front of it, and which is preferably provided with only one support or a double support being disposed in front as seen in the direction of the strike, then the transverse yoke 70 of the guide rod 71 is connected with the forward partial assembly and the support 55 of this is indicated in dot-dash lines in FIGURE 3. This can be accomplished, for example, in a manner similar to the embodiment shown in FIGURE 5*e*. Then the two partial assemblies can be advanced in separate steps as usual.

Also indicated in FIGURE 3 in dot-dash lines is an example of modification possibilities provided with the present invention for the guiding assembly 70, 71, 73 and the advancing cylinder 72. In order to render it possible to advance the three-leg assembly as an individual assembly, in the opposite direction from that discussed above, which is necessary, for example, when the assembly is used during mining with artificial gobbing where the assembly has its compact support facing the gobbing. In this case, the mining machine is positioned forwardly of the trestle end formed by the two single props **52***a* and **52***b* and the advancing device is mounted at its new modified position indicated in dot-dash lines and may be connected again with the mining machine.

FIGURES 4a, 4b, 4c, 4d and 4e

FIGURES 4*a* to 4*e* illustrate embodiments of the assembly which differ from those of FIGURES 2, 2*a*, 2*b* and 2*c* in that the coaxial support **85** is placed on its own bottom structure illustrated diagrammatically in FIGURE 4*a* in dashed lines and indicated at F and forms one of the individually-movable partial assemblies of a multisection total assembly with the rear bottom structure also indicated diagrammatically in dashed lines and indicated as R. In FIGURE 4*a*, the rear assembly is a two-prop support frame **60** having a transport path **50**. In FIGURE 4*b*, the rear assembly is a three-leg transport path trestle **86**. In FIGURE 4*c*, the rear assembly is a shorter three-leg trestle **87** provided to be spaced from the coaxial support a distance which corresponds to the breadth of the transport path **50**. According to the embodiments of FIGURES 4*d* and 4*e*, the rear assembly is a four-leg trestle **88** and **89**, respectively.

The most important difference between the assemblies of FIGURES 4*a* and 4*b* and 4*c* and that of FIGURES 4*d* and 4*e*, is that in the first group, the respective I-prop **15** of the coaxial support **85** carries a plate-like short cap **61** or **90**, **91**, respectively, and that the longitudinal girders or caps **52** or **92**, **93**, respectively, and which are independent, are provided on the yoke **25** of the E-prop **10** of the support **85**. These girders extend deeply into the region of the assemblies **60** or **86**, **87**, respectively. In contradistinction to this, in the assemblies of FIGURES 4*d* and 4*e*, there is a reverse arrangement and respectively one long girder or cap element **94**, **95** is connected with the I-prop **15** and, respectively, two shorter or short caps **96**, **97** are connected with the E-prop **10**. The girders **96** are formed of box profiles or beams or rails just like all of the other girders and are slidably connected with the upper frame of trestle **89** by means of a set of long springs **101**, **102** passing through the girders with a certain amount of play. This slidable connection is resilient and makes it possible to move the two partial assemblies independently of each other.

In the constructions according to FIGURES 4*a*, 4*b* and 4*c*, when the lower coaxial support **85** is advanced, the longer arms of its longitudinal girders can rest upon a knee or ledge **98** which is provided at the upper structure or the partial assemblies **60**, **86**, **87** and at the underside of the upper structure. In the embodiments of FIGURES 4*d* and 4*e*, the longer arms can rest upon the transverse strut **99** of the upper structure frame of the trestle **88** or **89**, respectively, and for this purpose the transverse strut is bent downwardly.

When using these assemblies during the winning in accordance with the artificial gobbing system, then a broad cantilever or bracket **63** or an extension **64** of longitudinal girder **94** can be provided at the T-shaped frame of trestle **86** by itself or in addition to jointed extensions **111** and this is illustrated in FIGURES 4*b* and 4*d* in dot-dash lines.

In the embodiments of FIGURES 4*a* to 4*c*, the girder frame supported by the yoke exerts force upon the roof by its end members and not by the portion which overlies the coaxial prop **85**. The support of the coaxial prop area is accomplished by the short girder which is mounted thereon. In accordance with the embodiment of FIGURE 4*a*, the girder frame **62** has an effect upon the roof by means of a pressure transfer plate **100***b* which is universally pivoted thereto and the caps of this frame are kept out of contact with the roof at that place where they are supported and this region of the roof is supported by the short girder **61** of the I-prop **15** of coaxial support **85**.

In the embodiment of FIGURE 4*c*, the assembly girder **93** at the top of the figure is provided with a universally mounted pressure plate **100***d* and this plate can be selectively inserted into any one of the recesses **100***c* and thus the girder is so constructed that the pressure plate can be exchanged or moved as desired. At the opposite end of this girder there is a pressure plate **100***a* which is welded to the girder or cap. No pressure plates are provided with the girder **93** shown in the lower part of this figure. The end of its shorter arm is solely provided with a broadened portion **100** which is disposed on the same level and this broadened portion is also provided at the longitudinal cap **95** of the assembly shown in FIGURE 4*e*. In the embodiment of FIGURE 4*d*, there is a special construction of a displaceable and additionally tiltable pressure transfer plate or double plate which is provided on the shorter arm of the cap **94**. The two plates **100***b* are separately pivotable about their axes and are disposed on a transverse arm carried by a retractable and extensible pin **100′** provided at the end face of the longitudinal cap **94**. The transfer arm itself is pivotable in the vertical plane.

FIGURES 5, 5a, 5b, 5c, 5d and 5e

In the embodiment illustrated in FIGURES 5, 5*a*, 5*b* and 5*e*, an arrangement is shown which provides the possibility of breaking down or disassembling the coaxial support and using its components to form two single props placed one behind the other. This is accomplished by removing the I-prop **15** from the E-prop **10** and placing it upon its own bottom plate **116**. Thus, a partial assembly **115** is formed which is shown in the drawing as being directed toward the working area of the face and being independently movable. The E-prop **10** remains in the bottom structure **51** of the remainder of the asseambly which is also reduced to a partial assembly **124**. This prop **15** is connected with the partial assembly **124** only by the hydraulic advancing device **72** which is effective upon the guiding element **133**, **71** connected to the frame body **120**, and this frame body **120** comprises the partial assembly **115**.

In order to place the prop **15** in a systematically controlled manner on a selectively higher setting load than that which it usually has, as was possible with the earlier described arrangement, it is inserted into a pot-like piston cylinder unit **119** which partially employs the principle of the E-prop **10**. This piston cylinder unit now forms only a setting load amplifier having a short stroke and having its pressure medium supply controlled by means of a permanently provided pressure control means such as a stationary pressure gauge. The hollow piston **118** of this unit is short as shown in the figure but can also be made of a greater length and the outer cylinder **117** of this unit which encompasses the prop **15** with a relatively large clearance holds the prop **15** with elastic holding rings (not shown) provided therebetween. The piston stroke of the setting load amplifier can be limited by a stop or also by an outlet or discharge nozzle which may be opened by the piston when the height of the desired stroke is exceeded.

The setting load amplifier is connected with the bottom plate **116** and in the event the outer cylinder of the setting load amplifier is raised, by a large extent, as shown in the figure, and in the case of longer props this would be to a correspondingly larger extent, then it forms in its second function the base for the prop carried by the hollow piston. If it were solely to function as a setting load amplifier, the cylinder could be of a substantially lower construction.

When conditions required continuous use of the coaxial support in its taken-apart or disassembled state of the two single props, as shown in FIGURE 5, it is then possible to replace the relatively voluminous E-prop **10** with a weaker prop such as a prop which is weaker by approximately 25–30% which then carries the yoke **25** after having been adapted to serve this purpose and which can also be equipped with means II.

A device which slows down the build-up of pressure is required in certain cases for controlling the pressure build-up in the prop in such a manner that the operator can control the prop setting load to a fine adjustment. In FIGURE 5, this function is accomplished by the elasticity of that portion of cap **14** supported by prop **15** which is maintained out of contact with the roof region **106** due to the effect of the plate **40**. Since the degree of bending is visible, the operator can control the pressure build-up in the cylinder in case the stationary pressure gauge fails to operate or in the event that no such pressure gauge is provided. Therefore, the operator can to a sufficiently safe degree and at least with a rough adjustment, differentiate the setting load of the prop and/or the effect of the setting load amplifier.

In order to make the amount of elastic bending of the cap even more clearly visible and particularly to make it larger optically, a relatively long rod **170** may be provided in a simple manner as can be seen in FIGURE 2. This rod extends along the longitudinal direction of cap **14** at a distance from the cap and is fastened at one end to a lateral pivot pin **171** provided in the region of the point of intersection of the prop axis and the cap axis. The rod thus acts as a pointer and at its free end points to a graduation **172** provided at the cap and this graduation is a scale or the like.

This indicator device which is provided at the upper portion of the support can be replaced when a setting load amplifier such as is shown in FIGURE 5 is used by a marking **172***a* provided at the outer prop of the hydraulic prop which coacts with a pointer **170***a* mounted on the upper edge of the cylinder **117** of the load amplifier.

It is also possible to simplify this arrangement, i.e. to dispense wtih said pointer if the scale is arranged deeper on the outer prop of the hydraulic prop so that it becomes more or less visible when the piston of the setting load amplifier is telescoped upwardly corresponding to the degree of bending of the cap.

Since the values indicated can be very small, normally it is well to transpose these values to a larger scale by suitable means. For this purpose a pulley **173** is mounted on the outer prop of the hydraulic prop at a higher level than in the case of the first described arrangement, over which pulley a cord **174** runs, one end of said cord being fixed on the upper edge of the cylinder of the amplifier, the other end bearing a weight on which a pointer **170***b* is fixed, said pointer co-operating with a scale **172***b*, fixed also on the cylinder. This arrangement results as needs not to be explained in the doubling of the values indicated.

The pressure transfer plate **40** can not be used under certain circumstances, for example, when the lowermost layer of the roof is too soft. When this occurs, any other retarding element can be used in place of the girder **14** which in that case is non-resilient. For example, the spring assembly **36** which is provided in the coaxial support shown in FIGURE 1 could be used. However, in the present case, this spring assembly would not be provided beneath the base of the prop **15** but rather suitably arranged at the head of the prop. In this arrangement, too, there is the possibility of providing an optical indicator of the above-mentioned type to observe the pressure build-up in the cylinder and/or the setting load build-up of the prop.

Thus, a device has been described which is a combination of resiliently bending elements for delaying or retarding the pressure build-up in the pressure chamber of the prop using any desired optical indicator to indicate the degree of bending. The element affecting the slowing down of the pressure build-up also takes over the function of the otherwise necessary and separate pressure indicator.

A setting load amplifier having a substantially larger diameter in comparison to the diameter of the respective prop carried by the amplifier renders it possible to achieve a pressure amplification up to the normal load of a prop even in the event a medium pressure is chosen which lies not in substantially below the usual medium pressure, for example, which lies already at a pressure of about 50 kp./cm.². Thus, such a setting load amplifier provides the largest range possible within which the operator can use the prop with differentiated setting load.

FIGURES 5 and 5*b* illustrate a special embodiment of holding frame **120** which surrounds the lower portion of the partial assembly **115**. This holding frame **120** forms the connecting member of this partial assembly to connect it with the advancing device or the guiding element of the advancing device. This frame is open upwardly and downwardly and within a limited range permits relative vertical movements and oblique positions of the partial assembly **115** which it surrounds. Lateral slots **122** are provided in the frame and holding pins **121** of the outer cylinder **117** are disposed in the slots and thereby secure the position of the guiding rods against undesired lateral pivoting during the advancing step.

FIGURES 5*a*, 5*b* and 5*e* show an embodiment for advancing and simultaneously controlling the direction of or straightening the assembly and this embodiment is modified with respect to the somewhat similar structure described in connection with FIGURES 3, 3*a* and 3*b*. This advancing and direction-controlling device essentially comprises a U-shaped body **131** which is pivotally mounted about a fixed point in the bottom structure **51**, this point being the pivot pin **130**. The legs **132** of body **131** are hollow and are chamber-like guides for two guide rods **71** which are cross-connected by the yoke **133**. At the ends **134** of the transverse yoke **133** which carries frame **120**, the pistons of the two cylinder piston units **72** are connected. When the guide rods **71** are pushed forward by placing the cylinders **72** under pressure, then the guide rods are guided in parallel to the longitudinal axis of the rear assembly and in a manner which is not influenced by the cylinders **72**. This occurs until their ends **135** enter into the chambers **136** at **137**. Chambers **136** are stationary and permit a limited pivoting of the rods **71** and supplement the pivotal chamber-like guides **132**. From this point of entry, lateral pivoting of the guide rods **135** about the point of rotation **130** of the U-shaped body **131** and therefore a change in direction of the advancing assembly is possible within the limits shown in FIGURE 5*e* in dot-dash lines. This pivoting depends upon whether one or the other of the cylinders **72** is placed under pressure.

The conical tapers **137** of the chambers **136** provide independent rectification of the advancing assembly **124** at the end of its advancing step to its parallel position with respect to the rods **71**. This is accomplished by pivoting the ends **135** of the rods about the point of rotation **130** into the neutral position. These rods enter into the tapers. The tapers **137** can also be placed close to the end of the chambers **132** of the U-shaped body **131**, and these chambers assume the guiding function for the guiding element in this embodiment.

A stop device such as the bolt which may be inserted at **140** makes it possible to set or arrest the direction control device in a predetermined direction and/or makes possible a limitation of its effectiveness to a degree of pivoting determined by the play remaining in the sliding chambers **132**. If desired, and particularly if the required pivoting motions are small, it is possible to forego the provision of making the sliding chambers pivotable.

When there are difficult or troublesome characteristics of the floor of the mine and particularly if it is inclined or dipping to a large degree, then a separate piston cylinder unit **138** may be provided for supporting the above-described pivoting operation and which can act independently if desired. This piston cylinder unit **138** is effective upon both ends **139** or only upon one of the ends, either directly or by means of a rod system **141**. In place of this unit, it is also possible to use a mechanical device, for example a spindle or the like.

A direction control device of the type described above can be used in any desired embodiment of a two-section assembly with, of course, a construction which is adapted thereto, and in such an event it can be advanced in two separate steps with the same advantages. However, it can also be used in connection with one-piece assemblies such as the one shown in FIGURE 2. In order for it to be effective the support **115** holding the guiding elements **70**, **71**, must be stable against rotation about its axis.

FIGURE 5*a* shows an example of how pivoting of the longitudinal inner girder frame **14** of the upper structure of the assembly can be carried out. This pivoting is to be substantially simultaneous with the pivoting motions of the described new guiding element. As shown in dot-dash lines, a guiding trough **131***a* is provided for this purpose at the frame-like upper structure **46***a*, **46***b* of the partial assembly **124**. The lateral edges **150** of the guiding trough engage a girder **14** which is supported at **151** and may be pivotally mounted in a manner which is similar to the embodiment shown in FIGURE 5*b* in which the pivoting body is pivoted about the pin **130**, by means of a pin **130***a* which for this purpose extends substantially coaxially in a recess provided at the transverse strut **44** of the upper structure or another similar pivotal mounting could be provided. In many cases, it is sufficient in a support assembly in accordance with FIGURES 5, 5*a*, 5*b* and 5*e* to provide wall projections which extend toward one another similar to the projections **77** in the sliding chambers **76** of FIGURE 3. These can form pivot bearings for the lower guiding element as well as for the upper longitudinal inner girder **14**.

In the embodiment shown in FIGURES 5 and 5*a*, it is further advantageous to provide the rear end of the upper structure frame **45** with a pressure plate **47** which is tiltable and is shown in FIGURE 2, or with a pressure plate **48** which is shown in FIGURES 5 and 5*a*, and which is mounted fixedly or detachably. As in the embodiment of FIGURES 2 and 2*a*, wedge gear mechanisms **113** actuated by cylinder piston units **114** are provided for pivoting the advancing caps **111** upwardly and downwardly.

In the embodiments of FIGURES 5*c* and 5*d*, the assembly illustrated in FIGURE 5 is supplemented by extensions **107** at the girder **14** and by caps **111** at the end of trestle **124** and this is for the purpose of using the assembly in winning operations in accordance with a gobbing method. In FIGURE 5*c*, the support assembly is shown in its new starting position, that is, after gobbing has been finished and before the winning operation starts in the new working area of the face of the mine. In this view, the elements of the upper structure of the trestle **124** are for reasons of clarity so drawn that they are not yet raised up to the roof, which is not really correct. FIGURE 5*d* illustrates the position in which the two partial assemblies are disposed after the new winning area is bared, and the winning machine has been advanced. The partial assembly **124** which is now the front assembly has been moved forwardly, but in this position the partial assembly has not been completely set.

FIGURE 6

FIGURE 6 shows an embodiment of an automatically operating setting load limiting device which can also be switched off and which is particularly excellent due to its simplicity and safety of operation.

In this embodiment an arrangement is shown which includes a shunt II which branches off from the pressure medium supply line I of the hydraulic prop. This pressure supply line is generally provided with a control valve S, a shut-off valve A1, and a pressure relief valve B1 which determines the normal load of the prop. In this shunt line II a shut-off valve A2 is provided and following it is a pressure relief valve B2 which can be or is set to the respective setting load stage. A check valve R is provided between the pressure relief valve B2 and the prop chamber.

This shunt which is provided with the above three components is an automatic setting load limiting device. When the prop is supplied with pressure medium by means of this shunt, pressure relief valve B2 which is set to a setting pressure which is less than the maximum setting load responds at this lower pressure of the medium and prevents the build-up of the setting pressure in the prop chamber, which exceeds this lower pressure of the medium. This pressure build-up can be caused by the increased pressure of the pressure medium which can be produced by the pump.

When the feeding of pressure medium has been blocked by closing the shut-off valve A2, the check valve in the line prevents any discharge of medium from the prop. This will otherwise be possible via the relief pressure valve B2, and the use of this check valve R therefore permits a further pressure build-up in the prop which can take place by the effect of rock pressure and it can not take place until the normal load has been reached. If the above-described equipment of the prop is increased by adding a permanently present pressure medium gauge, then still further advantageous results are provided.

The use of the pressure gauge in the shunt II makes it possible to limit at will and manually the setting load build-up in the prop in the region below the setting load level determined by the pressure relief valve B2.

By opening both of the shut-off valves A1 and A2, the pressure gauge can furthermore be used for controlling the relief pressure valve B2 whenever it is regulated to a different pressure stage or level and this feature can be utilized also if the pressure gauge is inserted in the line I. In this latter case, in addition to the above-mentioned feature for limiting the setting load by use of the line II, it is possible to provide a manually-controlled setting load limit in the range above the setting load determined by the pressure relief valve B2.

The use of the various features of the invention is not limited to the assemblies or devices with which the invention was described or use explained or for which its application was recommended. Rather, the invention comprises all support devices in which the use of these features per se in any desired combination is possible and advantageous.

Thus, the possibilities of application of the automatic setting load limiting device are not limited to hydraulic roof support assemblies or their props and prop setting load amplifiers of the type described but can also be used for limiting the setting load of any desired hydraulic roof supports. It can also be used for setting devices (setting guns) for hydraulic props of the so-called "open system" or for hydraulic setting devices for mechanical props. Thus, those props can be set in which with every new setting operation of the prop new pressure medium is forced into the pressure chamber with a setting load that is limited to any desired value depending upon the conditions of the individual case.

It is also possible to use the embodiment of the guiding element in the form of two guide rods connected by traverses and provided with two advancing cylinders. This embodiment is illustrated in FIGURE 5*c* and can be used in advantageous manner also with three single-prop assemblies, for example, those of FIGURES 2 and 2*b*.

Another feature of the invention is the provision of the coaxial prop shown in FIGURE 1 but having a short base into which the cylinder **11** of the outer prop is telescopically inserted. Thus, there are three telescoped members which include the abovementioned base, the external prop, and the internal prop. If desired, further props could be utilized so that instead of having two movable prop members, there could be three or more movable prop members. Clearly, the cylinders and pistons of each smaller prop are inserted within the cylinder of the next larger prop.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

What is claimed is:

1. A support device for supporting the roof of a mine in underground mining operation and of the type which can be used by itself or as a component of a support assembly, said device comprising, in combination:

an external prop including a cylinder and a hollow piston disposed therein which is open at the top;

an inner prop carried within said hollow piston and being telescopically movable independently of the hollow piston thereby to define a coaxial support, said props being of approximately the same length;

independent cap means provided on each of said props and arranged to be effective upon different regions of the roof of a mine; and

means for placing the props under the same pressure by a pressure medium and in a sequence which is selectable.

2. A device as defined in claim 1 wherein said inner prop includes a cylinder and a piston, there being play between the walls of the cylinder of the inner prop and the walls of the hollow piston of the external prop, and elastic holding means being disposed between said external prop hollow piston and the internal prop cylinder to locally fill in the play within the two to permit certain pivotal movements of the components with respect to each other.

3. A device as defined in claim 1 wherein the cap means on said external prop includes two caps independent of each other, and a laterally tiltably mounted yoke-like intermediate girder constructed to be of annular shape to provide passage of the inner prop through its central portion with a certain amount of play, said independent caps being universally mounted on said intermediate girder.

4. A support device as defined in claim 1 wherein the cap means of the external prop is of frame-like construction at least partially encircling the cap means of the inner prop at a certain spacing.

5. A device as defined in claim 1 comprising further supports, and said cap means for the external prop including a frame body which is also carried by said further supports.

6. A device for use in supporting the roof of a mine in underground mining operations by means of a hydraulic supporting element, said device comprising, in combination:

a single prop defining at least in part a support assembly and having a cylinder and a hydraulic piston therein;

a source of pressure medium including a pipe line connected to feed pressure medium into said cylinder, the size of the piston area and the pipe line pressure of the pressure medium being arranged to a comparatively high setting load which reaches to the normal load of the prop, said prop being provided with a substantial range of setting loads;

a stationary pressure gauge connected with said prop for rendering it possible to set the prop within the above-mentioned range in controlled stages which are selectable at will with respect to height and instant of time; and

means for so controlling said prop.

7. A device for supporting the roof of a mine in underground mining operations and of the type which can be used by itself or as a component of a support assembly, said device comprising, in combination:

an external prop including a cylinder and a hollow piston disposed therein which is open at the top;

an inner prop having a cylinder and a piston carried within said hollow piston and being telescopically movable independently of the hollow piston thereby to define a coaxial support, said props being of approximately the same length;

independent cap means provided on each of said props and arranged to be effective upon different regions of the roof of a mine;

means for placing the props under the same pressure by a pressure medium and in a sequence which is selectable;

a source of pressure medium including a pipe line connected to feed pressure medium into at least one of said cylinders, the size of the piston area and the pipe line pressure of the pressure medium being arranged to a comparatively high setting load which reaches to the normal load of the prop, said prop being provided with a substantial range of setting loads;

a stationary pressure gauge connected with said prop for rendering it possible to set the prop within the above-mentioned range in controlled stages which are selectable at will with respect to height and instant of time; and

means for so controlling said prop.

8. A device as defined in claim 7 comprising means for delaying the hydraulic pressure build-up and including a spring unit.

9. A device as defined in claim 7 including shut-off means for the pressure medium flowing to the cylinder and being settable to a predetermined pressure in the cylinder chamber and becoming effective when the pressure has been reached, and limiting the setting load.

10. A device as defined in claim 9 wherein said setting load limiting means includes

a shunt to the pressure medium supply line of the prop;

a check valve connecting the shunt and the supply line;

a shut-off valve connected before said check valve; and

a relief pressure valve connected between said shut-off valve and said check valve and being adjusted to the respective setting load which is smaller than the maximum setting load to prevent a pressure increase which exceeds the setting load when the prop pressure chamber is supplied with medium, this being accomplished by the pressure relief valve being actuated at this lower medium pressure, said check valve preventing, after the supply of pressure medium has been shut off, any discharge of pressure medium from the prop which would otherwise be possible via the relief pressure valve.

11. A support device comprising, in combination:

a hydraulic prop;

roof support means connected to said prop;

pressure medium supply means including a pressure line to the prop;

a shunt to the pressure medium supply line of the prop;

a check valve connecting the shunt and the supply line;

a shut-off valve connected before said check valve; and

a relief pressure valve connected between said shut-off valve and said check valve and being adjusted to the respective setting load which is smaller than the maximum setting load to prevent a pressure increase which exceeds the setting load when the prop pressure chamber is supplied with medium, this being acplished by the pressure relief valve being actuated at this lower medium pressure, said check valve preventing, after the supply of pressure medium has been shut off, any discharge of pressure medium from the prop which would otherwise be possible via the relief pressure valve.

12. A setting load limiting device as defined in claim 11 further comprising setter guns for setting mine props

of the open system and which guns are supplied with the pressure medium at each setting step from a pressure medium supply line connected to the guns.

13. A support device as defined in claim **1** wherein one of said cap means is a longitudinal girder, and a pressure plate mounted on said girder at a point spaced from the point of support of the girder by the prop so that a portion of the girder is maintained out of contact with the roof, said girder element being arranged to have increased elastic bending during the setting of the prop by which it is carried to thereby form a device for slowing down and also roughly indicating the pressure build-up in a prop.

14. A device as defined in claim **1** comprising a check valve disposed in a pressure medium supply line connected to the pressure chamber of the inner prop which is carried by the piston of the outer prop, said check valve, in the set phase of the support, in which the pressure medium supply line is not blocked, preventing the reflux of the pressure medium out of the pressure chamber of the inner prop but freeing the pressure medium supply to the inner prop as soon as a pressure relief on the inner prop below its normal setting load occurs because the outer prop is without pressure or because the piston of the outer prop is lowered and filling the pressure chamber of this prop, the piston of the inner prop being arranged to telescope upwardly to the same degree to which the outer prop is lowered and thereby to maintain the supporting function of the inner prop effective should the outer prop inadvertently become without pressure and accelerating the lowering operation of the piston of the outer prop when the outer prop is rendered pressure-less on purpose and doing this by stretching the inner prop and by means of the pressure which is thereby exerted upon the outer prop and which, if desired, ranges up to the value of the setting load of this prop.

15. A support as defined in claim **14** comprising a two-way cock disposed between the check valve and the cylinder chamber of the inner prop in the feed line and connected so that in one of its positions it frees communication between the pressure chamber and the check valve and in its other position it makes possible the discharge of pressure medium out of the cylinder chamber.

16. A support as defined in claim **14** wherein two poppet valves are provided which are mechanically coupled and the valve members of the two valves being connected by two meshing and oppositely effective gear rims which are vertically displaceable with respect to each other, the coupling being accomplished so that by the blocking motion of the poppet of one valve which blocks the supply line to the pressure chamber of the inner prop in which supply line the check valve is inserted, the poppet of the other valve is moved in the opposite direction, which valve is inserted in a second connection of the inner prop with the supply line, whether for the discharge of medium or also for further medium feed, and is opened.

17. A support device as defined in claim **13** comprising means connected with said girder for indicating the respective degree of bending of the girder in an optically enlarged manner to therefore measure prop pressure.

18. A support device as defined in claim **17** wherein a marking scale is provided on the cylinder of the hydraulic prop, a setting load amplifier in which said cylinder is disposed so that the scale indicates the degree to which the prop cylinder has been raised.

19. A support device as defined in claim **17** wherein said degree of bending indicating device includes a gear rack provided at the cylinder and a gear wheel which is rotatably displaced by the rack and mounted at the upper rim of the setting load amplifier so that the displacement is in correspondence with the movements of the outer prop, a pointer moving in front of a scale connected to be moved by the gear wheel with a step-up gearing.

20. A support assembly including the support device as defined in claim **1**, said assembly including two partial assemblies which include said support device, said coaxial prop forming a single support of the assembly and disposed at the side of the coal seam or at the side of the mine filling.

21. A support assembly as defined in claim **20** wherein said coaxial prop forms a support for one of said partial assemblies, a plurality of props for a second partial assembly, and a common bottom structure for the props of the second partial assembly and of the coaxial prop.

22. A support assembly as defined in claim **20** wherein one of the partial assemblies is constructed as a trestle and the other partial assembly includes the coaxial prop mounted on an independent bottom plate to define together with its cap means a partial assembly which is movable independently of the other partial assembly.

23. A support assembly as defined in claim **22** wherein the cap means of the coaxial prop forming a partial assembly has its carrying effect extended into the zone of the other partial assembly.

24. A support assembly as defined in claim **20** wherein the total assembly can be turned by 180° and used selectively in an arrangement of the coaxial support where it is directed toward the working area of the face or toward the mine filling area.

25. A hydraulic prop, comprising at least three telescopically assembled prop sections, at least two of said prop sections being hollow to receive an adjacent prop section in sliding relationship to form a piston-cylinder unit therewith, one of said hollow prop sections forming a base, the other of said hollow prop sections serving as a piston with relation to said base prop section and as a cylinder with respect to the remaining prop section, and load bearing means respectively connected to said other hollow prop section and remaining prop section to enable them to support roof engaging members.

26. A prop as defined in claim **25** wherein the sections are concentrically assembled within each other, the section of the largest cross-sectional dimensions carrying the cylinder of the piston unit which operates that having the next largest cross-sectional dimension which in turn carries the cylinder of the piston unit for operating the section having the next largest cross-sectional dimension.

27. A device as defined in claim **26** comprising relief valve means provided with each piston and cylinder unit other than the outermost unit to permit relative contraction at a predetermined load between the extended inner sections while the outer sections are undergoing extension.

28. In a hydraulic prop unit for supporting a mine roof, the improvement comprising, in combination: a hydraulic prop member, a cup-like body encompassing the base of said hydraulic prop member, said cup-like body including a piston disposed within a short-stroke hydraulic cylinder, said piston and said hydraulic cylinder extending upwardly into the region of the mine roof and the rim of the piston extending above the rim of the cylinder, and mounting means provided on the rim of said piston for carrying load-bearing members which provide a support effect at the roof of the mine.

29. A device as defined in claim **28** wherein said piston, said hydraulic cylinder, and said hydraulic prop member which is disposed within said cup-like body are arranged concentrically with respect to each other.

30. In a mine roof supporting device containing at least one assembly including a bottom structure, with upwardly extending props mounted on said bottom structure, and an upper structure carried by the props for engaging and supporting a mine roof, the improvement wherein:

(a) said props comprise an outer prop unit and an inner prop unit,

(b) said outer prop unit comprises a cylinder and a cup-like piston therein encompassing an end portion of the inner prop unit and having a rim extending above the rim of said cylinder,

(c) the rim of said cup-like piston engages and supports a first part of said upper structure, and

(d) the end portion of said inner prop unit opposite said outer prop unit engages and supports a second part of said upper structure whereby the second part of said upper structure can be raised and lowered separately from said first part of said upper structure.

31. The improvement defined in claim **30** and further comprising a frame-like yoke mounted on the rim of said cup-like piston for supporting said first part of said upper structure.

References Cited

UNITED STATES PATENTS

2,910,281	10/1959	Wilkenloh et al.	61—45
2,987,290	6/1961	Haarmann	248—357
3,184,206	5/1965	Meriaux et al.	248—357
3,218,812	11/1965	Wilkenloh	61—45

FOREIGN PATENTS

163,615	7/1953	Australia.
532,796	10/1954	Belgium.

ROY D. FRAZIER, *Primary Examiner.*

JACOB SHAPIRO, *Examiner.*

J. F. FOSS, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,371,901 March 5, 1968

Karl M. Groetschel

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the printed specification, line 7, after "Germany," insert -- Nov. 10, 1962, G 36,367; --.

Signed and sealed this 18th day of March 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents