Dec. 7, 1954 H. M. GREENE 2,696,258

OIL WELL CEMENTING PACKER

Filed May 15, 1950

Fig. 1.

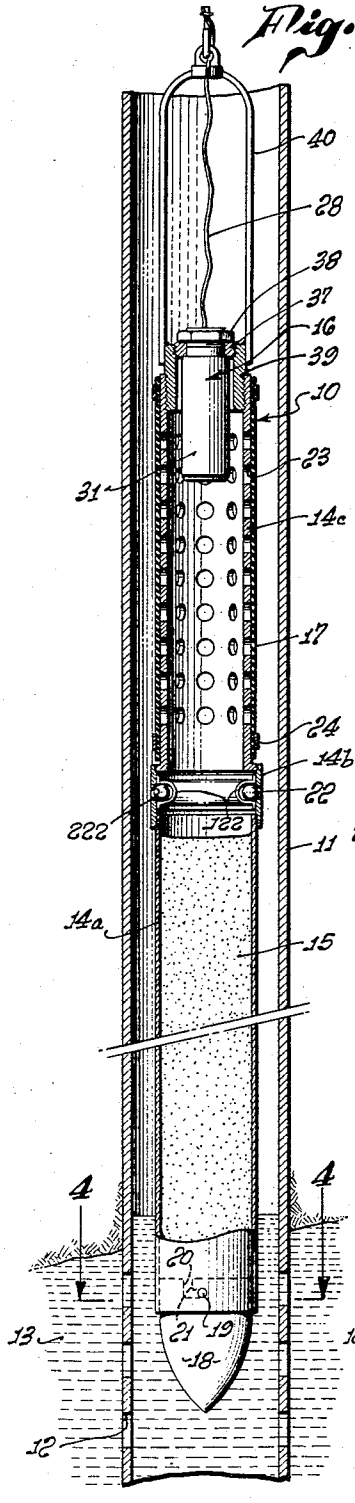


Fig. 2.

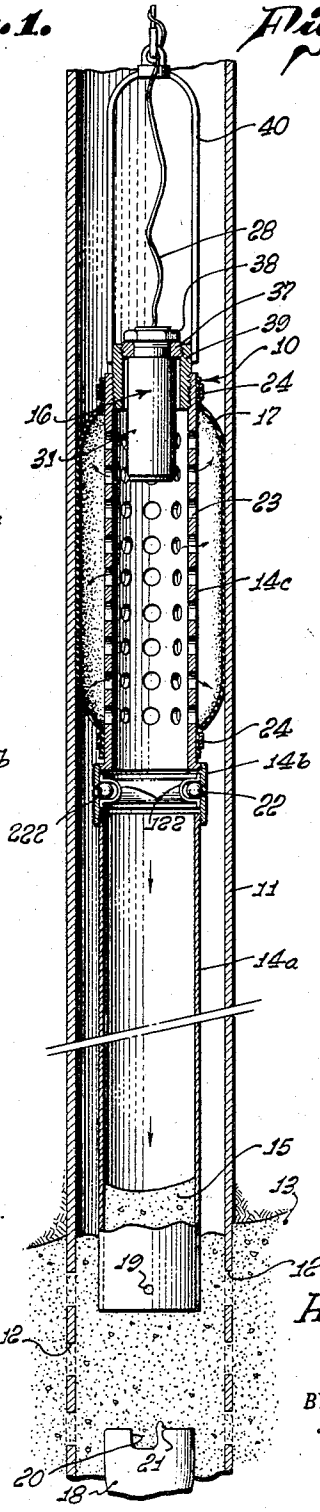


Fig. 3.

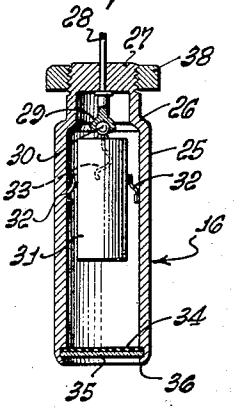
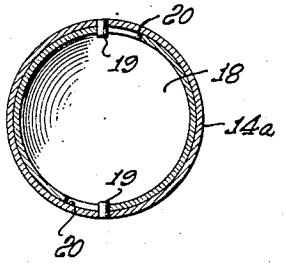


Fig. 4.



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OIL WELL CEMENTING PACKER

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16 Claims. (Cl. 166—63)

This invention relates generally to well tools and concerns particularly improved apparatus for depositing cement in a given zone within a well bore.

The present invention represents an improvement on my copending application Ser. No. 770,239, now Patent No. 2,591,807, in which I have disclosed a method and tool for depositing cement in a predetermined zone within a well bore by the force of an explosive or gas generating charge. Both the above and present inventions are particularly characterized by unique bore sealing means adapted for expansion by the cement displacing gases to plug the well bore above the zone being cemented and thus seal the bore against upward dissipation of the force of those gases. In this manner, virtually the entire force of the gases is directed against the cement to vastly increase the overall effectiveness of the cementing operation while permitting the use of a considerably smaller gas generating charge than has heretofore been required.

An important object of the present invention is to provide a cementing tool of the above character especially adapted to be retrieved after a cementing operation in a condition to be recharged with cement and gas generating material and used again. For this purpose, I provide improved bore plugging means so formed as to only temporarily expand during an operation and to then return to a contracted condition after the force of the actuating gases diminishes. The tool may thus be easily lowered and raised with the expansible plug in its contracted condition and free of any engagement with the bore wall. Particularly contemplated for sealing the bore is a novel resilient packer element, preferably in the form of a tubular rubber sleeve, adapted for expansion and contraction in accordance with the pressures as its opposite sides.

In order to permit reuse of the portion of the tool within which the body of cement is contained, I may provide the cement container with a closure specially formed to be opened by the force of the cement displacing gases to permit outward flow of the cement without harm to the main portion of the container. Preferably, this closure takes the form of a removable nose portion attached to the lower end of the cement container by means preformed to shear in response to the force of the generated gases.

Further features of the invention involve improved means for mounting the gas producing charge to the body of the tool in a manner facilitating recharging of the tool while serving also to direct the gases most efficiently against the body of cement. For this purpose, I prefer to employ a unique combustion or explosion chamber serving in effect as a "gas gun" removably mounted to the upper end of the tool body and directing the gases produced upon ignition of a contained charge downwardly against a lower body of cement. The resulting gases, in passing between the gas gun and cement, may be directed through the previously mentioned tubular packer sleeve to urge that sleeve outwardly and into sealing relation with the well bore. In order to prevent any moisture from reaching the gas producing charge, I prefer to seal the discharge end of the gun with a closure adapted to be relatively easily opened or ruptured by the force of the gases.

An additional object of the invention is to provide means for equalizing the pressures at the inside and outside of the cementing tool after the cementing operation,

and particularly if the lower discharge end of the tool is for any reason plugged. For this purpose, I provide one or more outwardly seating check valves in the wall of the tool acting to prevent outward flow of the gases of combustion from within the tool while permitting an inward flow of well fluid after the pressures within the tool have diminished.

The above and other features and objects of the present invention will be better understood from the following detailed description of the typical embodiment illustrated in the accompanying drawing in which:

Fig. 1 shows a preferred form of cementing tool embodying the invention and positioned within a well bore prior to a cementing operation.

Fig. 2 is a view corresponding to Fig. 1 but showing the tool during the cementing operation;

Fig. 3 is an enlarged vertical section through the gas gun of the device; and

Fig. 4 is the transverse section through the lower end of the tool and showing particularly the method of mounting its lower nose portion.

The cementing apparatus of the present invention is adapted to be used in any of the numerous situations where it may be desirable to deposit a body of cement in a given zone within a well bore. I have typically illustrated the situation where it is desired to close off a water area **13** communicating with a well through perforations **12** in casing **11**.

The preferred form of cementing tool **10** comprises essentially a tubular vertically extending body formed in three threadedly interconnected sections **14***a*, **14***b* and **14***c* and containing a body of cement **15**, a "gas gun" **16** carried by the upper end of the tool body and acting to direct the gases generated by a contained charge downwardly through the body and against the cement, and a tubular packer sleeve **17** adapted to be radially expanded against the well bore casing to form a seal preventing upward dissipation of the actuating gases.

The lower tubular portion **14***a* of the tool body serves to contain the body of cement **15** to be deposited within the well. The lower end of this cement container is closed by a downwardly tapering nose member **18**, which is attached to the body in a manner assuring retention of the cement during lowering of the tool while permitting the nose member to be blown downwardly from the body upon ignition of the gas generating charge. For this purpose, cement container **14***a* may carry a pair of inwardly projecting pins **19** receivable within bayonet slots **20** at the top of the nose member. When the gas producing charge is ignited and exerts a downward force on the body of cement, the material of the nose members shears or tears at **21** to the condition of Fig. 2, permitting downward expulsion of the nose member and downward and outward displacement of the body of cement.

The portion **14***b* of the tool body above cement container **14***a* carries a number of outwardly seating check valves **22** serving to prevent outward escape of the cement displacing gases through the wall of the body while permitting an inward flow of well fluid into the body when the pressure within the body is reduced below that at its outside. These valves may be of essentially conventional ball check valve construction, as shown, comprising spherical valve elements free for limited movement within cages **122** toward and away from seats **222**.

The upper tubular portion **14***a* of the body is perforated at **23** to permit outward flow of the generated gases against packer sleeve **17**. This packer sleeve is formed of rubber or similar resilient material and is peripherally clamped by bands **24** at its opposite ends to the end portions of perforated body section **14***a*. The packer sleeve is thus radially expansible to the condition of Fig. 2 by the gases and is then resiliently returnable to the condition of Fig. 1 when the pressure within the tool returns to normal.

The gas gun or firing chamber **16** comprises a cylindrical metallic vertically extending body containing an ignitible charge **31** and closed at its upper end by a transverse wall **27** serving to direct the gases produced by the charge downwardly against the body of cement. The charge is retained and positioned within the chamber

by means of the contacts that conduct electrical current to its inner ignition fuse **33**. Specifically, a first electrical lead extends through upper wall **27** of the chamber and carries within the chamber a socket contact **29** having resilent fingers adapted to grip an upper contact knob **30** on the gas producing charge **31**. Also, the charge carries a number of circularly spaced outer contact wires **32** engageable with the inner wall of the chamber and acting to both frictionally retain and laterally position the charge. Though it is contemplated that charge **31** may comprise any of various combustible or explosive materials, I preferably employ a composition characterized by a capacity to produce a relatively prolonged pressure and temperature surge rather than a sharp instantaneous explosion, to thus effectively force the cement from the container and into the well zone without danger or rupturing the tool body itself.

In order to assure that no well fluid or other unwanted moisture will reach charge **31**, the lower end of chamber **16** is closed and sealed by a rubber disc **34** and an aluminum disc **35**, both of which are retained to the chamber by upsetting the metal of the barrel at **36**. The chamber is connected into the upper end of perforated body section **14***c* by means of an annular threaded member **37** received about its upper end and clamped between an outer shoulder **26** on the chamber and a retaining nut **28**. Member **37** is threadedly connected to a tubular adapter **39** which in turn is suitably attached to the upper end of the tool, as by connection to adapter **39**, to support the tool within a well.

In preparing the tool for use, lower nose member **18** is first attached to the lower end of cement container **14***a* by means of bayonet connection **19—20**. Chamber **16** is then removed from the upper end of the tool as permitted by its threaded mounting, and cement is filled into the tool body through its open upper end. Sufficient cement will normally be poured into the body to substantially fill its lower imperforate section **14***a*. A gas producing charge **31** is slipped into the firing chamber through its open lower end and moved to the condition of Fig. 3 in which the charge is releasably retained by reception of its upper knob contact **30** within gripper socket **29**. Rubber and aluminum discs **34** and **35** may then be applied to the lower end of chamber **16** to seal it against the entrance of any well fluid after which the chamber is mounted to the upper end of the body as shown.

The tool is lowered into the well to the zone to be cemented, in this case the water area **13**, and an electrical circuit is then closed at ground level to introduce current to ignition fuze **33** through contacts **29** and **32** to thus ignite charge **31**. The gases produced by charge **31** open discs **34** and **35** and are directed downwardly by chamber **16** against the body of cement **15**. Of course the upper and side walls of the firing chamber or "gas gun" **16**, in order to carry out their gas directing function, are adapted to withstand without rupture the force of the gas generating charge. The increase of pressure within the tool forces packer sleeve **17** outwardly to its Fig. 2 condition to seal off the casing against upward fluid flow and simultaneously force the cement downwardly and outwardly from the lower end of the tool body. As previously brought out, the connection between nose member **18** and the cement containing portion of the body is sheared by the force of the explosive to permit downward and outward flow of the cement. The extreme pressure squeezes out substantially all of the moisture from the cement and, together with the heating of the cement by the generated gases, causes it to set instantly. As the pressure within the tool diminishes after an operation, packer sleeve **17** resiliently returns to its normal condition of Fig. 1, permitting removal of the tool from the well, and check valves **22** permit inward passage of well fluid into the tool to equalize the pressures at the opposite sides of the tool body. The tool may be prepared for reuse by merely attaching a new nose member **18** to the lower end of the body, filling a new charge of cement into the body and inserting a new gas producing charge into the gas gun **16**.

I claim:

1. Apparatus for depositing cement in a zone within a well bore comprising a vertically elongated container, a body of cement in said container, a gas generating charge adapted upon ignition to displace the cement through a lower outlet in the container and into said zone, plugging means carried by the container above said zone and adapted to be urged against the well bore by the force of the charge to seal the bore against upward dissipation of said force, a closure retaining the cement against discharge through said lower container outlet, and means attaching said closure to the container and preformed to be sheared by the force of the charge to permit bodily opening of the closure and flow of the cement into said zone.

2. Apparatus for depositing cement in a zone within a well bore comprising a vertically elongated container, a body of cement in said container, a gas generating charge adapted upon ignition to displace the cement through a bottom outlet in the container and into said zone, plugging means carried by the container above said zone and adapted to be urged against the well bore by the force of the charge to seal the bore against upward dissipation of said force, a tapered nose member closing said bottom outlet of the container to retain the cement against downward flow therefrom, and a bayonet connection between said container and nose member preformed to be sheared by the force of the charge to permit said downward flow of the cement.

3. Apparatus for depositing cement in a zone within a well bore comprising a vertically elongated container, a body of cement in said container, a gas generating charge adapted upon ignition to displace the cement from the lower end of the container and into said zone, plugging means carried by the container above said zone and adapted to be urged against the well bore by the force of the charge to seal the bore against upward dissipation of said force, and a check valve in the wall of the container at a location above said lower end thereof for preventing outward flow of gases from the container at that location while permitting inward flow of well fluid thereinto.

4. Apparatus for depositing cement in a zone within a well bore comprising a vertically elongated tubular body having a lower portion adapted to contain a body of cement and having an upper perforated portion, means for mounting a gas generating charge within said body above the cement to serve upon ignition to displace the cement downwardly through the lower end of said container and into said zone, and a tubular resilient packer sleeve carried about said perforated portion of the body and peripherally clamped thereto at its opposite ends, said packer being resiliently expansible against the bore wall by the force of the charge to seal the bore against upward dissipation of said force, and being resiliently contractible away from said bore upon the reduction of said force.

5. Apparatus for depositing cement in a zone within a well bore comprising a vertically elongated tubular body having a lower portion adapted to contain a body of cement and having an upper perforated portion, a chamber removably carried by the upper end of said body for containing a gas generating charge and serving upon ignition of the charge to direct the produced gases downwardly through the body to displace the cement downwardly through the lower end of said container and into said zone, and a tubular resilient packer sleeve carried about said perforated portion of the body and peripherally clamped thereto at its opposite ends, said packer being resiliently expansible against the bore wall by the force of the charge to seal the bore against upward dissipation of said force, and being resiliently contractible away from said bore upon the reduction of said force.

6. Apparatus for depositing cement in a zone within a well bore comprising a vertically elongated tubular body having a lower portion adapted to contain a body of cement and having an upper perforated portion, a chamber removably carried by the upper end of said body for containing a gas generating charge and serving upon ignition of the charge to direct the produced gases downwardly through the lower end of said container and into said zone, a tubular resilient packer sleeve carried about said perforated portion of the body and peripherally clamped thereto at its opposite ends, said packer being resiliently expansible against the bore wall by the force of the charge to seal the bore against upward dissipation of said force, and being resiliently contractible away from said bore upon the reduction of said force, a closure for the bottom of said body retaining the cement against flow downwardly therethrough, means attaching said closure to the body and preformed to be sheared by the force of the charge to permit said downward flow of cement, and a check valve in the wall of

said body at the upper end of said lower imperforate portion thereof acting to prevent gas flow outwardly from within the body while permitting inward fluid flow.

7. Apparatus for depositing cement in a zone within a well bore comprising a body for containing cement and adapted to be lowered to said zone, a chamber removably mounted to said body above the contained cement and adapted to contain a gas generating charge, said chamber comprising a tubular vertically extending side wall and a transverse top wall rigidly carried thereby serving to direct the gases produced upon ignition of a contained charge downwardly against the cement to displace the cement from the body and into said zone, said walls being constructed to withstand without rupture the force of a gas generating charge sufficiently strong to displace the cement from the body, means including a disc for closing and sealing the lower end of said chamber and adapted to be opened by the force of said gases, and plugging means carried by the body above said zone adapted to be urged against the well bore by the force of the charge to seal the bore against upward dissipation of said force.

8. Apparatus for depositing a well treating material in a zone within a well bore comprising a body adapted to be lowered to said zone and adapted to contain a mass of well treating material, a gas producing charge carried by the body adapted to produce large quantities of pressurized gases at a location to displace the material from said container and against the well bore wall at said zone, means for firing said charge, and a packer unit carried by said body having an essentially annular portion formed of flexible material in communication with said gas producing charge and adapted to be expanded against the bore wall by the force of said pressurized gases at a location to seal the bore against upward dissipation of said gas force, said body being closed to communication of said gas pressure to the well bore wall above said packer, and said body including means adapted to pass said well treating material from the body to the exterior thereof beneath said packer upon firing of said charge.

9. Apparatus as recited in claim 8, in which said body has a lower portion for containing said well treating material, and has an upper tubular portion with an apertured side wall, said packer unit comprising a tubular resilient radially expansible packer disposed about said apertured upper portion of the body.

10. Apparatus as recited in claim 9, including a downwardly opening gun chamber within said upper tubular portion of the body and containing said gas producing charge, said gun chamber comprising wall means defining upwardly extending sides of said chamber and substantially closing its upper end and serving to direct the gases produced by said charge downwardly, said wall means being constructed to withstand without rupture the force of said charge fired therein, said means for passing said material to the exterior of the body comprising a bottom closure for the body preformed to be opened by the force of said gas producing charge.

11. Apparatus as recited in claim 8, in which said last mentioned means comprise a bottom closure for the body preformed to be opened by the force of said gas producing charge.

12. Apparatus comprising a body adapted to be lowered into a well, a downwardly opening gas gun chamber carried by said body and adapted to receive a gas producing charge for discharging large quantities of gases under pressure, means for firing said charge, a packer carried by said body in communication with said gas producing charge and adapted to be expanded against the bore wall by the force of said pressurized gases at a location to seal the bore against upward dissipation of the gas force, said body being open to communication of the pressure of said gases to the well bore wall beneath said packer, and being closed to communication of said gas pressure to the bore wall above said packer, and said gas gun chamber comprising wall means defining upwardly extending sides of said chamber and substantially closing its upper end and serving to direct the gases produced by said charge downwardly, said wall means being constructed to withstand without rupture the force of a charge fired therein and producing gases acting against the well bore wall beneath the packer.

13. Apparatus as recited in claim 12 in which said body has a lower portion for containing a mass of well treating material at a location to be displaced from the body and against the well bore wall beneath the packer by the force of said gases, said lower portion of the body including means adapted to pass said well treating material from the body to the exterior thereof upon firing of said charge.

14. Apparatus as recited in claim 12, in which said body has a tubular essentially vertically extending portion with an apertured side wall and disposed about said gas gun, and said packer comprises a tubular resilient expansible packer element disposed about said apertured portion of the body and peripherally fastened thereto in sealing relation at two vertically spaced locations.

15. Apparatus comprising a body adapted to be lowered into a well, a gas producing charge carried by said body and adapted to discharge large quantities of gases under pressure, means for actuating said charge to discharge said gases, a packer unit carried by said body having an essentially annular portion formed of flexible material in communication with said gas producing charge and adapted to be expanded against the bore wall by the force of said pressurized gases at a location to seal the bore against upward dissipation of said gas force, said body being open to communication of the pressure of said gases to the well bore wall beneath said packer, and being closed to communication of said gas pressure to the bore wall above said packer.

16. Apparatus as recited in claim 15, in which said body has a tubular essentially vertically extending portion with an apertured side wall, and substantially closed at its upper end, and said packer unit comprises a tubular resilient expansible packer element disposed about said apertured portion of the body.

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