Nov. 20, 1962 L. W. TOELKE 3,064,734

BRIDGE PLUG

Filed Oct. 13, 1958 5 Sheets-Sheet 1

Fig. 1

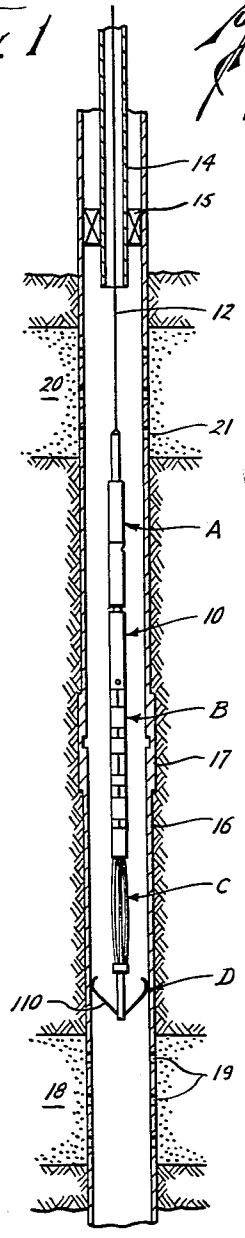


Fig. 2

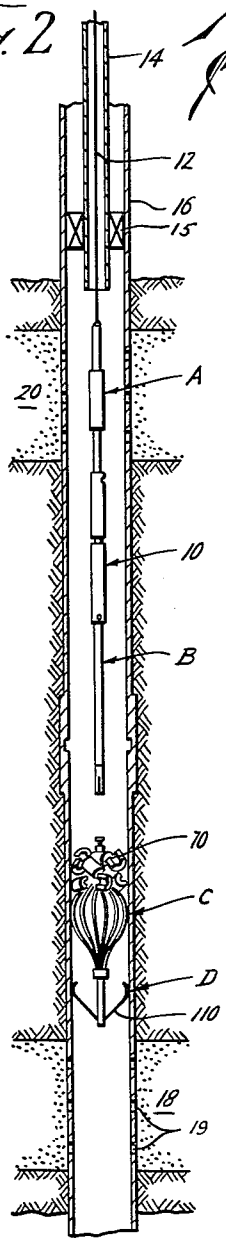
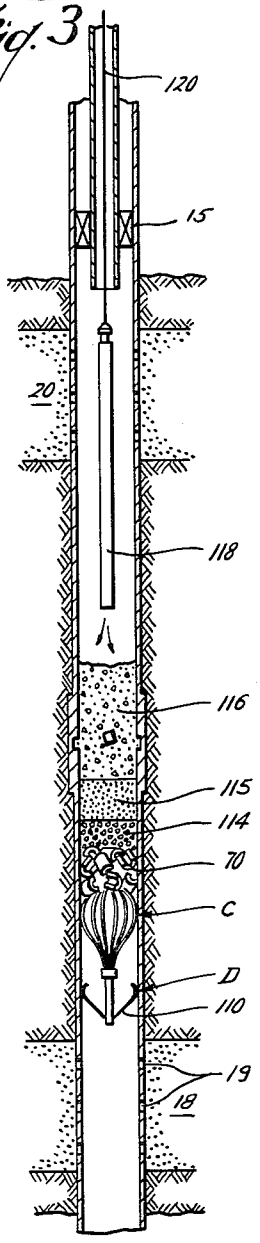


Fig. 3



INVENTOR.
Lester W. Toelke
BY James F. Wiley
Jefferson P. Hilke &
William A. Stout
ATTORNEYS

Nov. 20, 1962 L. W. TOELKE 3,064,734

BRIDGE PLUG

Filed Oct. 13, 1958 5 Sheets-Sheet 2

Fig. 4A

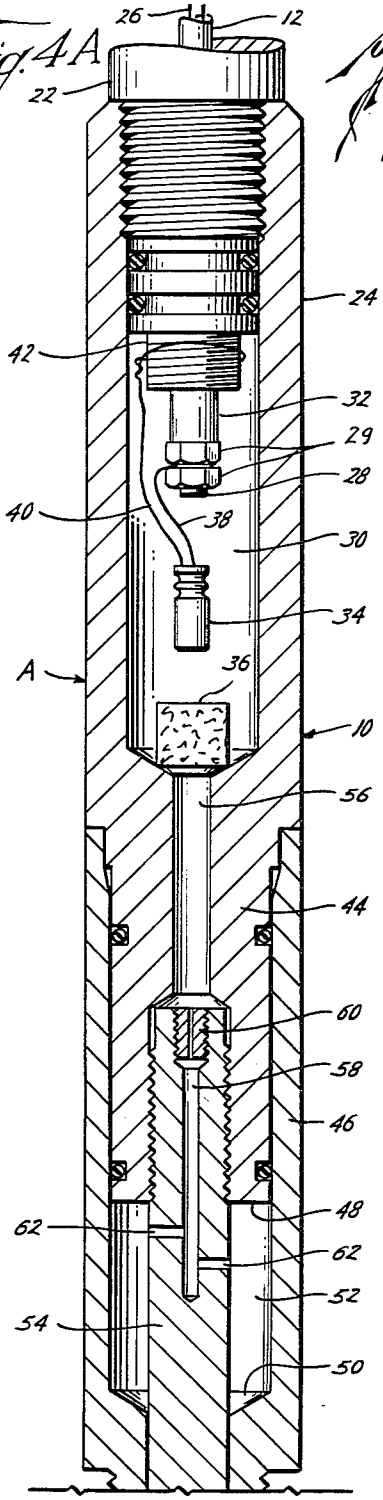
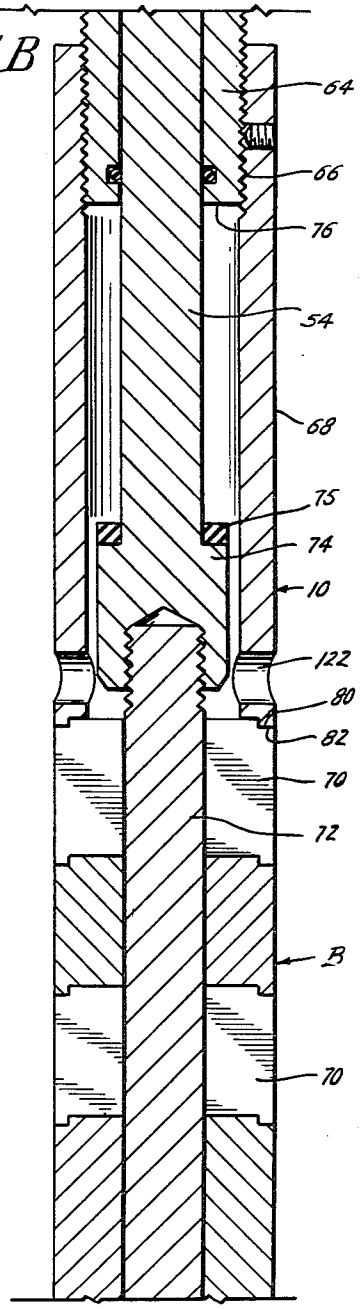


Fig. 4B



INVENTOR.
Lester W. Toelke
BY James F. Weiler
Jefferson D. Miller &
William A. Stout
ATTORNEYS

Nov. 20, 1962 L. W. TOELKE 3,064,734

BRIDGE PLUG

Filed Oct. 13, 1958 5 Sheets-Sheet 3

Fig. 4C

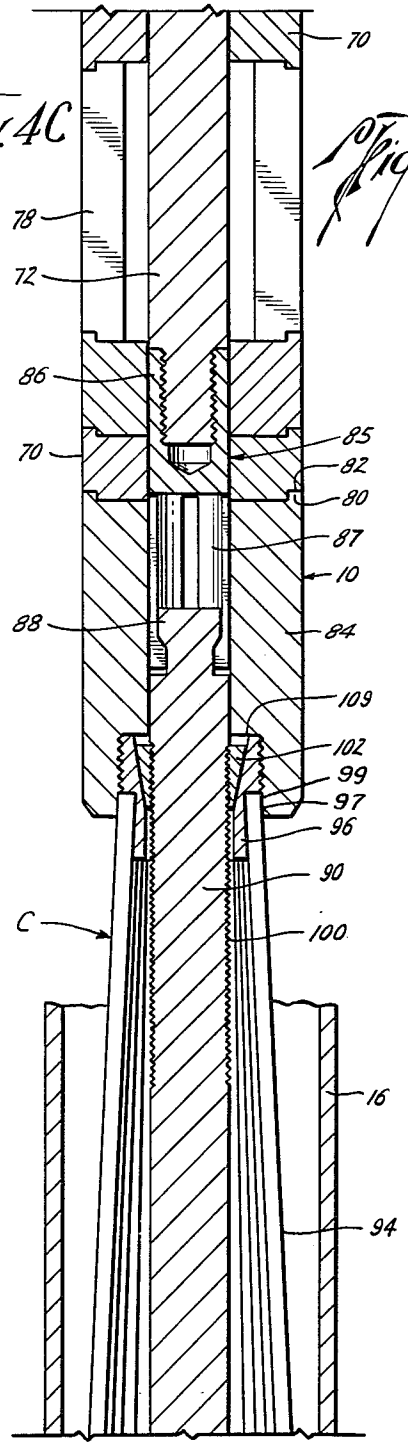
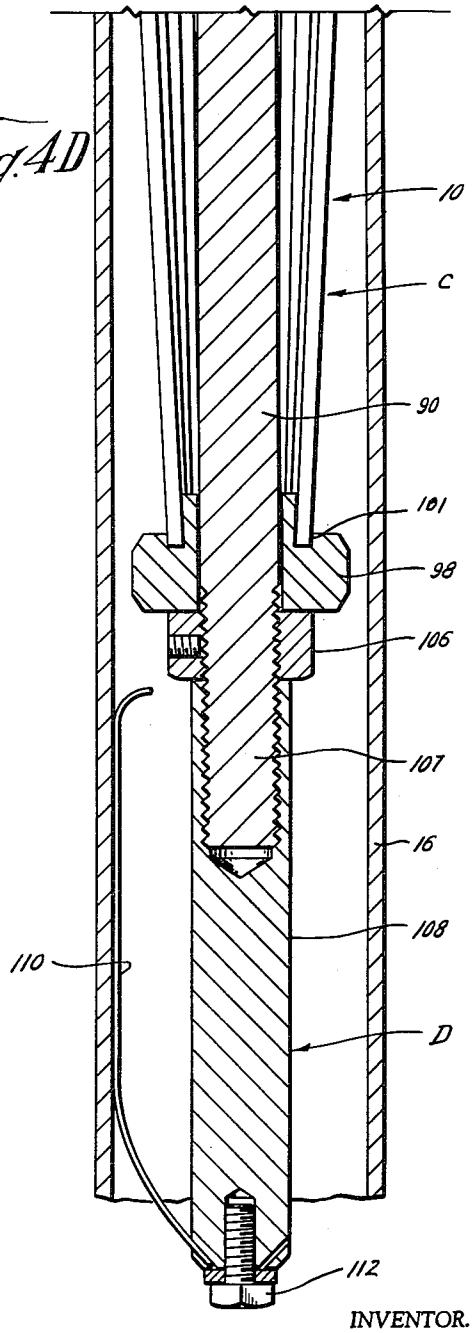


Fig. 4D



INVENTOR.
Lester W. Toelke
BY James F. Weiler
Jefferson D. Hiller &
William A. Stout
ATTORNEYS

Nov. 20, 1962 L. W. TOELKE 3,064,734

BRIDGE PLUG

Filed Oct. 13, 1958 5 Sheets-Sheet 4

Fig. 5A

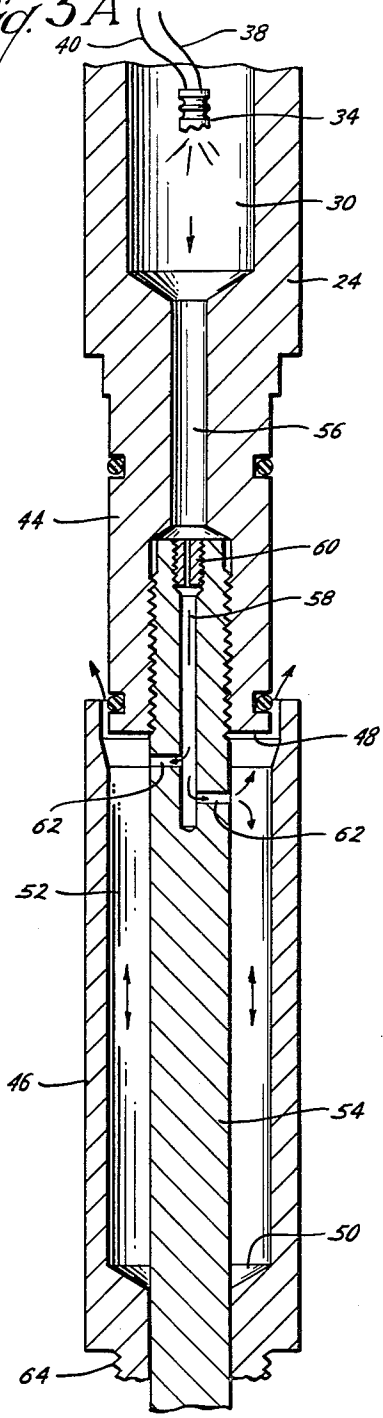


Fig. 5B

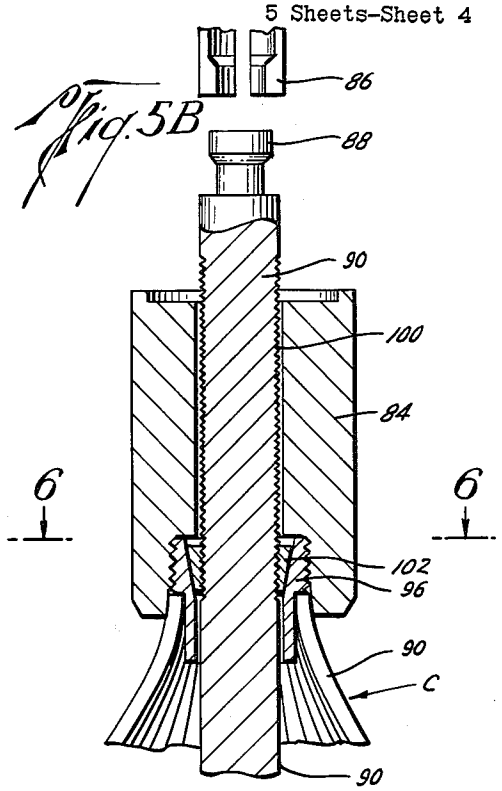
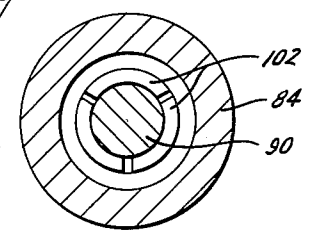


Fig. 6



INVENTOR.
Lester W. Toelke
BY James F. Weiler
Jefferson D. Hiller &
William A. Stout
ATTORNEYS

Nov. 20, 1962 L. W. TOELKE 3,064,734

BRIDGE PLUG

Filed Oct. 13, 1958 5 Sheets-Sheet 5

Fig. 7

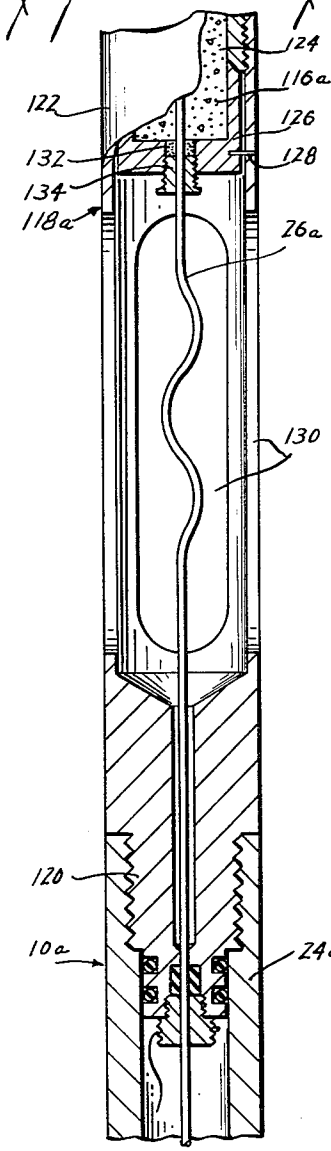


Fig. 8

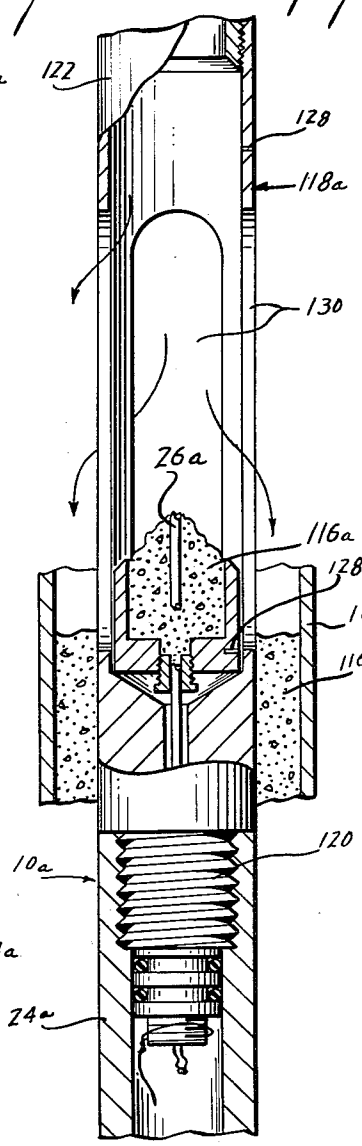


Fig. 9

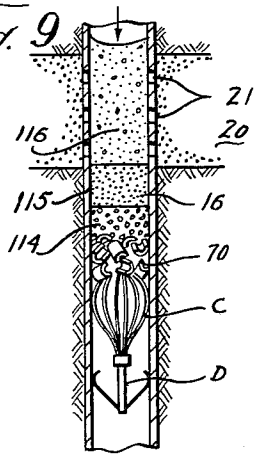
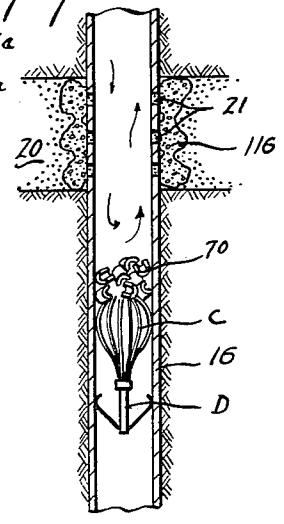


Fig. 10



Lester W. Toelke
INVENTOR.

BY James F. Weiler
Jefferson D. Miller
William A. Stout
ATTORNEYS

United States Patent Office 3,064,734 Patented Nov. 20, 1962

3,064,734

BRIDGE PLUG

Lester W. Toelke, Houston, Tex., assignor to Great Lakes Carbon Corporation, New York, N.Y., a corporation of Delaware

Filed Oct. 13, 1958, Ser. No. 766,971
9 Claims. (Cl. 166—63)

The present invention relates to bridge plugs.

Bridge plugs are set in oil, gas and like wells for many reasons. For example, bridge plugs are used for remedial plug back work, as a temporary or permanent bridge for abandonment, cementing, squeezing, acidizing, protecting producing zones, plugging off zones to produce from other zones, protecting well equipment and for use with testing tools and the like as well as other uses. Heretofore in setting bridge plugs and in methods of bridging wells or methods utilizing bridging plugs it has been necessary to remove the tubing, "kill" the well and run a plug of a size just slightly less than the bore in which it is to be set. These plugs are generally known as casing bridge plugs. In pulling the tubing of course, a rig is necessary as well as other work-over tools which is quite expensive and requires many man hours.

It would be highly advantageous to provide a method of bridging a well and a bridge plug therefor and methods utilizing bridging plugs in which it is unnecessary to pull the tubing from the well, kill the well and avoid the use of expensive rig equipment and man hours necessary for that purpose. The present invention is directed to such bridge plugs.

It is therefore an object of the present invention to provide a bridge plug for bridging wells and provide methods utilizing bridge plugs in which it is unnecessary to remove the tubing from the well bore or to kill the well with all their inherent disadvantages and expense.

Still a further object of the present invention is the provision of an apparatus for bridging a well and a bridge plug therefor and a method utilizing a bridge plug in which the bridge plug is lowered downwardly in the tubing, set in the casing below the tubing to provide a bridge base for bridging the well and in which suitable bridging materials are placed on top the bridging plug through the tubing, for example, bridging aggregate and then a suitable sealing material such as cement, various plastics, chemical sealers, resins and the like.

Still a further object of the present invention is the provision of an apparatus for bridging a well in which a bridging base is lowered downwardly through tubing in the well and set in the casing below the tubing and, subsequently, suitable bridging material is placed on top the bridging base thereby satisfactorily bridging and sealing the well.

Still a further object of the present invention is the provision of a method of bridging a well and of providing a bridge plug for a well in which the bridging operation may be performed by means of an electric conductor cable or a wire line.

Still a further object of the present invention is the provision of a bridging plug which is retractable to the extent that it may easily and readily be lowered by means of a wire line inside the tubing and includes means by which it may be expanded into bridging engagement with the wall of the casing or well below the tubing, which wall is generally of a larger inside diameter than the tubing.

Yet a further object of the present invention is the provision of such a bridging plug which carries bridging elements adapted to fall upon the bridging plug as it is being set.

Still a further object of the present invention is the provision of a bridging plug which may be used for a wide

variety of bridging uses, for example, one that may be lowered in the tubing and set in the tubing or lowered through the tubing and set in the casing or may be lowered in the casing and set in the casing or in the open hole for any and all of the usual bridging plug purposes.

Yet a further object of the present invention is the provision of a bridging plug of the charter mentioned which is completely drillable.

Still a further object of the present invention is the provision of a bridging tool which is positive and efficient in operation and economical to operate and set.

Still a further object of the present invention is the provision of a bridge plug assembly in which the bridge plug is made of drillable material but the other parts of the assembly, for example, the setting assembly, are made of a material, such as steel, so that they may be used again and again.

A still further object of this invention is the provision of a complete bridging and sealing assembly in which a combination bridge plug, setting assembly and sealing assembly are run into the well at the same time and coact to bridge and seal the well in one trip.

Other and further objects, features and advantages will be apparent from the following description of presently preferred examples of the invention, given for the purpose of disclosure, and taken in conjunction with the accompanying drawings, where like character references designate like parts throughout the several views, and where

FIGURE 1 is a diagrammatic view, in sectional elevation, of a bridging plug assembly according to the invention and useful in the method of the invention shown, lowered into position below tubing in a well bore for expanding into bridging engagement with the casing.

FIGURE 2 is a view similar to FIGURE 1 illustrating the bridging plug expanded into bridging engagement with the casing including bridging elements disposed on the bridging plug,

FIGURE 3 is a view similar to that of FIGURES 1 and 2 illustrating dumping of bridging cement on top of the bridging plug and bridging elements,

FIGURE 4A is a sectional elevational view of the upper part of the setting assembly of the bridging plug illustrated in FIGURES 1–3, inclusive,

FIGURE 4B is a continuation of FIGURE 4A illustrating an upper intermediate portion of the setting assembly and bridging element assembly,

FIGURE 4C is a continuation of FIGURE 4B illustrating a lower intermediate portion of the setting assembly, bridging element assembly, and bridging plug,

FIGURE 4D is a continuation of FIGURE 4C illustrating the lower portion of the bridging plug,

FIGURE 5A illustrates the upper portion of the setting assembly when it has been actuated to expand the bridging plug into bridging engagement with the casing,

FIGURE 5B is a fragmentary, sectional elevational view illustrating the bridging plug in expanded position,

FIGURE 6 is a cross-sectional view taken along the line 6—6 of FIGURE 5B,

FIGURE 7 is a fragmentary elevation, partly in section illustrating a sealing assembly in combination with the bridge plug assembly,

FIGURE 8 is a view similar to FIGURE 7 illustrating dumping of the sealing material,

FIGURE 9 is a fragmentary elevational view, partly in section, illustrating a method of sealing a formation traversed by the well bore, and

FIGURE 10 is a view similar to FIGURE 9 illustrating the sealing material being washed out of the casing with the formation sealed off.

Referring now to the drawings, and particularly to FIGURES 1, 2 and 3, the bridging plug assembly 10 is illustrated as being lowered on the wire line 12 through

the tubing 14 to be set in the casing 16 in order to seal off a depleted oil or gas zone 18 so that production may be obtained from the upper oil or gas zone 20. Ordinarily the packer 15 is provided to seal off the space between the tubing 14 and casing 16 although the packer 15 may be omitted, if desired.

The illustrations in FIGURES 1–3, inclusive, are of a typical and highly advantageous use of the present invention, however, as previously mentioned, the bridging plug may be used for all bridging purposes.

Turning now to the details of structure of a presently preferred apparatus of the invention as disclosed in FIGURES 4A–D, inclusive, the bridge plug assembly 10 includes a setting assembly A (FIGURE 4A), a bridging element section or assembly B (FIGURE 4B), a bridging plug C (FIGURES 4C and 4D) and a centralizer D (FIGURE 4D). As will be apparent later, the bridging element section B and centralizer section D may be omitted, however, these are highly advantageous in use.

Referring now to FIGURE 4A, a cable connection 22 is provided at the upper portion of the body 24 of the setting assembly A for connecting the bridge plug assembly 10 to the wire line 12. The cable connection 22 may be of any preferred type and is here shown as a threaded connection to the upper part of the body 24 although it may be secured in other ways. An electric conductor 26 is disposed in the wire line 12, as usual, which electric conductor 26 is connected to the electric contact 28 disposed in the firing chamber 30 in the upper end of the body 24. The electric contact 28 is insulated by means of the tubular insulator 32 threaded onto the electric contact 28 which is here in the form of a threaded member for ease of assembly.

Disposed within the firing chamber 30 are the electric firing cap 34 and the propellant 36, the cap 34 being electrically connected by the electric conductors 38 and 40 to the electric contact 28 by means of the nuts 29 threaded to the electric contact 28 and to a threaded extension 42 of the wire line or cable connection 22 which serves as a ground thereby completing the circuit to the cap 34. The purpose of the cap 34 and the propellant 36 is to provide the setting force for the setting assembly A. Any preferred cap or squib 34 and propellant 36 may be used.

The lower part of the body 24 has a reduced diameter portion or piston 44 which slidably extends into an intermediate body portion 46 of the setting assembly A, the lower end 48 of the reduced diameter portion 44 and the inner end 50 of the intermediate body portion 46 forming an expansion chamber 52 for a purpose later described.

A setting mandrel 54 is threadedly or otherwise secured to the lower end of the reduced diameter portion 44 of the body 24, which setting mandrel 54 slidably extends through the intermediate body portion 46.

Disposed in the body 24 is the duct 56 leading from the firing chamber 30 which communicates with the duct 58 disposed in the upper portion of the mandrel 54 and the choke screw 60, the duct 58 having the laterally extending ducts 62 so that expanding gases from the explosive propellant 36 flow through the duct 56, the choke screw 60, the duct 58 and out the lateral ducts 62 and into the expansion chamber 52 for bearing against the shoulders 48 and 50 thereby moving the reduced diameter portion 44 of the body 24 in the intermediate body section 46 outwardly relative to one another.

The choke screw 60 effectively increases the gas velocity and reduces the pressure build up rate to effectively provide a setting force for the setting section or assembly A. This is not necessary, however, and the choke screw 60 may be omitted. By the use of the choke screw, however, it is unnecessary to use a slow burning powder although a slow burning powder may be used if desired. Thus, it will be understood that any suitable arrangement by which sufficient setting force is provided may be used.

The intermediate body portion 46 of the setting assembly A terminates at its lower end in a threaded pin 64 which is threadedly connected in the box 66 of what might be termed the bridging material or junk ring section B of the bridging plug assembly. This last-mentioned section includes an upper body portion 68 which serves as a hold down adjustment sleeve for the split junk rings 70 disposed about the bridging material mandrel 72 which is threadedly connected to the lower head member 74 of the setting mandrel 54. The enlarged head member 74 also serves to limit upward movement of the mandrel 54 relative to the outer body sections of the tool by engaging the lower end 76 of the pin member 64. If desired, the shock absorber 75 may be added at the upper end of the head member 74 or it may be omitted.

As illustrated, a plurality of segmental junk rings 70 are disposed along a substantial length of the bridging material mandrel 72 and a release spacer 78 having an enlarged internal diameter is provided to insure release of the bridging plug C upon setting of the tool as presently described. It is noted that the hold down sleeve 68 and the junk rings 70 have the interfitting portions 80 and 82, as does the spacer release element 78, to insure that the junk ring 70 and the spacer release element 78 are releasably secured together when lowering or otherwise moving the bridge assembly in the tubing or casing, as may be the case.

Similarly, the upper bridge plug body section 84 is provided with the upwardly extending peripheral ring 80 which interfits into the peripherally-recessed portion 82 of the junk rings 70.

The lower end of the bridging material mandrel 72 is threadedly connected to a spring or collet type latch 85 which includes the threaded box member 86 from which the spring fingers 87 extend downwardly and grip around the enlargement 88 at the upper end of the bridge plug mandrel 90. The spring fingers 87 are held tightly about the enlargement 88 when confined within the bore of the upper bridge plug body section 84, but spring outwardly to release the enlargement 88 when not so confined. Thus, the mandrel 90 is releasably secured to the lower end of the bridging material mandrel 72 for the purpose of releasing the bridging plug as presently described.

Referring to FIGURES 4C and 4D, the bridging plug C includes a plurality of bridging ribs or strip like elements 94 secured to the upper bridge plug body section 84 at their upper ends and to the bridge plug foot member 98 at their lower ends such as by disposing their upper ends in the annular groove 97 formed by the head member 96 and counterbored portion 99 and their lower ends in the annular groove 101 formed in the bridge plug foot member 98. Obviously, the bridging ribs 94 may be secured to or carried by the bridging plug assembly C in any desired manner. The bridging plug mandrel 90 is provided at its upper end with a series of wickers or threads 100 which are engaged by the spring-like wedge member or latch 102 disposed within the upper body portion 96.

As best seen in FIGURE 6, the spring-like wedge member 102 is a segmental nut to permit expansion and contraction for engaging and disengaging the wickers 100 on the bridge plug mandrel 90 so that the head member 96 may automatically be latched and relatched in desired position.

The foot member 98 is restrained from downward movement by the nut 106 threaded to the threaded lower end of the bridge plug mandrel 90.

Threadedly connected to the lower end of the bridge plug mandrel 90 is a centralizer D which includes a generally cylindrical body section 108 and spring drag or wiper members 110 (only one being shown in this view) threadedly secured to the lower end of the body 108 by means of the nut 112. The drag springs 110 are arranged

to maintain the entire assembly in a generally centralized position within the tubing and the casing and are flexible enough to pass through the tubing when lowering the bridging plug assembly **10** in the tubing yet strong enough to centralize the bridge plug C when in the casing or open hole.

In operation, and referring to FIGURE 1, the bridging plug assembly **10** is lowered from the surface, not shown, by means of the wire line **12** through the tubing **14** down into the casing **16** to a point where it is desired to bridge off the casing, for example and as mentioned previously, to bridge off the lower depleted zone traversed by the casing **16** in order to produce from the upper zone **20**.

Once the bridging plug assembly is in the desired position, the firing cap **34** is electrically exploded which thereby explodes or ignites the explosive propellant **36**. As best seen in FIGURE 5A, to which reference is now made, the expanding gases move through the duct **56**, are retarded by the choke **60** until considerable pressure is built up in firing chamber **30**, then pass through the choke **60**, duct **58** and out the lateral passages **62** into the expansion chamber **52** and thus bearing against the shoulders **48** and **50** moving them outwardly relative to one another. This action, of course, moves the mandrel **54** upwardly which in turn moves the bridging material mandrel **72** (FIGURE 4B) and the bridge plug mandrel **90** (FIGURE 4C) upwardly, the split nut or latch **102** expanding sufficiently to permit upward movement of the bridge plug mandrel **90** relative to the upper bridge plug body member **84** of the junk ring section of the tool.

Referring to FIGURE 4C, when the mandrel **72** is moved upwardly sufficiently to move the collet or spring type latch **85** upwardly into the release spacers **78**, the spring fingers **87** move outwardly and release the enlargement **88** and thus the bridge plug C.

As best seen in FIGURE 5B, the collet type latch **85** is shown released from the enlargement **88** on the upper end of the bridging plug mandrel **90**.

Referring again to FIGURE 4D, as the bridge plug mandrel is moved upwardly relative to the lower body section **84** of the junk ring section of the tool, the ribs or spring bridging members **94** are compressed and expanded due to the lower bridge plug body member or foot **98** being moved upwardly by the nut **105** toward the upper bridge plug member **84** and its counterbored portion **109** into which head member **96** (FIGURE 4C) is threadedly secured.

As previously explained, the lock ring **102** expands to permit this upward movement but once the bridge plug mandrel **90** has moved upwardly its full stroke, the lock ring or latch **102** engages the wickers **100** and thus maintains the bridge plug in expanded position.

The initially expanded position of the bridge plug is best illustrated in FIGURE 2, to which reference is now made. At the same time the bridge plug is being expanded, and once it is released, the junk rings **70** are released and slide downwardly off the junk ring or bridging material mandrel **72** and provide a coarse bridging material on top of the expanded bridge plug **92**. The setting assembly A and bridging material assembly B may then be removed from the well by raising the wire line **12**.

In FIGURE 3, coarse bridging material, for example, gravel, marbles and the like **114** are disposed on top of the junk rings **70** and sand **115** and a short section of sealing material **116**, such as cement, various plastics, resins, chemical sealers and the like, are provided above the coarse bridging material **114**.

Preferably, the sealing material **116** is disposed or placed in position by means of lowering the dump bailer **118** through the tubing **14** by means of the cable **120**. While any desired dump bailer may be used, the dump bailer disclosed in my copending application Serial No. 647,383, filed March 30, 1957 is particularly useful for dumping sealing material, such as cement, through tubing. Also, the bridging material **114** and **115** may be so placed in position although, if desired, it may be dumped into the tubing **14** at the surface and permitted to fall down the tubing into position.

Once the well has been bridged, the upper zone **20** may be perforated, as at **21**, to produce this zone. Thus, the lower depleted zone **18** previously producing through the perforations **19** is bridged off and the upper zone is then produced without removing the tubing **14**.

While the bridging material section of the tool is highly advantageous in that it reduces the number of trips and the time required for completing the bridging of the well below the casing, it will be understood, that this section may be omitted and that the initial bridging material placed upon the bridging plug may be placed in position separately from the setting of the bridging plug.

Also, it should be noted, that while the explosive cap **34** is detonated electrically, which requires the use of an electric conductor wire line, this may be done mechanically or otherwise, in which event a cable may be used to lower the tool into the well, it only being necessary to drop a go-devil or some other device to engage a striker for striking a percussion type cap to ignite it. Also, if desired, the bridging plug may be set mechanically.

It is also noted, that the bridging plug assembly is suitably packed off and the wash ports **122** (FIGURE 4B) are provided in the body section **68** to permit movement of the head member **74** within the body section **68** even though well fluid is within. Advantageously, the retarding action of the head member **74** serves as a piston driving well fluid out of the wash ports **122**.

Preferably, the bridging plug C and centralizer D are made of an easily-drillable material, for example, aluminum. Also, if the bridge plug C fails to set, it merely drops to the bottom of the well and can be easily drilled out. Preferably, the setting tool A and retrievable parts of the bridging material section B are made of a material, such as steel, so that they may be used again.

It would be advantageous to bridge and seal the well all in one trip in order to avoid the time and expense of separately dumping the sealing material. The present invention includes and contemplates such an apparatus and method.

Referring now to FIGURE 7, where the reference letter "*a*" has been added to character numerals to designate like parts of FIGURES 1–6, inclusive, the dump bailer **118*a*** is combined with the bridging assembly **10*a***, only a fragment being shown in FIGURE 7, by threadedly securing the threaded lower end **120** of the dump bailer **118*a*** into the threaded upper end of the setting section body **24*a***.

The dump bailer **118*a*** includes a generally elongate tubular body **122** which includes in its upper portion the chamber **124** for retaining the sealing material **116*a***, such as cement and the like as previously mentioned, a cup or closure member **126** is releasably secured to the body **122** to form the lower closure of the chamber **124**. A shear pin **128** releasably secures the closure or cup-like member **126** to the body **122**.

Disposed in the lower portion of the generally tubular body **122** are a plurality of elongate windows **130** through which the sealing material **116*a*** is dumped as later explained.

While not shown, a cable connection, such as the cable connection **22** (FIGURE 4A) is used to connect the upper end of the body **122** and the electric conductor **26*a*** extends downwardly through the chamber **124**, through the packing or seal member **132** and gland nut **134**, through the window section **130** and to the electric contact **28** (FIGURE 4A). Thus, the bridge plug is set as previously described.

Means, not shown, are provided to release the closure **126**, for example, a firing chamber and arrangement such as utilized in the setting tool A which is actuated on reverse polarity of the electric conductor **26*a*** which applies

downward force against the closure cup **126** shearing the shear pin **128**.

No more detail of the specific dump bailer is given as any dump bailer having releasable means for dumping the sealing material may be used and the dump bailer, as such and by itself, does not constitute the present invention. For example, my copending application, Serial No. 647,383, previously referred to, discloses details of the dump bailer **118***a*.

In use, the bridge plug assembly **10** including the dump bailer **118***a* is lowered on an electric wire line such as indicated at **12** in FIGURES 1 and 2. The bridge plug C is set as previously described and then the dump bailer **118***a* is actuated to release the closure cup **126** so that it falls to the position illustrated in FIGURE 8. The sealing material **116***a*, such as cement, is thus dumped into the casing **16***a* to form a sealed area such as shown in FIGURE 9. The dump bailer **118***a* and the setting assembly A may then be removed from the well. By the combined apparatus the bridging and sealing are advantageously accomplished in a single trip in the well and may be used through tubing for setting in the casing below the tubing, or in the casing without tubing.

The method of the invention has been touched on in the description of the operation of presently preferred apparatus according to the invention in one of its many applications and uses. One aspect of the method of the invention comprises, lowering a bridging plug through tubing, setting the bridging plug in the casing below the tubing, providing bridging material on top of the bridging plug and providing a sealing material such as cement, plastic or other sealing agents on top the bridging material. Preferably, in the method of the invention, a bridging assembly such as previously described is used. It will be understood, however, that other bridging plugs or assemblies may be used in the method of the invention, it only being necessary to provide a bridging plug which is retractable sufficiently so that it may be lowered through tubing and expanded to engage the casing below the tubing. Also, any desired bridging materials may be disposed on the bridging plug and these may be provided either by lowering them or dropping them from the surface or by lowering them through the tubing in a dump bailer.

For added strength, the method contemplates setting the cement column at a location so that it will be in perforations or opposite a collar. This gives improved locking and sealing properties.

It should be noted that no rig is required for bridging the well by the present apparatus and method and that ordinarily only about twenty-four hours cement setting time is required after dumping the cement. Other cementitious materials may be used which require shorter or longer setting times.

The apparatus and method of the invention may be used for other purposes, such as in squeeze cementing an upper formation it is desirable to seal off a lower formation to protect this lower formation from cement contamination resulting from the squeeze. In the event it is desired to seal off the formation **20** and produce from the formation **18** (FIGURES 1–3), and referring now to FIGURE 9, the bridging plug C is set slightly below the formation **20**, say about two feet. Bridging material or aggregate such as gravel **114** and finer material **115** is then dumped on top of the bridging plug C and junk rings **70** up to about the lowest perforation **21**. Cementitious material **116** is run in the dump bailer **118** and dumped so that only the perforations **21** in the section of the casing adjacent the formation **20** are covered. The dump bailer **118** is then removed or the wire line is packed off at the surface. Flow pressure is then applied to the tubing with conventional means at the surface, not shown. This places a pressure squeeze on the cement, which has not yet set, and drives it back into the perforations **21** as shown in FIGURE 10. This is allowed to set for a short period of time, say about one hour for oil well cement now in use, and the pressure is then removed. The time allowed is such that the cement is set solidly enough and dehydrated in the perforations **21** to a point that when the bulk of the cement in the casing is washed out it will not wash out of the perforations.

Upon removal of the pressure, after completion of the low pressure squeeze, the cement above the plug is circulated out of the hole, leaving the cement in the perforations in a set high strength condition thus sealing off the perforated zone **20**.

The bridging plug may then be knocked to bottom with "sinker bars" or other means or it may be left in place since the oil from formation **18** will flow through the ribs of the bridging plug.

Preferably, when using the bridging plug for squeezing, the bridging plug is set in a collar, such as indicated at **17**, so that the ribs will bulge out into the collar **17**, thus giving greater resistance to slippage.

If desired, the combined dump bailer bridging assembly illustrated in FIGURES 7 and 8 may be used in connection with this method.

Thus, the present apparatus and method may be used for any and all bridging purposes. Also, the bridging plug may be set in casing without running through tubing when desired. It may also be set in an open hole when desired for the purpose of supporting test tools and the like. It is noted that the bridging plug itself holds no fluid pressure from either direction but simply provides a bridge which serves as a base for a column of cementitious or other sealing material to provide the desired seal.

The present invention is therefore well suit and adapted to attain the objects and ends and has the advantages mentioned as well as others inherent therein.

While only presently preferred and representative embodiments of the apparatus of the invention have been given for the purpose of disclosure, numerous changes in details and arrangements of parts of the apparatus of the invention as well as uses thereof will suggest themselves to those skilled in the art which are encompassed within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A bridge plug assembly comprising, a bridge plug including a mandrel, a plurality of generally longitudinally extending bridging ribs disposed about the mandrel, a first end of each of said ribs secured to the mandrel, the second end of each of said bridging ribs slidably disposed about the mandrel, releasable latch means latching the second end of each rib on the mandrel thereby preventing sliding movement on the mandrel, means on the mandrel engageable by the latch means for latching the second ends on movement of said first and second ends toward each other, and setting means including means for moving said first ends toward said second ends thereby moving the intermediate portions of said ribs outwardly.

2. A bridging plug assembly comprising, a bridge plug including a bridging plug mandrel, a plurality of generally longitudinally extending bridging ribs disposed about the mandrel, the lower end of each rib secured to the mandrel, the upper end of each of said bridging ribs being slidably disposed on the mandrel, releasable latch means releasably latching the upper ends to the mandrel, slip means on the mandrel engageable by the latch means for latching the upper ends on movement of the lower and upper ends toward each other thereby setting the bridging ribs in bridging position; a setting assembly including a body disposed above the bridge plug, a setting mandrel slidably disposed in the setting body, said body forming a cylinder about a portion of the setting mandrel, a piston on the setting mandrel and disposed in said cylinder, a firing chamber carried by the piston, a duct leading from the firing chamber into

the cylinder whereby ignition of an explosive in the firing chamber and expanding gases therefrom serve to move the piston upwardly relative to the body thereby raising the setting mandrel and the bridge plug mandrel; and releasable connecting means connecting the setting mandrel and the bridge plug mandrel constructed and arranged to release the mandrels upon upward movement of the bridge plug mandrel relative to the body.

3. The bridge plug assembly of claim 2 where the releasable means comprises an enlargement on the upper end of said bridge plug mandrel and includes spring latch elements extending from the setting mandrel disposed about said enlargement and a releasing chamber in the body above said releasable connection whereby upon upward movement of said mandrels said spring latch elements move into the releasing chamber and are released.

4. A bridging plug assembly comprising: a bridge plug including a bridge plug mandrel, a plurality of longitudinally extending bridging ribs disposed about the mandrel, the lower end of each rib secured to the mandrel, the upper end of each rib being slidably disposed on the bridge plug mandrel, releasable latch means latching the upper ends to the mandrel, said latch means arranged to relatch upon upward movement of the mandrel relative to the upper ends thereby setting the bridging plug in bridging position; a setting assembly including an elongate body disposed above the bridging ribs, a setting mandrel slidably disposed through the body, a piston cylinder formed in the body about the setting mandrel, a piston disposed on the setting mandrel in the cylinder, a firing chamber carried by the piston, ducts leading from the firing chamber into the cylinder whereby ignition of an explosive in the cylinder and formation of expanding gases causes movement of the piston in the cylinder thereby moving said setting mandrel; a bridging element assembly including a bridging element mandrel secured to the setting mandrel, a plurality of bridging elements disposed about the bridging element mandrel, releasable means holding said bridging elements about said mandrel releasable upon release of the bridging element mandrel and the bridge plug mandrel, and a releasable connection connecting the lower end of said bridging element mandrel and the upper end of said bridge plug mandrel, said releasable connection arranged to be released upon upward movement of said mandrels relative to said setting assembly body, whereby upon ignition and expansion of said explosive, the bridging plug is set, the setting assembly and bridging element assembly are released and the bridging elements fall downwardly on to said bridging ribs.

5. The bridging plug assembly of claim 4 in which the releasable connection comprises an enlargement on an end of one of the bridge plug and bridging element mandrels and spring fingers extending from the other of said mandrels disposed about the enlargement, means normally confining said fingers, and a releasing chamber of extended internal diameter whereby upon upward movement of said mandrels and movement of said spring fingers into the releasing chamber permits expansion of said releasing fingers and release of said releasable connection.

6. A bridge plug assembly comprising a bridge plug including a mandrel, a plurality of generally longitudinally extending bridging ribs disposed about the mandrel, a first end of each of the ribs secured to the mandrel, the second end of each of the ribs being slidably disposed about the mandrel, releasable latch means on said mandrel adjacent the second end of said ribs for latching the second ends on the mandrel on axial movement of said second ends toward the first ends, setting means for moving said first and second ends of each of the ribs toward each other thereby bending the ribs and moving the intermediate portions of the ribs outwardly, releasable connecting means connecting the mandrel to said setting means, and means releasing said connecting means on a predetermined movement of the mandrel.

7. A bridging plug assembly comprising a mandrel, a plurality of generally longitudinally extending bridging ribs disposed about the mandrel, the first end of each of the ribs secured to the mandrel, the second end of each of the ribs being slidably disposed about the mandrel, releasable latch means latching the second end of each rib on the mandrel, means on the mandrel engageable by the latch means for latching the second ends on movement of said first and second ends toward each other, a plurality of bridging elements releasably carried by the mandrel above the bridging ribs, setting means for moving said first and second ends of the ribs toward each other thereby moving the intermediate portions of the ribs outwardly, releasable connecting means connecting the mandrel to said setting means, and means releasing said connection means, mandrel and bridging elements, on a predetermined movement of the mandrel.

8. The bridging plug of claim 7 where the bridging elements comprise segmental junk rings.

9. A bridging plug assembly comprising: a bridge plug including a bridge plug mandrel, a plurality of longitudinally extending bridging ribs disposed about the mandrel, one end of each of said ribs secured to the bridging plug mandrel, the second end of each of said ribs slidably disposed on the bridge plug mandrel, releasable latch means latching the second ends to the bridging plug mandrel, said latch means arranged to relatch upon movement of the bridging plug mandrel relative to the second ends thereby setting the bridging plug in bridging position; a setting assembly including an elongate body disposed above the bridging ribs, said body including a cylinder having an open end, a piston disposed in said cylinder, a setting mandrel slidably disposed in the body and connected to the piston, a firing chamber adjacent the piston, a passageway leading from the firing chamber from one side of the piston to the cylinder on a second side of the piston whereby creation of an expanding gas in the firing chamber causes movement of the piston in the cylinder thereby moving said setting mandrel until said piston moves out of said open end; a bridging element assembly including a bridging element mandrel secured to the setting mandrel, a plurality of bridging elements disposed about the bridging element mandrel, releasable means holding said bridging elements about said mandrel, said releasable means being releasable upon release of the bridging element mandrel from bridge plug mandrel, and a releasable connection connecting the lower end of said bridging element mandrel and the upper end of said bridge plug mandrel, said releasable connection arranged to be released upon a predetermined upward movement of said bridging element and bridge plug mandrels relative to said setting assembly body whereupon upon expansion of a gas in the firing chamber the bridging plug is set, the bridging element mandrel and the bridge plug mandrels are released from each other, the bridging elements fall downwardly on the said bridging ribs, and said piston moves out the open end of the cylinder releasing the gas from the firing chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

1,676,785	Lewis	July 10, 1928
1,979,802	Kinley	Nov. 6, 1934
2,229,325	Greene	Jan. 21, 1941
2,618,345	Tucker	Nov. 18, 1952
2,621,744	Toelke	Dec. 16, 1952
2,701,615	Riordan et al.	Feb. 8, 1955
2,708,973	Twining	May 24, 1955
2,728,395	Howard	Dec. 27, 1955
2,735,496	Wilson	Feb. 21, 1956
2,800,185	Teplitz	July 23, 1957
2,815,817	Conrad	Dec. 10, 1957
2,831,540	Huber	Apr. 22, 1958
2,911,048	Dublin et al.	Nov. 3, 1959

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,064,734

November 20, 1962

Lester W. Toelke

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 55, for "a method of" read -- an apparatus for --; column 2, line 7, for "charter" read -- character --; column 5, line 74, after "March 30, 1957" insert -- , now abandoned, --; column 9, line 10, before "means" insert -- connecting --.

Signed and sealed this 2nd day of July 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents