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METHOD AND MEANS FOR EXCLUDING WATER
PENETRATION INTO WELL BORES
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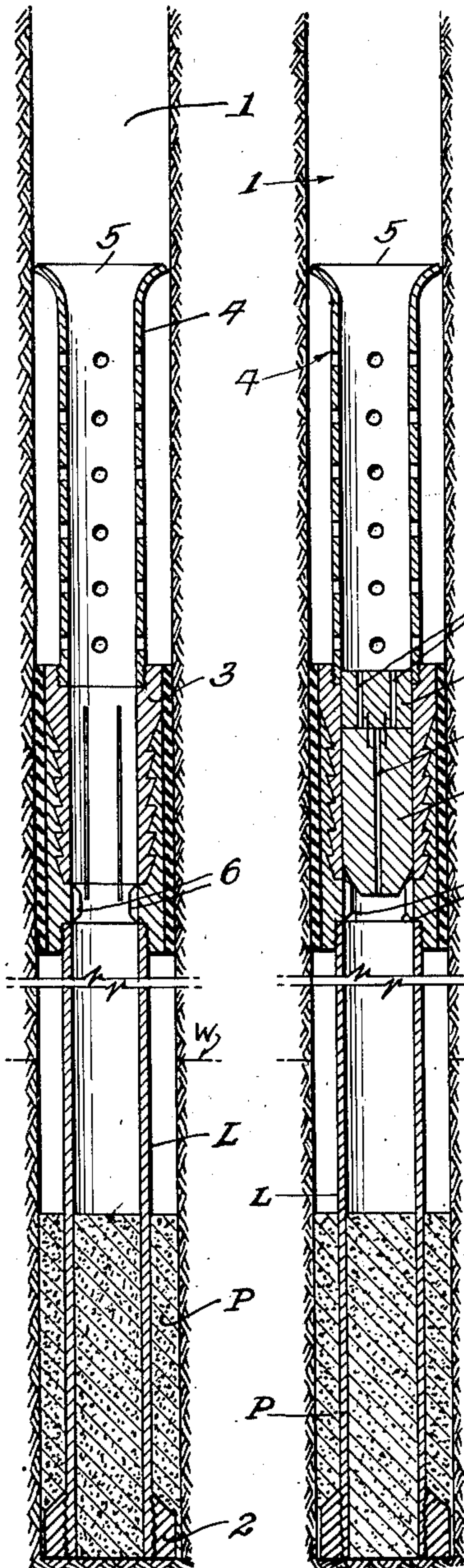


FIG. 1.

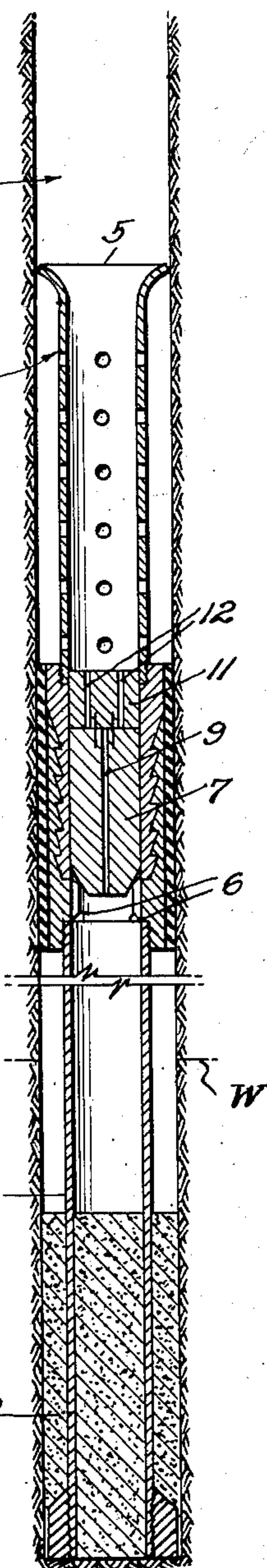


FIG. 2.

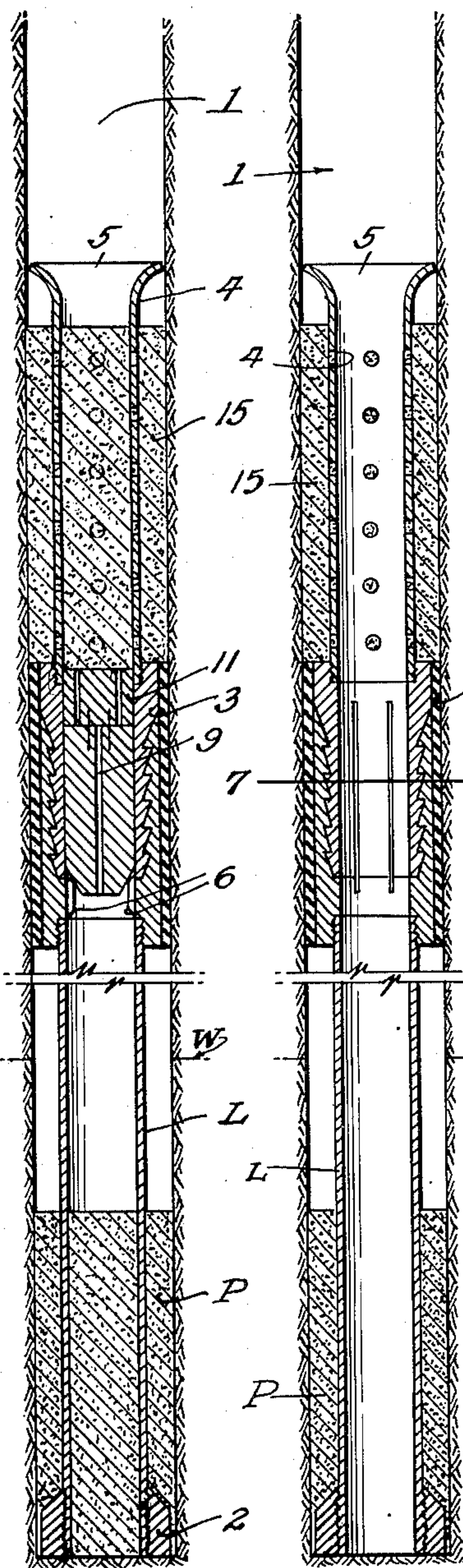


FIG. 3.

FIG. 4.

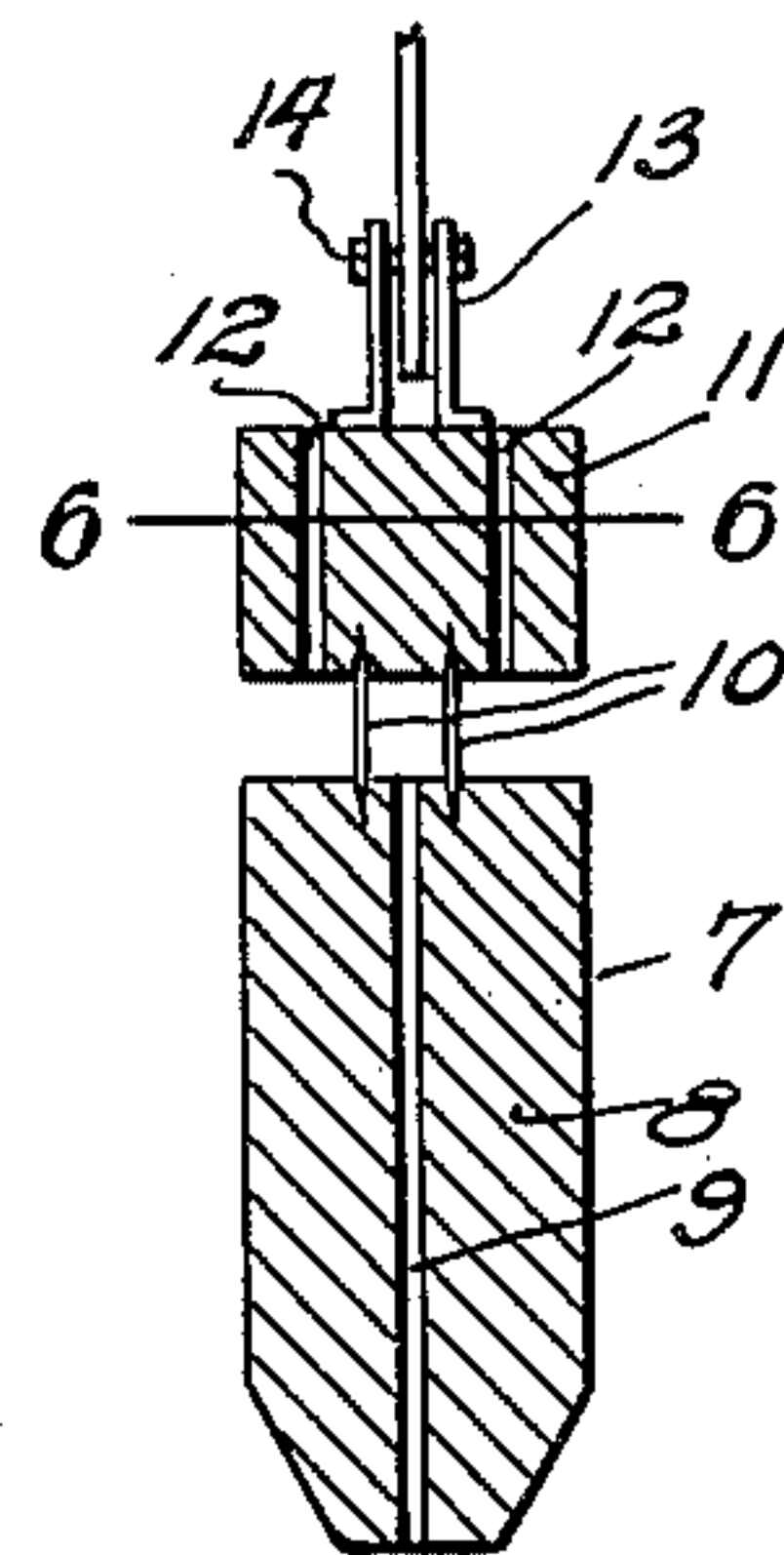


FIG. 5.

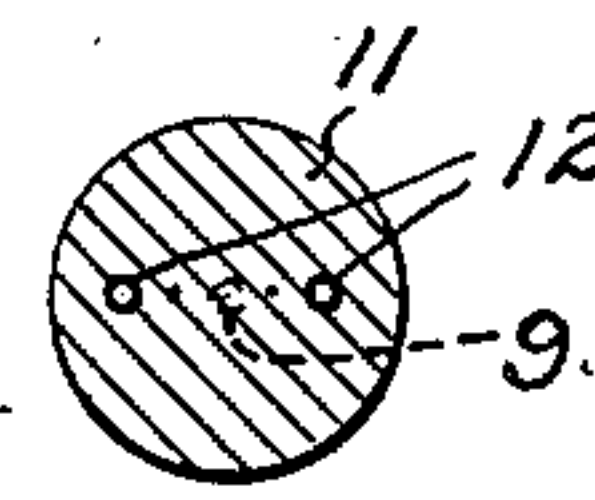


FIG. 6.

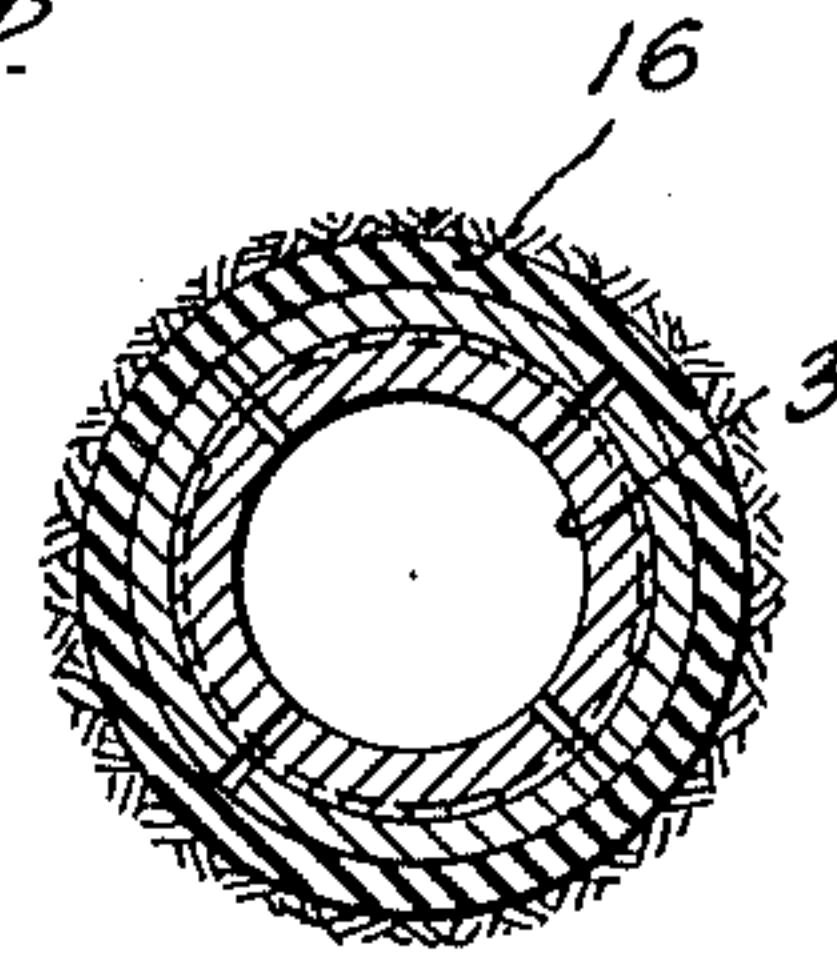


FIG. 7.

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METHOD AND MEANS FOR EXCLUDING
WATER PENETRATION INTO WELL
BORES

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8 Claims. (Cl. 255—1.8)

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The present invention provides an improved method and apparatus for excluding the entrance of water into well bores when the latter are being drilled and when under production. An object of the invention is to provide a method and apparatus for this purpose in which a liner and packer assembly is placed in a well bore when a zone of water penetration is encountered, whereby to seal off further water flow and permit drilling of the well to be continued.

It is a present practice in the drilling of gas, oil and sulphur-producing wells to exclude undesired water penetration by placing in the well bore lengths of standard metallic casing which extend from below each water zone to the top of the bore. In certain instances, the casing is used in association with packers and cementitious mixes which set or harden in the bore in the zone or zones of water-bearing formations. In all these methods, however, casing is used extending throughout the length of the well bore. Such casing is at present expensive and difficult to procure, and it is therefore another object of the invention to provide a method of sealing a well bore against water infiltration in which the use of ordinary well casing is dispensed with and in place thereof metallic liners are employed in positions confined to the localized zone or zones only of water penetration into the well bore.

A further object is to provide a novel method and means for sealing a well bore against undesired water penetration in an effective and economical manner and with the use of but a minimum amount of material and the employment of relatively unskilled labor.

For a further understanding of the invention, reference is to be had to the following description and the accompanying drawing, in which:

Fig. 1 is a vertical sectional view taken through a well bore disclosing the initial step of the present invention which comprises placing in the bottom of the well bore a liner and packer assembly with the bottom of the liner submerged in a liquid plastic;

Fig. 2 is a similar view disclosing the operation of inserting a destroyable plug on removable stops disposed in the liner;

Fig. 3 is a similar view disclosing the operation of introducing a body of liquid plastic or slurry on the top of the packer and the removable plug in the liner assembly;

Fig. 4 is another similar view in which the liner has been drilled or bored to remove from within the same the set or hardened bodies of the plastic, the plug and removable stop in opening the internal passage of the liner;

Fig. 5 is a detail sectional view of the plug;

Fig. 6 is a horizontal sectional view taken on the line 6—6 of Fig. 5;

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Fig. 7 is a transverse horizontal sectional view on the line 7—7 of Fig. 4.

Referring more particularly to the drawings, the numeral 1 designates a well bore or hole drilled by customary methods through earth and other geological formations. During the drilling of the bore or hole, and when water-bearing formations are encountered, as indicated at the level W, causing free water to collect and rise in the bottom of the hole, I introduce into the bottom of the bore or hole a body of a liquid plastic or slurry. While many such materials are available, I have used advantageously a phenol-base plastic having a setting time of approximately two hours, the setting time of which may be controlled by the employment of various catalytic agents, such as a citrate. The amount of the plastic or slurry employed may vary, but I preferably introduce a sufficient quantity to develop a body thereof from six to ten feet in height and which is in direct contact with the walls of the bore 1.

Following the introduction of the plastic body, indicated at P, in the bottom of the well bore, and while the plastic or slurry is in a more or less liquid condition prior to its setting, I introduce into the well bore a metallic liner L of the same weight and diameter of casing ordinarily used in the well at that point. The liner carries the same type casing shoe 2 on its bottom joint ordinarily used at that point of well bore formation. The liner carries a ratchet-type packer 3, which can be set by the weight of the lowering tools. When the packer is installed, its position in the well bore will be approximately thirty feet above the top of the water zone W. A ten foot joint of perforated casing 4 carrying at its top a guide shoe 5 is installed above the packer.

Formed in connection with the packer are drillable stops 6, which form a seat for the support of the tapered lower end of a plug 7. This plug comprises a main cylindrical body section 8 through the axis of which extends a passage 9 for the travel of water while the plug is being seated. The body section 8 is connected by means of double pointed spikes or nails 10 with a normally spaced cap or closure section 11. This section is formed with one or more passages 12 extending vertically therethrough, but with said passages arranged laterally and out of alignment with the body section passage 9. The upper part of the cap section 11 is provided with a stirrup 13 equipped with a transverse bolt 14 to which a string of well tools, not shown, may be connected for the lowering of the plug into the well bore and seating the same firmly on the stop shoulders 6 of the packer section 3. When the plug is thus seated, the spikes 10 penetrate the plug section to a greater degree so that the cap section is

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seated on the upper surface of the body section 3 and the passage 9 closed.

With the plug seated, as disclosed in Fig. 3, another plastic body or slurry 15 is introduced into the well bore and deposited on the top of the plug, the slurry passing through the perforations of the liner section 4 into engagement with the earth or rock walls of the bore, sealing off the well against water infiltration above the packer. The plastic or slurry body 15 may be composed of a flowable mixture of mud and a barium salt which hardens after a period of setting to form a dense solid mass.

Following such hardening or setting of the plastic bodies above and below the packer section, a drill is then passed through the liner assembly to clear the interior thereof and form a smooth-wall passage for the continuance of the well drilling operations. The drills readily pass through the plastic body 15 within the liner leaving about the perforated section 4 a sleeve which closely engages the walls of the bore. The plug is preferably formed from wood so that it, too, may be readily penetrated and destroyed by the drilling operation. Likewise at the same time, the stop 6 may be cut free and, thereafter, the plastic material P in the bottom of the liner assembly. The well is then bailed to remove water and upon completion of the bailing the further drilling of the bore may be continued.

If a second lower water-bearing stratum is encountered, the same type of liner assembly is used to seal the same off, except that the diameter of the second liner assembly is such that it will pass through the first-described assembly. I prefer to employ the ratchet-type of packer with its surrounding sleeve 16 of rubber, since such a packer can be set by the weight of the tools handling the same, the tools being arranged on a mandrel, not shown, which will not enter the top of the liner assembly. By the provision of the mechanical packer and the second body of plastic material applied thereto, water is prevented from rising in the well hole or bore above the water-bearing formation, the same being stopped effectively by the expansible packer. Permanency is attained by the addition of the second body of plastic material, so that reliance need not be placed on the mechanical packer itself, which tends to deteriorate with the passage of time.

I claim:

1. The method of sealing well bores undergoing drilling against water entry, which comprises depositing on the bottom of a well bore when a water-bearing formation is penetrated a vertically positioned liner assembly, said assembly embodying in joined relation a lower pipe section, an intermediate packer section and an upper pipe section, introducing into said well bore in a mobile state a solidifiable plastic body in an amount sufficient to fill at least the lower part of said lower section and the space between the outer wall surface of said lower section and the adjoining wall surface of the well bore, expanding said packer section to bring the same into sealing engagement with the walls of said bore above said water-bearing formation, seating a plug in said packer section above said plastic body, introducing a second body of a solidifiable plastic into said well bore and depositing the same on said packer section and said internal plug in a quantity to at least partially fill the interior of said upper section and the space between the outer wall surfaces thereof and ad-

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jacent wall surfaces of the well bore, causing said plastic bodies to set and solidify, and thereafter removing from the interior only of said liner assembly the upper and lower bodies of plastic composition contained therein and said plug, whereby to form a smooth wall passage through the liner assembly for the continuance of well-drilling operations.

2. The method of sealing well bores undergoing drilling against water entry, which comprises depositing on the bottom of a well bore when a water-bearing formation is penetrated a body of solidifiable plastic composition in a mobile state, introducing into the well bore for deposit on the bottom thereof and in said body of plastic composition a tubular liner assembly, said assembly embodying in joined relation a lower pipe section which has its lower part embedded in said plastic body, an intermediate packer section which is arranged above said plastic body and an upper pipe section having perforated side walls, said upper and lower pipe sections having the walls thereof spaced from the adjacent walls of the well bore and said packer section having an expansible periphery, expanding said packer section to cause its periphery to be engaged directly with the walls of the well bore above said water-bearing formation, introducing into said packer section in a seated position therein a destroyable plug member, introducing into the upper pipe section for deposit on said packer section and said plug a second body of a solidifiable plastic composition in a fluid state, whereby to cause said second plastic body to at least partially fill the interior of said upper pipe section and the space formed between the outer wall surfaces of said upper pipe section and the adjoining wall surfaces of the well bore, causing the plastic bodies to set and solidify and thereafter disintegrating said plastic bodies and said plug and removing the same from the interior of said liner assembly to provide through the latter an uninterrupted passage for the continuance of well-drilling operations.

3. The method of sealing well bores to preclude subterranean water flow therein, which comprises introducing into the bottom of a well bore when a water-bearing formation is encountered during the drilling of the well bore a solidifiable plastic body in a fluidic state, while the plastic body is in said state positioning on the bottom of the well bore a tubular metallic liner assembly composed of a lower pipe section, an intermediate expansible packer section and an upper pipe section, depositing said lower pipe section of the liner in said plastic body with the outer wall surfaces thereof spaced from the wall surfaces of the well bore, expanding said packer section to cause its outer surfaces to engage directly with the wall surfaces of said bore above said water-bearing formation, said upper pipe member being formed with perforate side walls disposed in spaced relation from the wall surfaces of the well bore, seating in the packer section a destroyable plug having a water passage extending therethrough, closing said passage when the plug is fully seated, introducing a second solidifiable body of a plastic composition into the well bore, said latter body being disposed on said packer section and plug therein, so that said second body is arranged within the upper liner section and in the space between the outer walls thereof and the wall of said well bore, causing said bodies of plastic composition to set

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and harden, and thereafter drilling through the plastic body within the interior of said upper liner section, the plug in the packer section and the plastic body within the lower liner section to remove the drilled materials from said liner section and to produce an unobstructed passage through the entire liner assembly.

4. The method of sealing well bores undergoing drilling operations against the introduction of water through the side walls of the bore, which comprises depositing in the bottom of the well bore after penetration of a water-bearing formation a solidifiable mass of plastic material to fill the well bore a distance above the bottom thereof; placing in said mass of plastic material prior to its solidification the lower end portion of a vertically arranged tubular liner; sealing the space between said liner and said well bore above said water-bearing formation; plugging said liner intermediate its ends; depositing a second mass of solidifiable plastic material in the well bore and liner above the plugged and externally sealed region thereof; causing the first and second masses of plastic material to solidify; and thereafter drilling through the second mass of solidified plastic material disposed in said liner, the plugged region of said liner, and the first mass of solidified plastic material disposed in said liner to form an opening extending completely through the liner.

5. The method of sealing well bores against the introduction of undesired fluids from a water-bearing formation encountered during drilling operations which comprises depositing in the well bore below the point of introduction of undesired fluids therein a mass of solidifiable plastic material; placing a tubular liner vertically within the bore with the lower end thereof positioned within said mass of plastic material and in spanning relation to the point of entry of undesired fluids; externally sealing the space between said liner and the walls of said well bore above said water-bearing formation; plugging the liner internally and intermediate its ends and above the point of entry of undesired fluids; depositing a second mass of solidifiable plastic material within the well bore above the plugged region of said liner; permitting said first and second masses of plastic material to set and solidify; and thereafter drilling through said second mass of plastic material, the plugged region of said liner and said first mass of plastic material disposed within said liner to provide through the liner an uninterrupted passage for the continuance of well drilling operations.

6. The method of sealing well bores against the introduction of undesired fluids from a water-bearing formation encountered during well drilling operations which comprises depositing a mass of solidifiable plastic material above and below the point of entry of undesired fluids within the well bore; placing a tube between said masses of plastic material in spanning relation to the point of entry of undesired fluids within the well bore; causing said masses of plastic material to solidify between the outer walls of said tube and the inner walls of the well bore and within the tube above and below the point of entry of undesired fluids within the well bore; and thereafter drilling through the solidified masses of plastic material to form an uninterrupted passage through said tube for the continuance of well drilling operations.

7. The method of sealing a well bore undergoing drilling against inflow of water from a sub-

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terranean water-bearing formation penetrated by the bore, which comprises: depositing on the bottom of the bore and below said formation a solidifiable mass of plastic material, placing in said bore a tubular liner, the length of the latter being such that with the lower end of the liner embedded in said plastic material on the bottom of the bore the upper end of said liner will project a substantial distance above said water-bearing formation, said liner having a diameter throughout the major portion of its length less than that of said bore whereby to provide an annular space between the liner and the walls of the bore, expanding a mechanical packer carried by said liner intermediately of the length thereof to seal off said space above said water-bearing formation, seating an internal destroyable plug in said liner in the general horizontal plane of said packer, depositing the second mass of a solidifiable plastic material in said annular space and within said liner, with said second mass of plastic material resting on said packer and plug above the region of water entrance into said bore, and following solidification of said masses of plastic material drilling through the same and said plug to form an unobstructed opening extending completely through the liner, said liner between the first and second bodies of plastic material having an imperforate wall structure forming a closed chamber for confining water in said formation and preventing entry thereof into the interior of said liner.

8. The method of sealing well bores undergoing drilling against undesired water entry, which comprises: depositing on the bottom of a well bore, when a water-bearing formation is penetrated, a solidifiable body of plastic composition; also, positioning in the well bore for deposit on the bottom thereof a tubular vertically positioned liner assembly having an intermediately disposed expansible packer section; expanding the packer section to cause the same to engage directly adjoining wall surfaces of the well bore above said water-bearing formation; producing in and around the upper part of said liner assembly on and above said packer section a second solidifiable body of plastic composition; thereafter removing the solidified portions of said bodies originally positioned in said liner assembly, whereby to produce in the latter an unobstructed passage suitable for the passage of tools used in the continuance of further drilling operations.

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