Sept. 3, 1957 R. W. FARRAR 2,804,928

CASING RUNNING CHOKE

Filed June 15, 1953

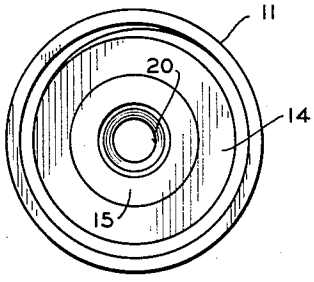


FIG. 2

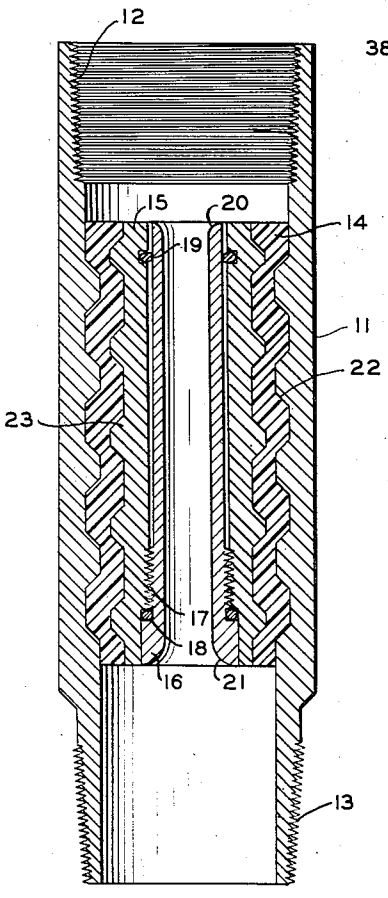


FIG. 1

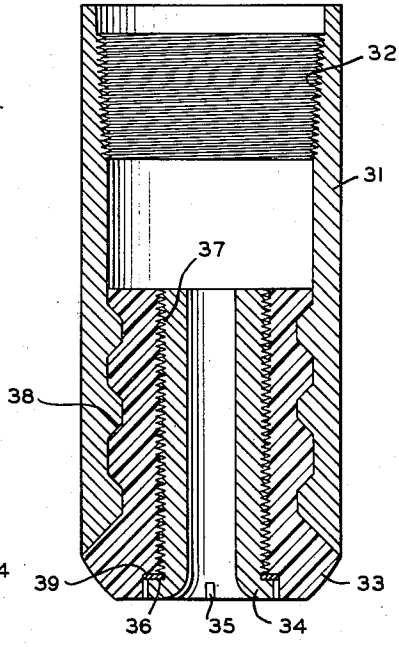


FIG. 3

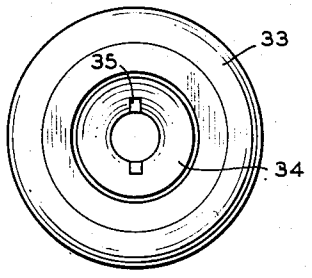


FIG. 4

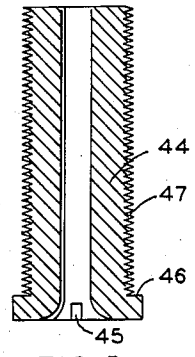


FIG. 5

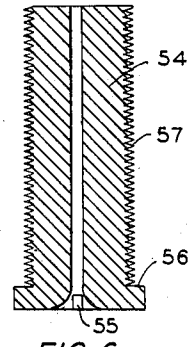


FIG. 6

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United States Patent Office 2,804,928 Patented Sept. 3, 1957

2,804,928

CASING RUNNING CHOKE

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Application June 15, 1953, Serial No. 361,647

3 Claims. (Cl. 166—224)

This invention relates to deep well casing running chokes. In one aspect it relates to an insertable deep well casing running choke. In another aspect it relates to an insertable choke having a predetermined diameter for use in running deep well casings.

In drilling deep wells by rotary methods, drilling muds are used for the prevention of blowouts, for removing drill cuttings and for cooling the drill bits. When a well is filled with drilling mud and an open end casing is run into the hole mud overflows from the top of the casing rather than from the annular space between the casing and the walls of the well.

To complete an oil or gas well many operators prefer to install a "float shoe" or "float collar" at or near the bottom of the casing string. Such a shoe or collar contains a check valve which allows downward flow of fluid through the pipe but prevents upward flow. Although such a device has certain advantages there are also very serious disadvantages, particularly in certain areas and fields. When using a float valve one disadvantage is that it is necessary to interrupt the casing running process periodically to fill the casing with drilling fluid from above to prevent collapse of the pipe due to the weight of fluid in the annulus which is unbalanced from within the pipe. The loss of time occasioned by the filling operation is in itself a disadvantage but not as serious as the difficulty with stuck casing which in certain areas is likely when the casing running process is interrupted for more than very short intervals.

Another very serious disadvantage to the use of conventional float valves is the large pressure build up which occurs opposite the lower end of the casing due to the drilling fluid displaced by the casing being forced through the narrow annulus between the casing and the walls of the well. In many cases this results in the break down of a permeable section of earth formation and loss of drilling fluid, thus increasing the danger of a blowout. Even if a blowout does not occur the formation may continue to take fluid after the cementing operation begins and thus prevent the cement from rising to the desired height outside the casing.

Another disadvantage of filling the casing from the top is that air pockets may be entrained. These air pockets, under critical conditions, can, when circulated into the annulus, lighten the column of mud sufficiently to cause a blowout.

Another disadvantage of filling the casing from the top is that in some cases plugging of the valve occurs due to settling out of lost circulation mud, cuttings, scale, etc.

Attempts have been made to solve the problems by using pressure controlled valves which allow filling from the bottom, but such have, in general, been unsatisfactory.

Usually the casing cannot be run completely open, since, when the casing is nearly as large as the hole, i. e., the annulus between the casing and the walls of the well is small in comparison to the cross section of the casing, the displaced drilling fluid will flow up through the casing and overflow on the drilling rig floor.

According to my invention I have devised an insertable restrictive casing choke for admission of mud into the bottom of the casing during running of the casing. I further provide that such a choke, or orifice, may be constructed of any suitable and predetermined size depending upon the rate at which it is desired to flow the mud into the casing and on other conditions. Such chokes of different diameters may be assembled into the same or different diameter casings.

During running of casing at a given rate of speed, I have found that when my casing running choke apparatus of a predetermined desired size and discharge characteristics dependent upon the size of casing, depth to which run, size of hole, and flow properties of the mud, is inserted into the bottom of the casing, the mud enters the casing at a rate which will maintain the liquid level inside the casing at a point close to but below the derrick floor and will not permit the mud to overflow from the casing onto the derrick floor.

An object of my invention is to devise a simple casing running choke.

Another object of my invention is to provide a casing running choke apparatus in which choke orifices of predetermined and desired sizes may be inserted.

Another object of my invention is to provide a casing running choke which is inexpensive to manufacture.

Still another object of my invention is to provide a casing running choke for permitting faster running of well casing.

Yet another object of my invention is to provide a simple casing running choke which can eliminate or replace the presently used complicated and difficult to operate equipment for controlling the flow of mud into the bottom of the casing during running operations.

Yet another object of my invention is to provide a simple casing running choke for controlling the flow of mud into the bottom of the casing without building up pressures within the well to a breaking point of weak formations.

Still other objects and advantages of my invention will be obvious to those skilled in the art upon reading the following specification and drawing, which respectively describes and illustrates preferred embodiments of my invention.

In the drawing, Figure 1 is a longitudinal sectional view of one embodiment of my invention.

Figure 2 is an end view of the apparatus of Figure 1.

Figure 3 is a longitudinal sectional view of another embodiment of my invention.

Figure 4 is an end view of the apparatus of Figure 3.

Figure 5 is a longitudinal sectional view of an embodiment of my invention for use with a portion of the apparatus of Figure 3.

Figure 6 is a longitudinal elevational view of still another embodiment of my invention which may be used with a portion of the apparatus of Figure 3.

Referring now to the drawing and specifically to Figure 1, reference numeral **11** identifies an elongated piece of tubing, a nipple or a collar having about the same diameter as that of the well casing. Threads **12** and **13** should be of such size and shape as to mesh operatively with a casing fitting or directly with threaded ends of casing sections. On the interior of the middle portion, longitudinally of this nipple **11** are corrugations **22**. An annulus of a plastic, resinous polymer or other material **14** is provided in such a manner that it fits tightly and securely against corrugations **22**. Preferably such material should be molded in place in the nipple **11**. Another annulus **15** which may be of metal is provided with corrugations on its exterior surface to mesh with the corrugations **22** of the material **14**.

A preferable method of manufacture is to insert a re-

movable plug, not shown, into the bottom end of the nipple **11** to such a point as desired for the bottom of the elements to be subsequently installed. After inserting such a plug the annulus **15** is placed upon this plug and properly positioned. A liquid material is then flowed into the space between the outer corrugated surface of the annulus **15** and the inner corrugated surface of the nipple **11**. This liquid material, after curing, on setting or hardening, forms the plastic or resin **14**. Such curing may be at atmospheric or elevated temperature, with or without added catalyst and at atmospheric or elevated pressure. After this curing operation, the aforementioned plug, not shown on the drawing, is removed and a choke tube **16** of predetermined inside diameter is inserted and held in place by threads **17**. The threads on the inner wall of the annulus **15** may be cut prior to the forming operation just described or they may be cut afterwards, as desired. One or more grooves may be cut in the outer wall of the choke tube **16** and in the inner wall of the annulus **15** for accommodation of O-ring seals **18** and **19**. The ends of the choke tube **16** may if desired be beveled or rounded to form surfaces **20** and **21** to improve the flow characteristics of the insertable choke tube **16**.

In the use of such a casing running choke as that just described the assembly may be installed on the bottom of the casing or at a joint or two above the bottom, as desired. When the choke tube **16** of proper diameter has been installed in the nipple **11** and the nipple placed at or near the bottom of the casing string the casing may then be run into the well. During the casing running operation it is intended that the drilling mud should flow upward through the choke tube **16** at such a rate that the level of the mud in the casing will remain at a point near but always below the drilling platform so as not to overflow thereon. If the choke tube **16** has too large a diameter, mud will enter the casing too rapidly and may overflow on the drilling platform. If the diameter of the choke tube is too small the mud will not enter the casing sufficiently fast and the casing running operation will be undesirably retarded.

To determine the proper size of choke tube **16**, a calculation involving several variables must be made. A sample calculation, illustrating the method of calculation which has been successful in field tests, follows:

ρ=Drilling fluid density (lbs./gal.)	9.2
Ty=Drilling fluid yield value (lbs./ft.^{2})	.0385
r=Drilling fluid rigidity (lbs./ft. sec.)	.0097
L=Depth of hole (ft.)	6942
V=Casing running speed (ft./sec.)	2
a=Average cross section of pipe (ft.^{2})	.068
A=Average cross section of annulus (ft.^{2})	.392
V_a=Equivalent fluid velocity in annulus (ft./sec.)	
(DAT)=Diameter of annulus between casing and hole (in.)	4
D=Diameter of hole (in.)	11
do=Outside diameter of pipe (in.)	7
di=Inside diameter of pipe (in.)	6.06
g=Acceleration due to gravity (ft./sec.^{2})	32.2

$$V_a=V\frac{a}{A}+\frac{1}{2}=2\frac{.068}{.392}+.5=1.35$$

P_a=Pressure drop in annulus, lbs. per sq. in.=

$$\frac{LT_y}{2.25(DAT)}+\frac{32 \text{ or } V_aL}{g(DAT)^2}$$

$$=\frac{6942(.0385)}{2.25(4)}+\frac{32(.0097)(1.35)(6942)}{32.2(4)^2}=35.3$$

P_p=Pressure drop in pipe, lbs. per sq. in.=

$$\frac{LT_y}{2.25di}+\frac{32rVL}{g(di)^2}$$

$$=\frac{6942(.0385)}{2.25(6.06)}+\frac{32(.0097)2(6942)}{32.2(6.06)^2}=23.2$$

P_c=Pressure drop across choke, lbs. per sq. in.=

$$P_a-P_p=35.3-23.2=12.1$$

D_c=Diameter of choke, in.=$2\sqrt{\frac{Q}{\pi c}}\sqrt[4]{\frac{16.76\rho}{Pcc}}$

Q=Quantity of fluid through choke (ft.^{3}/sec.)

$$=\frac{\pi}{576}Di^2V=\frac{\pi}{576}(6.06)^2 2=.400$$

C=Discharge coefficient of choke=0.9

$$D_c=\sqrt[2]{\frac{.400}{0.9\pi}}\sqrt[4]{\frac{16.76\times 9.2}{12.1}}$$

$$=2(.375)1.89=1.42 \text{ in.}$$

Using the above illustrated method of calculation the casing choke sizes used in the following examples were determined, and chokes of these sizes were used in running casings in the following wells:

Example I

Well	Location	Inside diam. of choke, inches	Length and diam. of casing	Diam. of hole, inches
Hudgens No. 1	Texas	1¼	6,588 ft. of 7" O. D.	8¾
Forrest No. 1	Texas	1¼	6,942 ft. of 7" O. D.	8¾
Puckett "E" No. 1	Texas	1¾	5,187 ft. of 9⅝" O. D.	12¼

In these three runs performance of the casing chokes was good in every respect.

If it is desired to use my casing running choke as a shoe element on the bottom of the string of casing the choke element may take the form illustrated in Figure 3. In this figure a resinous or plastic material **33** may be provided within pipe **31**, as shown. The inside wall of this element **33** is threaded to accommodate the annulus or choke tube **34**. Reference numeral **37** is intended to identify the meshing threads of the choke tube **34** and element **33**. Corrugations **38** hold element **33** rigidly in place. At the bottom end of the choke tube **34** is provided a shoulder **36** which may be tightened when against a gasket **39** so that the element **34** will not inadvertently become loosened. Slots **35** are provided for use of a tool for removing or inserting choke tube **34**. Threads **32** are provided at the upper end of the pipe **31** for fastening this apparatus to the end of the string of casing.

Figure 5 is intended to illustrate a choke tube **44** provided with threads **47** and a shoulder **46** for insertion into the member **33** of Figure 3 in place of the choke tube **34**. Slots **45** are for loosening or tightening this element. The choke tube of Figure 5 is intended to be exactly like the choke tube **34** of Figure 3 with the exception that its inside diameter is smaller. The use of such a choke tube of relatively small diameter would permit the running of a string of casing at a slower rate than when choke tube **34** was used.

In Figure 6 is illustrated still another choke tube **54** in which the inside diameter is still smaller. This choke tube of Figure 6 is provided with slots **55**, a shoulder **56** and threads **57** similar to those of the choke tubes of Figures 3 and 5.

The choke apparatus of my invention may be used in running casing in wells in which it is desired to cement the casing. When a casing cement job is to be done the cement may be pumped into the casing in a conventional manner. When sufficient cement has been introduced a follow plug is inserted and mud is pumped into the casing to lower the plug to force the cement down the casing,

out through the casing choke and up into the annulus between the casing and the walls of the well. The casing choke and its supporting elements are intended to be sufficiently rigid as to provide a shoulder on which the cement follow plug may rest. When the follow plug reaches this shoulder pressure is maintained on the mud in the casing until the cement has had ample time to set. After the cement has hardened to the desired extent and if it is desired to drill the well deeper the drill with its supporting tubing may be lowered into the well and the cement follow plug and the choke tube and its supporting elements are drilled out and the well continued on down to any desired depth.

Since the choke tube and its supporting elements may need to be drilled out they should be made of a material which can be drilled out. Such material may be resinous or plastic material adapted to be cured either catalytically or noncatalytically. The elements supporting the choke tube may also be constructed of metal providing it can be drilled out by conventional oil well drills. Such metals as pewter, Wood's metal, brass or other metal can be used provided it can be drilled out. It is obvious that steel should not be used since such metal could not easily be removed by an oil well drill.

The plastic, resin or metal element of Figure 3 may be cast-in-place in a manner described in relation to the annulus **14** of Figure 1. A blank may be used as a core to provide an axial opening throughout the length of element **33**. After curing or hardening of this material the blank may be removed and the inner cylindrical wall threaded to accommodate a threaded choke tube.

If it is not desired to drill a well deeper, after the cementing job the choke tube and its supporting elements may be left in the well. This latter condition would exist when the well had been drilled below an oil or gas producing formation. The casing would then be perforated adjacent the producing formation and the well produced in a conventional manner.

Example II

	(*a*)	(*b*)
ρ=Drilling Fluid Density (lbs./gal.)	9.2	15(.125)
T_y=Drilling Fluid Yield Value (lbs./ft.^{2})	.0385	.07-.18
τ=Drilling Fluid Rigidity (lbs./ft. sec.)	.0097	(.025).021-.032
L=Depth of Hole (ft.)	7,000	7,000
V=Casing Running Speed (ft./sec.)	1	4
a=Average Cross Section of Pipe (ft.^{2})	.068	.068
A=Average Cross Section of Annulus (ft.^{2})	.392	.392
V_a=Equivalent Fluid Velocity in Annulus (ft./sec.)	.673	2.69
(DAT)=Diameter of Annulus Between Casing and Hole (in.)	4	4
D=Diameter of Hole (in.)	11	11
do=Outside Diameter of Pipe (in.)	7	7
di=Inside Diameter of Pipe (in.)	6.06	6.06
g=Acceleration Due to Gravity (ft./sec.^{2})	32.2	32.2
P_a=Pressure Drop in Annulus, lbs. per sq. in.	32.7	126.5
P_p=Pressure Drop in Pipe, lbs, per sq. in.	21.5	83.2
P_c=Pressure Drop across choke, lbs./sq. in.	11.2	43.3
D_c=Diameter of Choke, in.	1.022	1.65
Q=Quantity of Fluid Through Choke (Ft.^{3}/Sec.)	.20	.80
C=Discharge Coefficient of Choke	.9	.9

The data of Example II obtained by the above illustrated method of calculation is illustrative of conditions in which casing running chokes of different sizes are adapted for use in running the same size casing into wells of the same diameter and depth.

The calculated diameters determined above (Example II) are merely illustrative of one method of calculation. In commerce, such chokes might be made to the closest one eighth inch diameter. For example, the 1.022 inch diameter can be made the standard diameter of 1 inch, and the (*b*) example, 1.65 inch, can be made 1⅝ inch.

Other suitable methods of calculation of the open diameter of a casing running choke can be used. The herein given method is merely exemplary of one method which has been found satisfactory and reliable in practice.

One important advantage of my casing running choke is the reduced warehouse inventory required. For any given size of casing it is merely necessary to maintain in stock an assortment of sizes of orifice tubes such as tubes **16** and **34** of Figures 1 and 3, respectively. No other part of the apparatus is required to be stocked in quantity.

While certain embodiments of my invention have been described for illustrative purposes the invention is obviously not limited thereto.

I claim:

1. A deep well casing running choke assembly for use in running well casing in a deep well containing drilling mud comprising, in combination, a pipe, means for attaching the upper end of said pipe to a deep well casing, a rigid annular member disposed coaxially with respect to said pipe and rigidly affixed to the inner wall thereof, a second rigid annular member disposed coaxially with respect to said first annular member and rigidly affixed to the inner wall thereof, and a third and removable rigid annular member having an unobstructed passageway of predetermined diameter and drilling mud flow characteristics disposed removably and rigidly within said second annular member so that drilling mud will not overflow the top end of the casing during casing running operations.

2. A deep well casing running choke assembly for use in running well casing in a deep well containing drilling mud so that the drilling mud will not overflow the top end of the casing comprising, in combination, a pipe, means for attaching the upper end of said pipe to a deep well casing, a corrugation on the inner wall of said pipe, a first rigid annular member having an exterior corrugation and being disposed coaxially with respect to said pipe and rigidly and immovably affixed to the inner wall thereof, said corrugation on the outer wall of said annular member fitting the corrugation on the inner wall of said pipe, the inner wall of said annular member being threaded, a second and removable rigid annular member having an unobstructed passageway of predetermined inner diameter and drilling mud flow characteristics being threaded within the threaded first annular member, and a seal intermediate the second annular member and the first annular member to seal against leakage of fluid therebetween.

3. A deep well casing running choke assembly for use in running well casing in a deep well containing drilling mud so that the drilling mud will not overflow the top end of the casing comprising, in combination, a pipe, means for attaching the upper end of said pipe to a deep well casing, a corrugation on the inner wall of said pipe, a first rigid annular member having an exterior corrugation and being disposed coaxially with respect to said pipe and rigidly and immovably affixed to the inner wall thereof, said corrugation on the outer wall of said annular member fitting the corrugation on the inner wall of said pipe, a corrugation on the inner wall of said first rigid annular member, a second rigid annular member having an exterior corrugation and being disposed coaxially with respect to said first annular member and rigidly and immovably fixed to the inner wall thereof, said corrugation on the outer wall of said second annular member fitting the corrugation on the inner wall of said first annular member, screw threads disposed on the inner wall of said second annular member, a third and removable rigid annular member having an obstructed passageway of predetermined inner diameter and drilling mud flow characteristics being threaded within the threaded second annular member, and a pair of seals intermediate said third and second annular members sealing against leakage of fluid therebetween.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

1,580,558	McLaine	Apr. 13, 1926
1,671,580	Greve	May 29, 1928
1,776,613	Baker	Sept. 23, 1930
1,882,314	Burt	Oct. 11, 1932
2,116,408	O'Leary et al.	May 3, 1938
2,161,283	Crowell	June 6, 1939
2,228,630	Kail	Jan. 14, 1941
2,253,537	Scaramucci	Aug. 26, 1941
2,401,665	Schick	June 4, 1946
2,571,478	Otis	Oct. 16, 1951
2,698,054	Brown et al.	Dec. 28, 1954