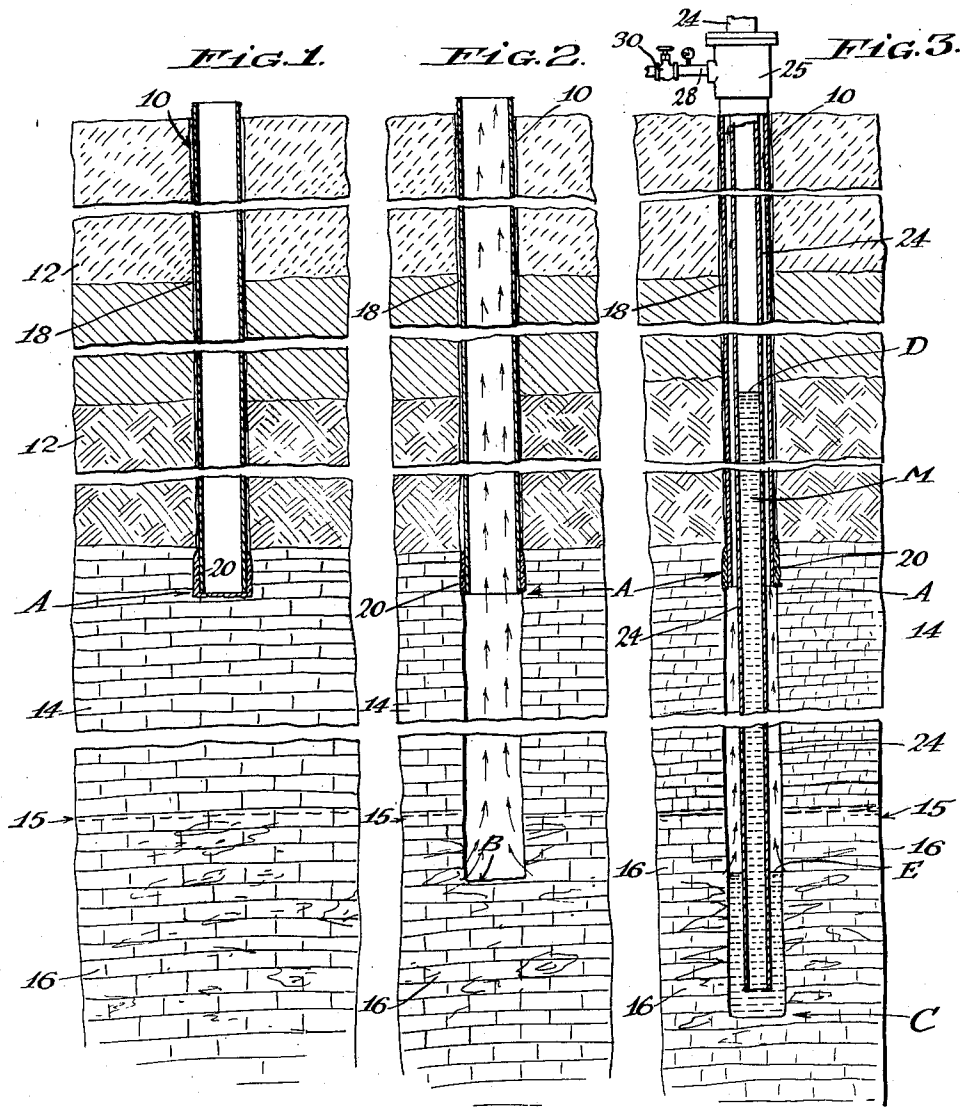
April 8, 1930. N. O. MILLER 1,753,440

METHOD OF DRILLING WELLS IN GAS FORMATIONS

Filed May 17, 1927 3 Sheets-Sheet 1



INVENTOR
NED O. MILLER.
Edmund A. Strauss
ATTORNEY

April 8, 1930. N. O. MILLER 1,753,440

METHOD OF DRILLING WELLS IN GAS FORMATIONS

Filed May 17, 1927 3 Sheets-Sheet 2

FIG. 4.

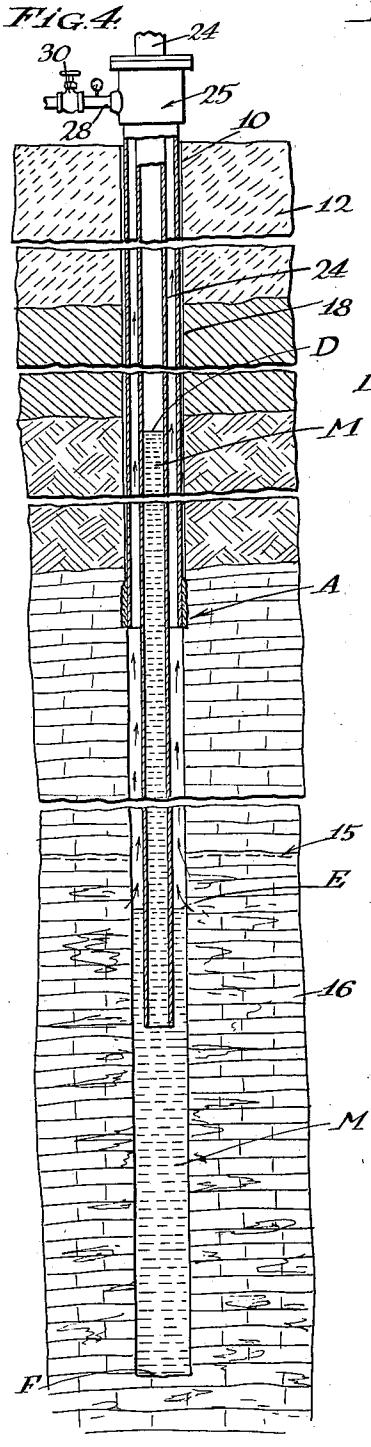


FIG. 5.

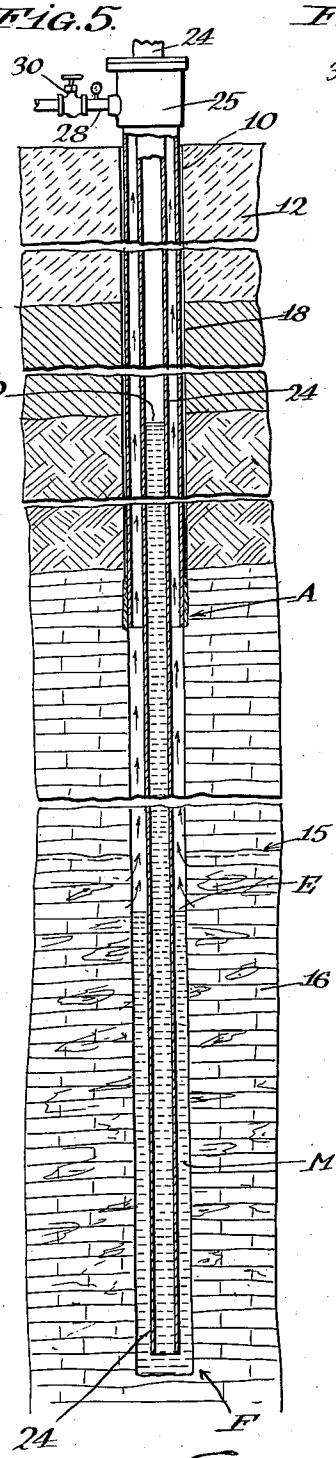
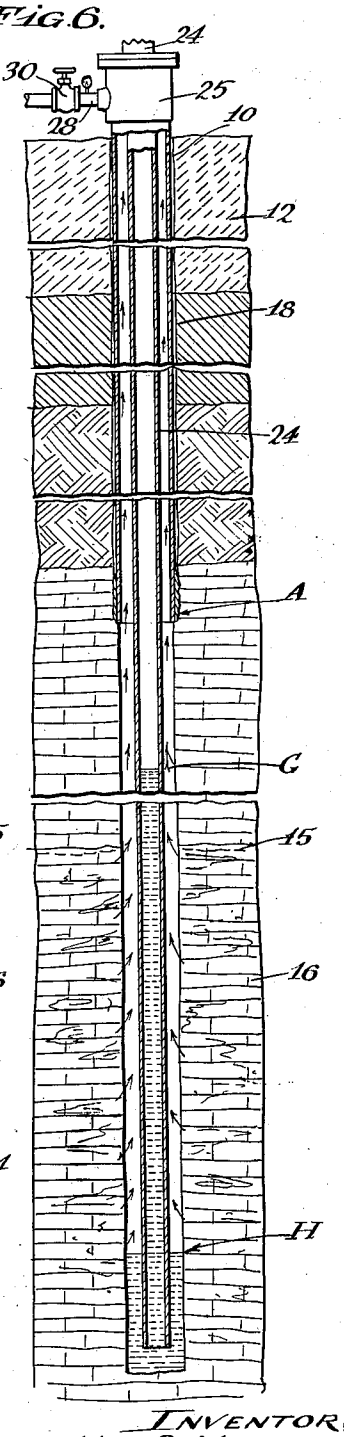


FIG. 6.



INVENTOR
NED O. MILLER.
Edmund A. Strauch
ATTORNEY.

April 8, 1930. N. O. MILLER 1,753,440

METHOD OF DRILLING WELLS IN GAS FORMATIONS

Filed May 17, 1927 3 Sheets-Sheet 3

FIG. 7.

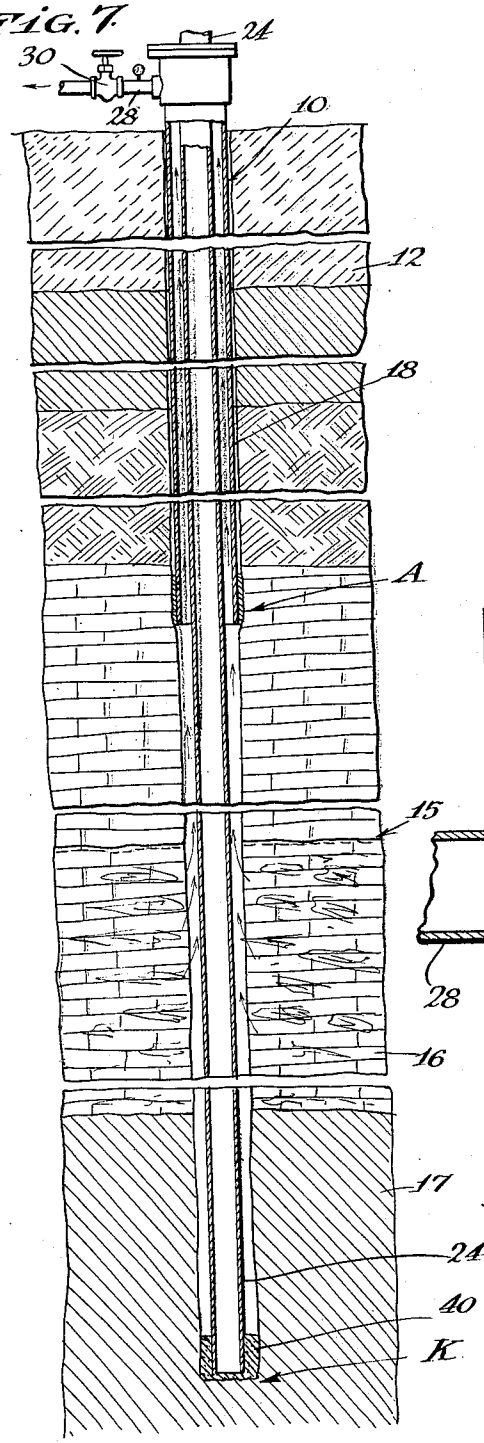
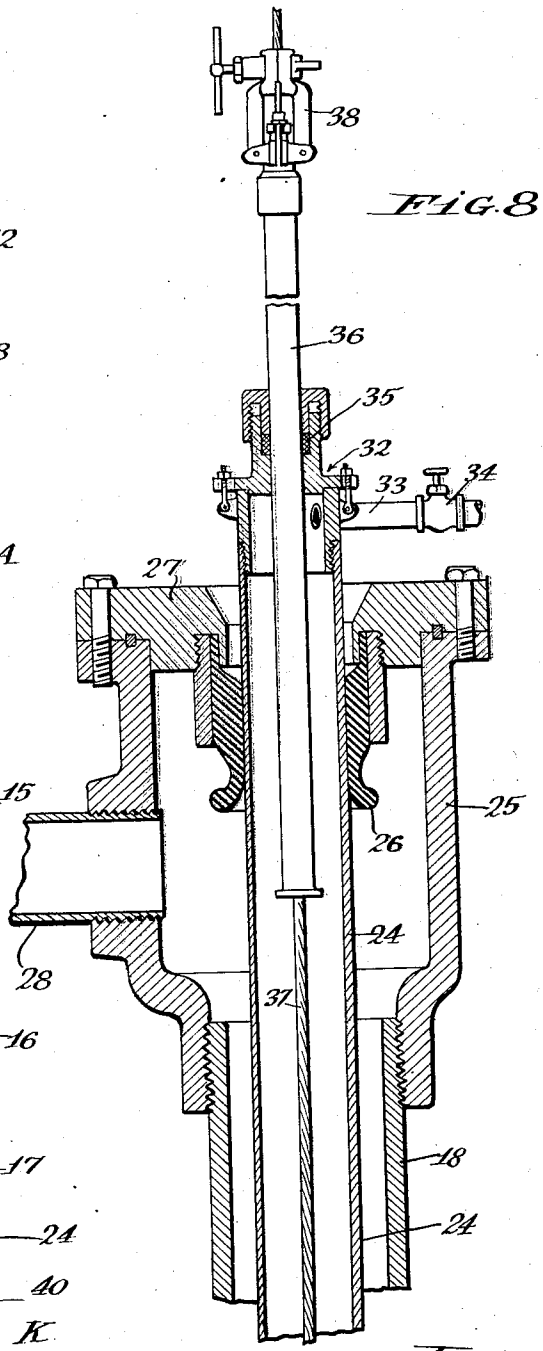


FIG. 8.



INVENTOR
NED O. MILLER.
Edmund A. Strauss
ATTORNEY.

Patented Apr. 8, 1930 1,753,440

UNITED STATES PATENT OFFICE

NED O. MILLER, OF AMARILLO, TEXAS

METHOD OF DRILLING WELLS IN GAS FORMATIONS

Application filed May 17, 1927. Serial No. 192,001.

This invention relates to the drilling of deep wells where gas formations are encountered or are expected to be encountered, and is a method for cutting off, controlling and conserving the gas which is tapped during the drilling operations while at the same time permitting drilling to continue.

It frequently happens where gas formations are found that, unless adequate means for control are provided, large quantities of gas escape and are wasted, and often blow-outs occur with consequent loss or damaging of tools, casing and equipment together with the more serious misfortune of dangerous fires and injuries to the workers.

It is the primary object of the present invention to make it possible to avoid these conditions and thoroughly control the gas flow when encountered.

Briefly, the invention resides in sinking the outer casing through the upper strata and then landing and cementing it off in the usual way, the landing being accomplished at a relatively short distance above the expected gas formation. The hole is then drilled below the casing until gas is encountered, whereupon an inner string is lowered into the hole and then capped and sealed off as with a blow-out preventer. Water, or drilling mud, is then introduced into the inner string sufficient to establish a hydrostatic head and rise up on the outside of the casing to balance the gas pressure. Drilling then continues below the string and through the mud while the hydrostatic head is maintained, water being added and the string being lowered as required. After having drilled through the gas formation into a gas-free formation, the said inner string is landed and cemented off, whereupon drilling therebelow may continue in the usual manner without danger, the gas having been effectually controlled and saved. The invention resides also in such other features of novelty as may be herein presented.

In the accompanying drawings wherein the various steps of the method are illustrated diagrammatically, Figs. 1 to 7 represent the successive major steps, wherein

Fig. 1 indicates the landing and seating of the outer casing somewhat above the gas horizon.

Fig. 2 indicates the further drilling until the gas formation is tapped.

Fig. 3 shows how the inner string is lowered and a hydrostatic head is built up therein to overcome the gas pressure thus far encountered.

Fig. 4 represents the drilling and reaming through the water to extend the hole into the gas formation while the hydrostatic head is maintained.

Fig. 5 indicates the lowering of the inner string to the bottom of the hole of Fig. 4.

Fig. 6 shows how the water is then bailed out to maintain only the hydrostatic head required and reduce the extent of water contact with the formation.

Fig. 7 represents the drilling beyond the gas formation into a gas-free formation and the landing of the inner string in the latter; and

Fig. 8 shows a type of blow-out preventer and a circulating head which may be employed in carrying on the various operations.

Commencing with the representation in Fig. 1, a hole 10 of the maximum desired size is drilled through the various upper sands and water strata 12 to a point —A— in a sub-stratum known or believed to be a short distance above the horizon 15 of the gas bearing stratum 16 which in turn might be above a gas-free stratum 17 (Fig. 7) below which oil-bearing formation is to be sought.

The outer casing 18 is then landed at the point —A— and is usually cemented in at 20 in order to shut off water or other undesired substances found in the strata above and to seal in gas to be encountered below. Drilling and reaming, as indicated in Fig. 2, are now continued until the hole penetrates to the point —B— in the gas formation 16. Drilling and reaming are then further continued, perhaps more cautiously, until gas is found in such amounts as to be wasteful or dangerous whereupon drilling is stopped at the point —C—, Fig. 3. Now an inner string of casing 24 is lowered into the hole and a blow-out preventer 25 of any desired type is connected, that shown being secured to the

upper end of the outer casing 18 and having (Fig. 8) a compressible rubber valve 26 carried by a closure 27, and also an outlet 28 to a gas line controlled by a valve 30. The upper end of the string 24 is capped with a circulating head 32 provided with a water inlet 33 controlled by valve 34 and with a packing gland 35 through which passes the barrel 36 of the drill cable 37 held by the grip 38.

The blow-out preventer 25 and the head 32 having been secured in position, water or drilling mud —M— or the like of sufficiently high gravity, is fed into the inner casing 24 and the outlet valve 30 is closed, the introduction of water or mud being continued by the well known method of lubricating the water into position in order to relieve all pressure in excess of atmospheric above the level —D— inside the casing string 24 (see Fig. 3) until a level is reached at —D— in the inner casing and at —E— outside the casing in order that the hydrostatic head in the casing between points —D— and —E— is increased sufficiently to balance the gas pressure, there being a sufficient head of liquid outside the casing to prevent the gas from breaking around the lower end thereof and blowing up through the liquid column.

This balancing of the gas pressure having been obtained, drilling and reaming is resumed and carried on in the liquid and below the end of the inner string until a point —F—, Fig. 4, has been reached which is deep enough for the attachment of another section of casing, liquid having been added meanwhile as required to keep up the hydrostatic head above the lower end of the string. The string is now lowered to a point adjacent to the bottom of the hole as indicated in Fig. 5 and the liquid is bailed out as indicated in Fig. 6 to lower the level in the string to the point —G— and in the hole to the point —H— which maintains the same hydrostatic head in the string 24 as before and restores the well to the same relative conditions as before by maintaining the same height of liquid outside the string. This makes it possible however to reduce the extent of liquid contact with the gas stratum to the minimum, which is a desirable condition to obtain. It is assumed that the gas pressure is the same as previously. However, if the gas pressure has increased during the last stage of drilling, the hydrostatic head in the casing string must be increased, accordingly in order to balance the pressure. It should be understood that, as above indicated, balancing as here used always includes the maintenance of a slight liquid head outside the inner string to prevent the gas from breaking around the lower end of said string. This slight head may be around 15 to 50 feet of water, for example.

Drilling and reaming may be again resumed to deepen the hole by another length, and these operations are repeated as often as necessary to drill through the gas formation 16 and into a stratum 17 which may or may not contain gas but at which point it is desired to set and cement the casing therebelow as indicated at —K— in Fig. 7, the liquid being then bailed down to establish the same condition as obtained by bailing in Fig. 6.

The casing string 24 may now be landed and cemented off as indicated at 40 thus sealing off the gas above the point —K— and confining it outside said inner casing, whereby it may be withdrawn from the outlet 28 or other attachment as desired. The cementing off at 40 may be accomplished in any preferred manner. For example, the required amount of cement may be dumped into the bottom of the hole by a dump bailer and a valved plug lowered on to the body of cement; mud is then pumped into the well to force the plug down and the cement up outside the casing until it assumes the position shown, it being then allowed to set.

The gas thus being effectually shut off and under control, it is merely necessary, after the cement has set, to bail out the mud and continue with drilling in the usual fashion until oil is reached. While the operation has been described with cable tools principally in mind, it may be readily adapted to rotary or combination tools.

From the foregoing it will be seen that gas may be cut off and controlled by lowering the inner string as required and keeping a head of liquid therein sufficient to balance the gas pressure while drilling is carried on through the liquid, the string being sealed off when the gas formation has been passed.

What I claim is:

1. A method for drilling wells through gas formations comprising landing an outer casing above the gas formation, equipping said casing with means to prevent blow-out, lowering an inner string through said means and continuing drilling below said casing, both said drilling and said lowering being accomplished while maintaining a pressure in said string sufficient to balance gas pressure encountered outside the string.

2. A method for drilling a well through a gas formation comprising landing an outer casing above said formation, lowering an inner string into said casing and sealing off between said casing and string, introducing liquid to establish a hydrostatic head in said string approximately sufficient only to balance gas pressure outside thereof encountered while passing through said formation, and drilling through said liquid below said string while maintaining said head.

3. A method for drilling a well through a gas formation comprising landing an outer casing above said formation, lowering an inner string into said casing and sealing off

between said casing and string at the top thereof, introducing liquid to establish a hydrostatic head in said string sufficient to balance gas pressure outside thereof encountered while passing through said formation and to trap the gas in the space between said casing and string, and drilling through said liquid below said string while maintaining said head, said inner string being lowered as drilling advances and while maintaining said gas pressure.

4. A method for drilling a well through a gas formation comprising landing an outer casing above said formation, lowering an inner string into said casing and sealing off at the surface between said casing and string, introducing liquid to establish a hydrostatic head only in said string sufficient approximately only to balance gas pressure outside thereof encountered while passing through said formation, and drilling through said liquid below said string while maintaining said head, said inner string being lowered as drilling advances, continuing drilling into a lower formation, lowering said inner string and sealing said string in said lower formation.

5. A method for drilling wells through gas formations comprising drilling to a point somewhat above the formation, landing an outer casing in the hole, drilling below the casing until gas is encountered, lowering an inner string into the hole, sealing between the casing and inner string to retain gas therebetween, introducing liquid into the inner string to rise outside thereof and to establish a hydrostatic head therein sufficient to approximately balance the encountered gas pressure, and drilling below the string through said liquid while maintaining the head on the liquid at approximately gas balancing value.

6. A method for drilling wells through gas formations comprising drilling to a point somewhat above the formation, landing an outer casing in the hole, drilling below the casing until gas is encountered, lowering an inner string into the hole, sealing between the casing and inner string to retain gas pressure therebetween, introducing liquid into the string to rise outside thereof to a limited extent only and to establish a hydrostatic head therein sufficient to balance the encountered gas pressure and permit the space between said casing and string to fill with gas, drilling below the string through said liquid while maintaining the head on the liquid, and as the hole is drilled lowering the string while maintaining said liqud head.

7. A method for drilling wells through gas formations comprising drilling to a point somewhat above the formation, landing an outer casing in the hole and cementing off the lower end thereof, drilling below the casing until gas is encountered, lowering an inner string into the hole, sealing near the surface between the casing and inner string, introducing liquid into the string to rise outside thereof and to establish a hydrostatic head therein sufficient to approximately balance the encountered gas pressure and trap the gas in the casing, drilling below the string through said liquid while maintaining the head on the liquid, drilling through the gas formation into sub-formation while maintaining the liquid head, and lowering the string and sealing off the same in said sub-formation while maintaining said head.

8. A method for drilling wells through gas formations comprising drilling to a point somewhat above the formation, landing an outer casing in the hole and cementing off the lower end thereof, drilling below the casing until gas is encountered, lowering an inner string into the hole, sealing between the casing and inner string at the surface, introducing liquid into the string to rise outside thereof a limited distance and to establish a hydrostatic head therein sufficient only to approximately balance the encountered gas pressure and permit the space between said casing and string to fill with gas, drilling below the string through said liquid while maintaining the head on the liquid, drilling through said gas formation into gas-free formation while maintaining said liquid head, lowering said string into said gas free-formation and cementing off therein while maintaining said head, bailing out said liquid, and continuing drilling.

9. A method for drilling wells through gas formations comprising landing an outer string of casing above the gas formation, mounting upon said casing means for retaining gas pressure and preventing blow-out and adapted to permit passage of an inner string of casing, lowering an inner string through said means and continuing drilling below said casing while maintaining a hydrostatic pressure in said string sufficient to balance gas pressure encountered outside the string.

10. A method according to claim 6 wherein, as the inner string is lowered the liquid head is adjusted to conform with changed levels of the lower end of said string and with changes in gas pressures.

In witness that I claim the foregoing I have hereunto subscribed my name this 7th day of May, 1927.

NED O. MILLER.