

April 8, 1969

E. T. CUGINI ET AL

3,437,149

CABLE FEED-THROUGH MEANS AND METHOD FOR WELL HEAD CONSTRUCTIONS

Filed May 31, 1967

Sheet 1 of 2

FIG. 2.

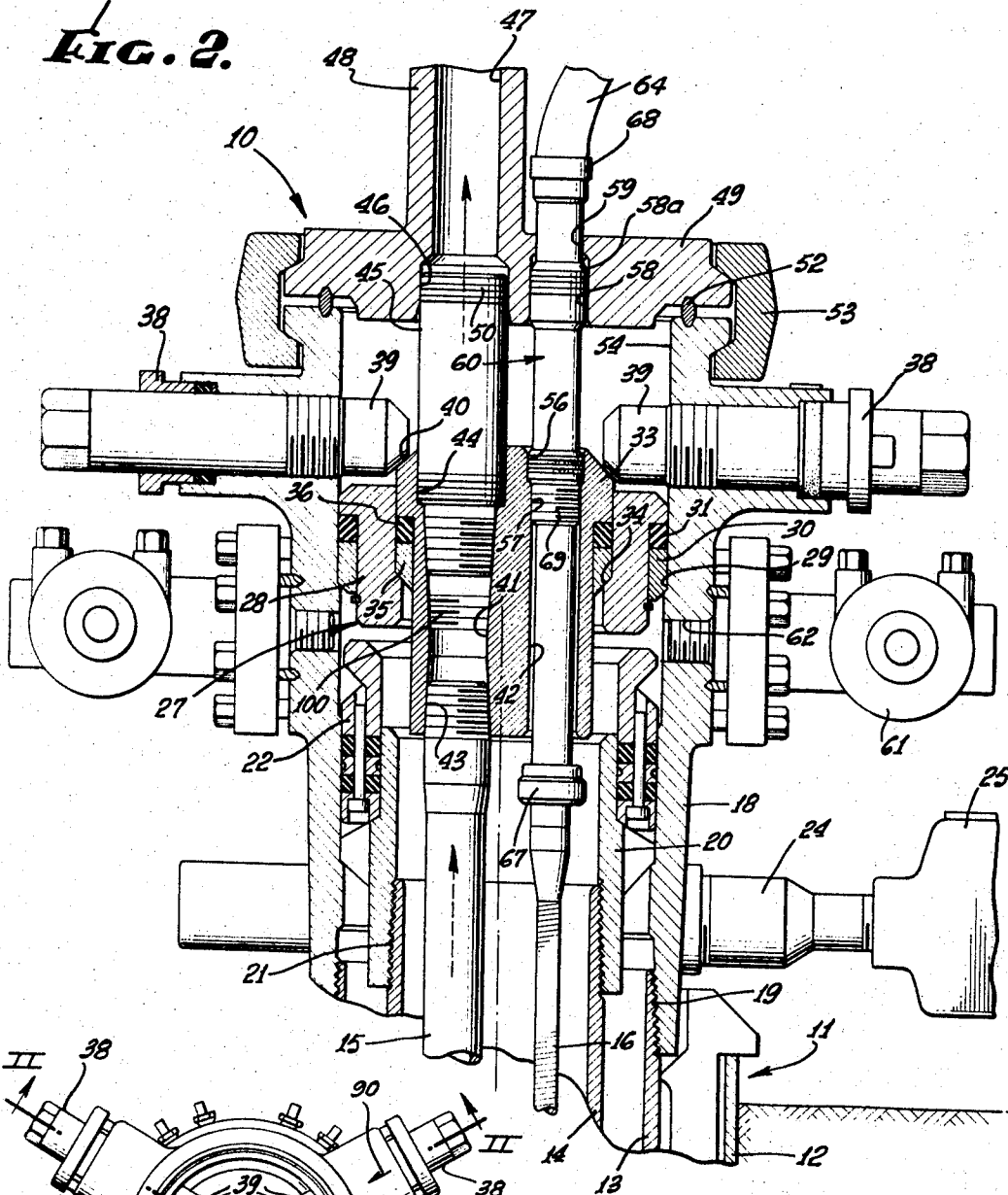
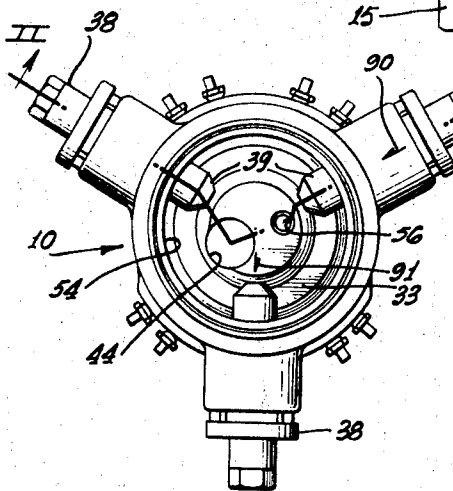


FIG. 1.



EDWARD T. CUGINI
WALLACE S. JEANNERETT
INVENTORS

By Miketta, Glenney, Pome & Smith

ATTORNEYS.

April 8, 1969

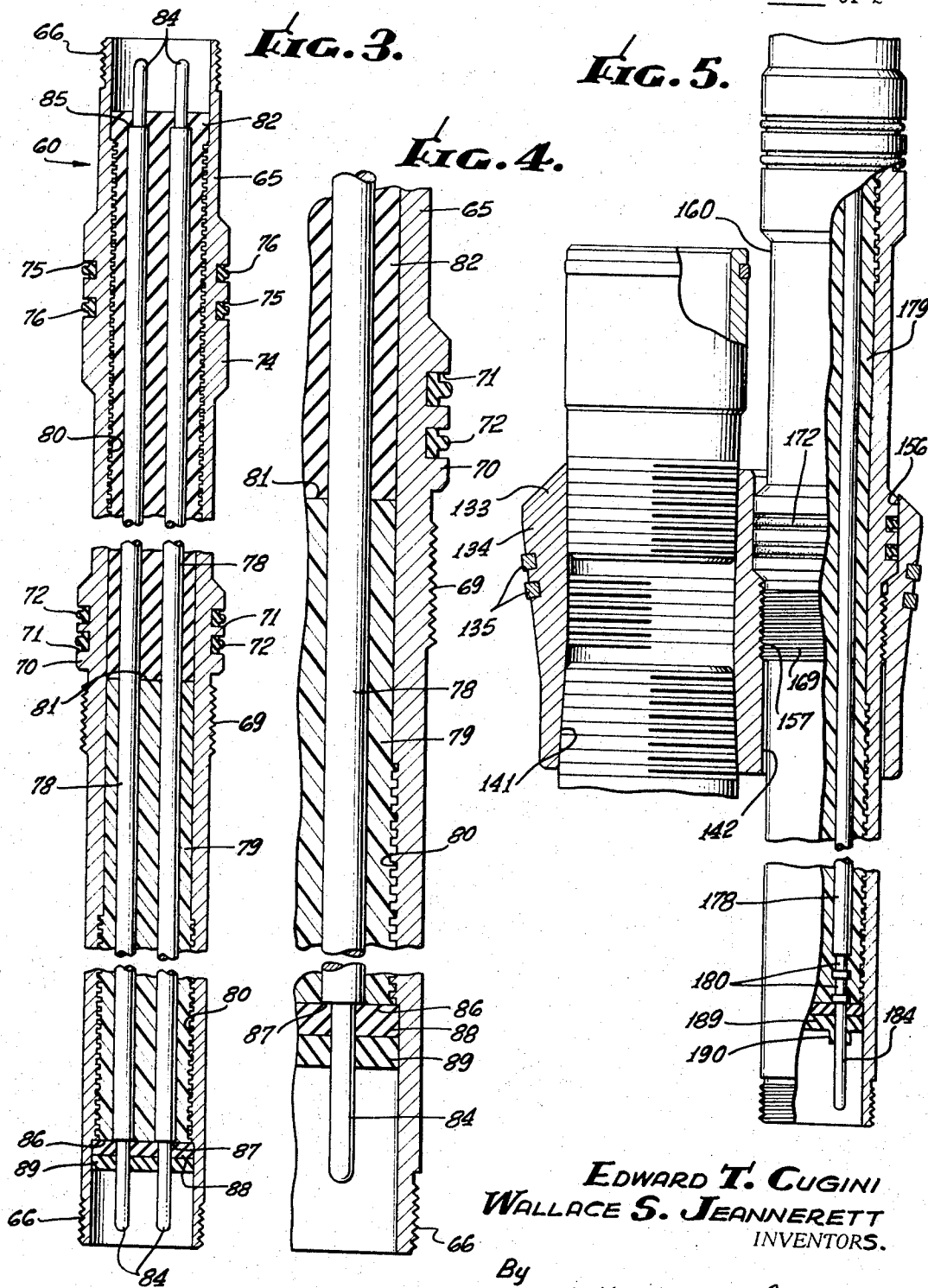
E. T. CUGINI ET AL

3,437,149

CABLE FEED-THROUGH MEANS AND METHOD FOR WELL HEAD CONSTRUCTIONS

Filed May 31, 1967

Sheet 2 of 2



EDWARD T. CUGINI
WALLACE S. JEANNERETT
INVENTORS.

By Miketta, Glenney, Pome & Smith
ATTORNEYS.

1

2

3,437,149 CABLE FEED-THROUGH MEANS AND METHOD FOR WELL HEAD CONSTRUCTIONS

Edward T. Cugini and Wallace S. Jeannerett, Brea, Calif.,
assignors to Shaffer Tool Works, Brea, Calif., a corpo-
ration of California

Filed May 31, 1967, Ser. No. 642,587

Int. Cl. E21b 23/00, 33/06; H01r 9/04

U.S. Cl. 166—315

14 Claims

ABSTRACT OF THE DISCLOSURE

A pressure resistant cable feed-through means extending from outside a well head construction to within a well casing and passing through a pressure zone in the well head with coupling means at opposite ends and conductors embedded in a dielectric material molded within and protected by a rigid metal casing or shell. The feed-through means facilitates assembly of a well head and may be carried by hanger means adapted to be passed through a blow-out preventor.

BACKGROUND OF THE INVENTION

Prior proposed well head constructions have included passing of electrical cable through a well head to the interior of the well head casing. Such prior constructions have usually required threading an armored or insulated electrical cable through hanger means or other well head parts in the well head and securing the cable as by clamps, and sealing or packing of the electrical cable against well pressures. Often splicing of the cable was required in or adjacent to such pressure zones in the well head construction. When the casing or well was under pressure or when pressure tests were being made through the well head construction, such prior proposed cable installations were subjected to such pressure that insulation was often damaged, cracked and conditions were created which sometimes caused rapid deterioration of the cable-insulation covering. When the insulation covering was penetrated and broken, dielectric characteristics of the insulation became reduced with the result that the cable might overheat, a short circuit might occur between conductors, and burning and destruction of the cable might occur. Moreover, threading and then clamping of such cable in the well head sometimes caused mechanical crushing of the cable insulation by the clamp means. This facilitated the more rapid deterioration of the cable insulation when the cable was subjected to internal well pressures within the well head construction. Moreover in such prior proposed cable well head arrangements, considerable time was employed in handling and threading the cable in the well head. Such installation was often made under dangerous and hazardous conditions without well blow-out preventors.

SUMMARY OF THE INVENTION

This invention relates generally to well head constructions and particularly well head constructions in which electrical energy or power is fed through a well head into the well casing for operation of various apparatus and tools used within the well casing. In an example of the invention, a rigid, pressure resistant, protected, power feed-through means is carried by a dual-type tubing hanger means and is so constructed and arranged as to facilitate assembly and disassembly of the well head when electrical power is desired for use in a well.

The present invention contemplates an electrical power feed-through means which obviates the disadvantages of the prior methods and apparatus for running an electrical cable through a well head apparatus and provides advantages not contemplated heretofore. The present invention generally comprises a well head cable feed-through means contained within an elongated rigid casing or shell secured to and supported from a tubing hanger and adapted to be attached to the tubing hanger when a tubing production string is assembled therewith. Electrical connection with a cable in the well casing is readily made through a pressure-type coupling connector device. The invention contemplates such a cable feed-through means which is readily and conveniently packed off or sealed not only when assembled with the tubing hanger means but also when a top sealing flange for the well head is assembled with the well head. The internal arrangement of conductors embedded within one or more bodies of dielectric material molded in the metal shell prevents pressure leaks through the cable feed-through means and also protects the bodies of dielectric material from deterioration caused by mounting or securing the feed-through means or from pressure conditions within the well head.

It is therefore a primary object of this invention to disclose and provide a well head construction having novel means and a method for utilizing and installing electrical cable in a well.

An object to this invention is to disclose and provide a cable feed-through means for a well head construction which facilitates assembly and installation of a well head under blow-out preventor conditions.

Another object of the invention is to disclose and provide a cable feed-through means wherein electrical conductors and insulation therearound are protected from well pressures, well conditions, and well testing pressures.

A further object of the invention is to disclose and provide a well head construction having a cable feed-through means associated therewith in novel manner and including a rigid casing connected with a hanger means and with a sealing flange covering a casing head.

Still another object of the invention is to disclose and provide a cable feed-through means having a rigid casing or shell housing a plurality of conductors in dielectric material, the casing extending through a well pressure zone and having coupling means for connecting opposite ends of the conductors and casing to a cable within the well and an electrical power source without the well.

A specific object of the invention is to disclose and provide a cable feed-through means having a novel arrangement of casing, conductors, and dielectric material for providing effective resistance to well pressures, fluid well conditions, and deterioration of insulation for said conductors.

Various objects and advantages of the present invention will be readily apparent from the following description of the drawings which show an exemplary embodiment of the invention.

In the drawings:

FIG. 1 is a top plan view of a well head apparatus embodying this invention with a sealing flange removed.

FIG. 2 is an enlarged fragmentary sectional view of the well head apparatus shown in FIG. 1, the sectional view being taken in the vertical plane indicated by line II—II of FIG. 1.

FIG. 3 is an enlarged sectional view of a cable feed-through means embodying this invention, the section being taken in a plane passing through the axis of the feed-through means.

FIG. 4 is an enlarged fragmentary sectional view of the feed-through means shown in FIG. 3 and taken in the same plane as FIG. 3.

FIG. 5 is an enlarged fragmentary view of a tubing hanger and an associated cable feed-through means embodying a modification of the invention.

In the drawings a well head apparatus generally indi-

cated at 10 embodying this invention may be associated with a casing means 11 which extends into a well hole and is of well-known construction and arrangement. In this example, within an outer pipe 12 may be concentrically arranged an intermediate casing 13 and an inner casing 14. Inner casing 14 may receive in spaced relation a production tubing 15 and an electric power cable 16. The production tubing 15 may extend into the well for passage therethrough of well fluids such as oil, water, etc. The power cable 16 extends into the well for connection with various types of electrically actuated devices adapted for use within the casing means and the well.

In general, well head apparatus 10 may comprise a casing head means 18 having a threaded connection at 19 to the upper end of intermediate casing 13. Within the lower portion of casing head 18, a mandrel body 20 is threaded as at 21 to the upper end of inner casing 14. A replaceable packing unit 22 provides a seal between the upper portion of mandrel body 20 and the opposed inner surface of casing head 18. Below the replaceable packing unit 22 is thus formed an annular zone between the inner casing 14 and the intermediate casing 13 to which communication may be provided by a suitable nipple 24 on the casing head and an associated valve means 25.

Above mandrel body 20 hanger means are provided for supporting production tubing string 15 and electrical cable 16 which extend into the well casing. The hanger assembly generally indicated at 27 may comprise a primary hanger body 28 landed on an inwardly and downwardly tapered annular surface 29 through an annular gland means 30 which includes a seal ring 31. Within the primary hanger body 28 may be landed a tubing hanger body or support means 33 through a tapered inwardly annularly inclined landing surface 34 on the primary hanger body and a packing gland means 35 which includes a seal ring 36. Locking screws 38 in circumferential spaced relation about casing head 18 provide beveled ends 39 for wedge engagement with a beveled surface 40 on top of tubing hanger body 33 for securing the tubing hanger body and the primary hanger body 28 in assembled relationship with the casing head 18.

The tubing hanger body 33 may extend below the primary hanger body 28 and partially into the mandrel body 20. Hanger body 33 may be provided with a pair of throughbores 41 and 42 having axes lying in a plane offset from the geometric axis of the tubing hanger body 33. Throughbore 41 may be provided with a bottom threaded connection as at 43 to the upper end of production tubing string 15. Above threaded connection 43, threads 100 provide a connection to a suitable back pressure valve (not shown) which may be installed in the tubing hanger for and during landing thereof and then later removed for a production operation as later described. The upper end of throughbore 41 may be slightly enlarged to provide a socket at 44 for reception of the lower end of a spacer pipe 45. The upper end of spacer pipe 45 may be received in an enlarged socket 46 provided at the lower end of a bore 47 formed in upstanding hub 48 of seal flange 49. Packing means 50 seals the ends of spacer pipe 45 in the sockets 44, 46.

The seal flange 49 covers and closes the top of casing head 18. Between opposed peripheral marginal faces of seal flange 49 and of casing head 18 is mounted a gasket ring 52 which may be suitably compressed by well-known annular clamp means 53. Seal flange 49 and the hanger means 27 including the primary hanger and tubing hanger define a well head pressure test zone 54.

Suitable valve means 61 may be carried by casing head 18 and provided communication through a port 62 with pressure test zone 54 and the inner casing 14 through the circulating mandrel body 20. Suitable testing ports for the several zones in the casing head may be provided in well-known manner and are not shown.

Throughbore 42 of tubing hanger 33 is provided with an upwardly facing enlarged socket 56 and somewhat reduced in diameter threaded section 57 adjacent thereto.

Seal flange 49 is provided with a downwardly facing enlarged socket 58 and an opening 59 both of which are axially aligned with the axis of throughbore 42.

Means for providing a rapid facile connection to cable 16 during assembly of the well head construction while maintaining blow-out prevention comprises a unitary pre-assembled power feed-through means 60 which extends below tubing head 33 and into mandrel body 20, through pressure zone 54 above tubing head 33, and through opening 59 for connection above the seal flange 49 with a feed cable means 64. Feed-through means 60 is best seen in FIG. 3. An elongated rigid tubular hollow housing or shell 65, which may be made of suitable metal material such as steel, is provided with opposite threaded ends 66 for connection to suitable pressure-type couplings 67 and 68 for securing and protecting under pressure conditions electrical cable connections to conductors of the feed-through means. Shell 65 includes a threaded portion 69 intermediate its ends for engaging internal threads of throughbore 42 at 57 to secure shell 65 to tubing hanger 33.

Adjacent to threaded portion 69, shell 65 may be provided with an enlarged external annular portion 70 having a pair of annular grooves 71 which carry annular sealing or packing rings 72. The enlargement 70 with seal rings 72 are received within socket 56 of tubing hanger 33 when the shell 65 is threadedly connected to threads 57 and provides a pressure seal of the cable feed-through device 60 with tubing hanger 33.

Spaced from enlarged portion 70 a preselected distance, shell 65 includes a second enlarged annular portion 74 provided with a pair of spaced grooves 75 which receive seal rings 76. Enlarged portion 74 and seal rings 76 are received within socket 58 of sealing flange 49 to provide a pressure seal therewith when sealing flange 49 is assembled with casing head 18.

Within shell 65 are a plurality of electrical conductors 78 arranged in spaced parallel relation. Conductors 78 may be solid copper of selected gauge and are embedded throughout approximately their entire length in dielectric material formed within shell 65 as by molding under pressure. In this example, approximately the lower one-half of the length of shell 65 may be filled with a dielectric material having characteristics of rigidity, hardness, toughness, and chemically resistant and unaffected by chemical conditions within a well. Such a dielectric material may comprise suitable epoxy compositions.

Epoxy material 79 is molded under selected ram pressures in shell 65 in such a manner that the material 79 fills internal grooves 80 formed on the internal surface of shell 65 as by cutting threads having a suitable pitch and depth. In this example, a suitable pitch may be about six threads per square inch and a suitable depth of grooves may be approximately .015 inch. In general, the configuration of the thread may be square cut. The employment of threads 80 on the internal surface of shells 65 provides continuous interlocking of the molded epoxy material with the shell. In addition, there is a substantial increase in interfacial contact area between the epoxy material and the shell for bonding of the epoxy material to the internal surfaces of the shell. Thus, the lower portion of shell 65 provides a construction which, when subjected to relatively high well pressures such as at 3,000 p.s.i. and above, will withstand and resist pressure leaks within the shell 65. Deterioration of the epoxy material under pressure and adverse chemical conditions is thus minimized and is effectively reduced.

In the approximately upper one-half of shell 65 and as shown in this example, above the external thread 69, the conductors 78 may be embedded as by pressure molding in a dielectric material having characteristics of being softer and more flexible than epoxy material 79 and yet being pressure and chemical resistant, such as selected neoprene rubber-like compositions. In this example, the upper portion of shell 65 is similarly provided with inter-

nal square-cut threads 80 for a substantial portion of the upper one-half of the shell. The neoprene material 82 is similarly molded under pressure within shell 65 to provide a tight bond between the material 82 and the conductors 78 and shell 65. Between internal threaded portions of shell 65, the central internal surface portion may be cylindrical and generally uninterrupted with the two dielectric materials bonded thereto and having end faces in molded bonded contact as at 81.

In this example, the upper end portion of the molded neoprene material 82 partially covers the projecting electrical contact prongs 84 formed at the end of conductors 78 and serving to longitudinally position conductors 78 by molded interengagement of material 82 with shoulders 85 defining prongs 84. In the bottom half of shell 65, the epoxy material 79 is molded with an end face 86 lying in the same plane as shoulders 87 on the conductors 78 and defining the bottom prongs 84. Against end face 86 and shoulders 87 may be seated a contact alignment disc 88 having an interfacial seal with a neoprene disc 89 positioned thereover.

Couplings 67 and 68 may be of pressure-type of suitable manufacture and may be readily electrically engaged with prongs 84. It will be readily apparent that conductors 78 are embedded in epoxy and neoprene material which is bonded and interengaged with shell 65 and the conductors so that pressure leaks therethrough are substantially minimized and virtually eliminated.

In the modification shown in FIG. 5, a different construction of tubing hanger is illustrated and is identified at 133 and is adapted to be landed in a tubing head without the use of a primary hanger as described in the prior embodiment. External surfaces 134 are outwardly flared and provide sealing glands 135 in such surface. The tubing hanger 133 includes throughbores 141 and 142. Throughbore 142 provides threads at 157 and a socket at 156 for connection respectively to a threaded portion 169 of a power feed-through device 160. Above the threaded section 169 is provided enlarged packing means 172 for reception within socket 156 as heretofore. The feed-through device 160 includes solid conductor cables 178 embedded in dielectric material 179 as in the prior embodiment. In this example, the lower end of conductor 178 may be provided with spaced annular recesses 180 for embedment and interlocking engagement with the material 179. Contact disc 189 may be provided with an annular integral collar 190 encircling terminal 184 and cooperable with a coupling connector (not shown).

In each of the embodiments described above the tubing hanger may be prepared for installation by connecting a production string 15 thereto. A back pressure valve may be installed in bore 41; other types of pressure holding devices may be used in the production string or well if desired. Feedthrough means 60 (or 160) may then be threadedly connected at 57 to the tubing hanger with packing 72 in tight sealing engagement with socket 56 in the hanger. The bottom end of feed-through 60 extends below hanger 33 for coupling to cable 16 by coupling connector 67. When tubing 15, back pressure valve feed-through means 60, and connector 67 are in assembly with the tubing hanger, the hanger may be landed through a blow-out preventor (not shown) on the primary hanger 33 (or 133). The upper portion of feed-through means 60 extends above the tubing hanger. Upon installation of the spacer pipe 45 and lowering of a seal flange over the casing head, the upper packing 76 is sealingly engaged in socket 58 in the seal flange and assembly thereof completed.

It should be noted that in the event well pressures cause release or breaking of the threaded connection at 57 of the feed-through means 60 with the hanger 33, the shoulder 58a formed on sealing flange 49 at the bottom of socket 58 will serve as a stop means to prevent disassembly of the feed-through means with the sealing flange and well head.

To facilitate such installation where the feed cable includes a bent or curved portion above seal flange 49, index or reference marks 90 and 91 (FIG. 1) may be provided respectively on the upper portion of the casing head and on the tubing head. Alignment of the marks 90, 91 locates the feed-through means for easy coupling to a feed cable 64.

It will be readily apparent to those skilled in the art that the cable feed-through means facilitates speed of installation of a tubing head means with an electrical connection therethrough. Provision of pressure-type electrical coupling connectors at ends of the rigid shell provide further protection against pressure leaks through the cable connection.

When it is desirable to pressure test the well head construction, the internal well pressures are resisted by steel shell 65 and the effect of pressure at ends of the steel shell and upon the dielectric material is substantially eliminated and minimized.

It will be understood that the feed-through means of this invention may be made integral with a tubing hanger, that is, top or bottom nipple-like or metal extensions may be provided on a tubing hanger in alignment with a throughbore and conductors plotted or embedded in dielectric material within the bore and extensions. The extensions may have coupling connectors at their ends. A throughbore in a tubing hanger may provide a bottom coupling connection to a cable and only an upper pipe extension with a packing means may be provided above the hanger. In each instance, the invention contemplates that the conductor feed-through for the tubing hanger be protected by a metal pressure shell which facilitates assembly of a well head and which prevents damage, mutilation, deterioration and break down of the dielectric material under pressure, test, and operating conditions found in a well head installation.

While exemplary dielectric material as epoxy and neoprene have been described, other types of pressure and chemical resistant dielectric material may be used, such as glass and synthetic plastic compositions which bond tightly to metal and which will prevent interior leakage along the interfaces of the metal and dielectric material.

It will be understood by those skilled in the art that various modifications and changes may be made in the example of the invention described above and all such modifications and changes coming within the scope of the appended claims are embraced thereby.

We claim:

1. In a well head apparatus including a casing head means, the combination of:

hanger means supported from said casing head means; a sealing means for said casing head means spaced above said hanger means and defining therewith a pressure zone;

means providing a throughbore in the hanger means with an enlarged bore portion at its upper end;

means providing a throughbore in said sealing means with an enlarged bore portion opposed to the enlarged bore portion of the hanger means;

a unitary cable feed-through means carried by said hanger means, passing through said throughbores of the hanger means and sealing means and adapted to be assembled with the hanger means before landing in the casing head,

said feed-through means having packing means for sealing engagement with the enlarged bore portion of the hanger means;

packing means on the feed-through means for sealing engagement with the enlarged bore portion of the sealing means is assembled with the casing head means;

and cable coupling means at opposite ends of said cable feed-through means and below said hanger means and above said sealing means;

whereby said cable feed-through means may be assembled with said hanger means and connected to a cable

within a well by said coupling means, said tubing hanger means being then adapted to be landed within said casing head, and said sealing means assembled over said packing means on said feed-through means and assembled with said casing head.

2. A well head apparatus as stated in claim 1 wherein the feed-through means includes a pressure shell extending above and below said hanger means.

3. In a well head apparatus having a casing head means provided with a hanger means, the combination of:

a tubing hanger means adapted to be landed in said hanger means,

said tubing hanger means including a throughbore having internal threads at one end;

a unitary cable feed-through means extending through the throughbore of said tubing hanger means, said feed-through means having coupling means at one end for connection to a cable below the tubing hanger means and coupling means at the opposite end for connection to a feed cable,

said feed-through means including a continuous rigid pressure shell having threaded engagement with the internal threads of said hanger means and having means for sealing engagement with said tubing hanger means.

4. In a well head apparatus as stated in claim 3 including a sealing flange spaced above said tubing hanger means; and

means on said shell for sealing engagement with said sealing flange.

5. A well head apparatus as stated in claim 4 including stop means on said sealing flange for said pressure shell.

6. In a well head apparatus as stated in claim 3 wherein said feed-through means includes a plurality of spaced conductors with said shell:

a pressure resistant dielectric material molded about said conductors and bonded to said shell; and

a relatively soft deformable dielectric material molded about said conductors in an adjacent portion of the shell and bonded thereto.

7. A well head apparatus as stated in claim 3 wherein said cable feed-through means includes:

one or more conductors within said shell;

a body of epoxy material embedding said conductors in one portion of said shell; and

a body of neoprene material embedding said conductors in a continuous portion of said shell.

8. A cable feed-through means for use in a well head apparatus including a pressure zone comprising:

an elongated hollow tubular pressure shell of metal;

a rigid dielectric material in one portion of said shell and bonded to internal surfaces thereof;

a flexible deformable dielectric material in an adjacent portion of said shell and bonded to internal surfaces thereof;

a plurality of spaced parallel conductors embedded and molded in continuous relation within said dielectric material;

pressure washers of dielectric material at one end of the body of rigid material for transmitting pressure to the end face of said rigid material; and

spaced external packing means on said pressure shell for sealing engagement with spaced parts of a well head apparatus on opposite sides of the pressure zone.

9. A cable feed-through means as stated in claim 8 including means adjacent one packing means for connecting said shell with a hanger means.

10. In a method of installing an electrical power feed in a well head under blow-out conditions, said well head including a casing head, and a hanger means, the steps of:

passing a lower portion of a pressure shell enclosed cable feed-through means through an opening in said hanger means and securing the same thereto before landing said hanger means in said casing head;

connecting an electric cable to the feed-through means before landing of the hanger means;

landing the hanger means in said casing head;

passing an upper portion of said feed-through means through a sealing flange while said flange is being assembled with said casing head; and

connecting an electric feed cable to the upper portion of the feed-through means after the sealing flange is secured to the casing head.

11. In a well-head apparatus, the combination of:

a casing head means;

means for supporting a tubing and an electrical feed-through means, said supporting means being removably seated on said casing head means;

said feed-through means including a rigid shell extending through an opening in said support means, said shell having means for sealing engagement with and for connection to said support means,

said shell extending above and below said support means for coupling to electrical cable at locations above and below said support means,

and continuous conductor means embedded in dielectric material for approximately the entire length of said shell.

12. In an apparatus as stated in claim 11 including stop means supported from said casing head above said support means and cooperable with said rigid shell.

13. In a method of installing an electrical power feed in a well head under blow-out conditions, said well head including a casing head, and a hanger means, the steps of:

passing a lower portion of a pressure shell enclosed cable feed-through means through an opening in said hanger means and securing the same thereto before landing said hanger means in said casing head;

connecting an electric cable to said lower portion of the pressure shell enclosed feed-through means before landing of the hanger means;

landing said hanger means in said casing head with an upper portion of the pressure shell feed-through means extending above the hanger means;

and connecting an electric feed cable to said upper portion of the feed-through means after the hanger means is secured to the casing head.

14. In a method of installing an electrical power feed in a well head, said well head including a casing head and a supporting means for tubing and electrical feed-through means, the steps of:

passing a portion of a rigid pressure shell enclosing cable feed-through means through an opening in said support means,

sealing and securing the shell to the support means before assembling said support means with said casing head;

connecting an electric cable to said pressure shell feed-through means at the aforesaid portion of said pressure shell,

seating the support means on the casing head and removably securing the same thereon,

and connecting an electric feed cable to a portion of the feed-through means on the opposite side of said support means after the support means is secured to the casing head.

References Cited

UNITED STATES PATENTS

2,001,946	5/1935	Tschappat	166—88 X
2,707,030	4/1955	Ortman	166—88
2,760,579	8/1956	Kabakoff	166—75
2,931,379	4/1960	Haydin	166—75 X
2,991,441	7/1961	Butler et al.	339—218 X
3,290,639	12/1966	Driemeyer	339—218 X

JAMES A. LEPPINK, *Primary Examiner.*

U.S. Cl. X.R.

75 166—88; 339—218