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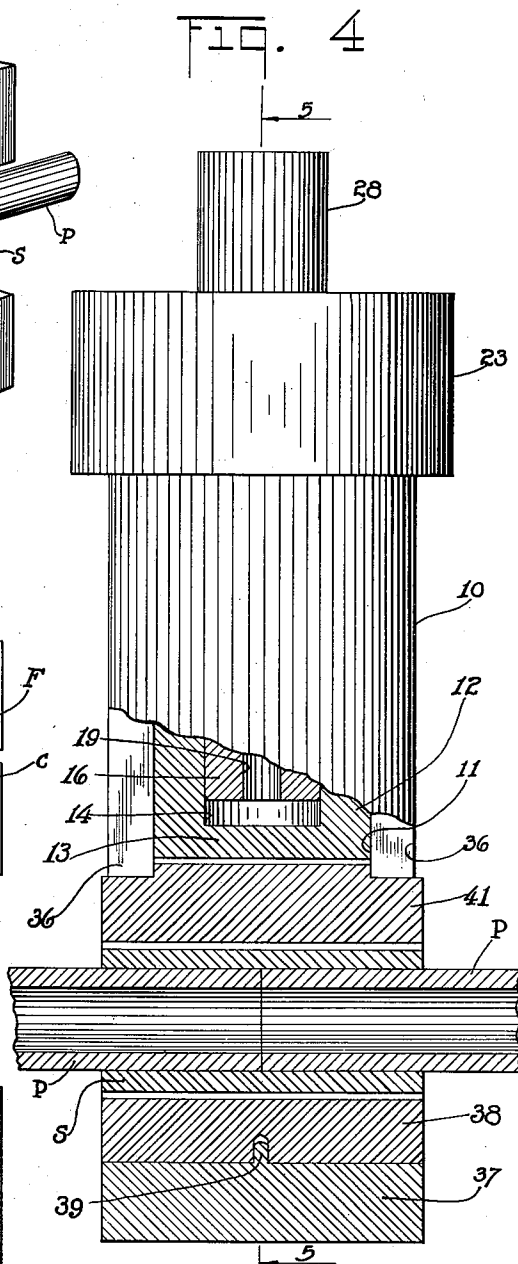
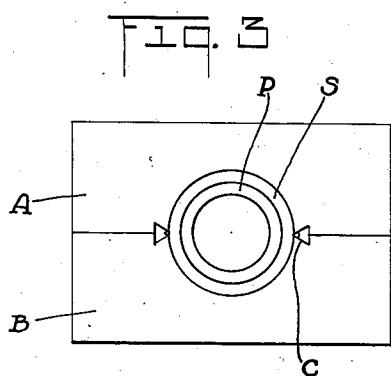
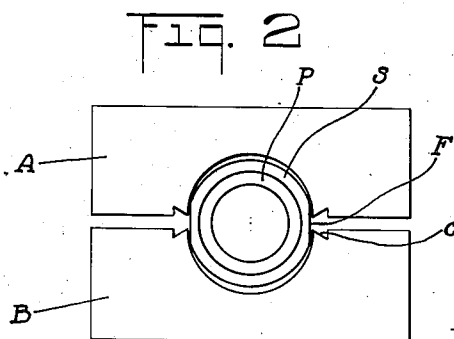
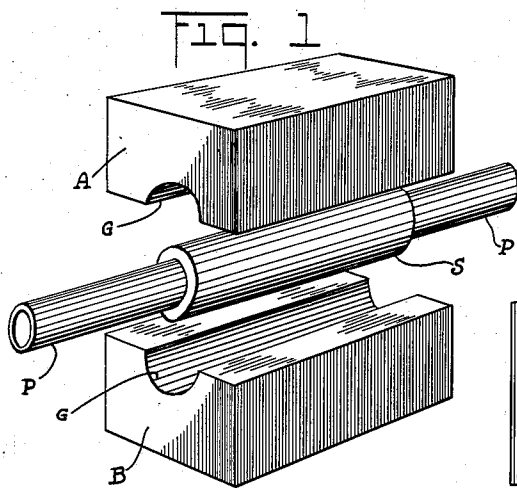
R. TEMPLE, JR

2,064,129

METHOD AND APPARATUS FOR FORMING JOINTS

Filed Dec. 8, 1934

3 Sheets-Sheet 1



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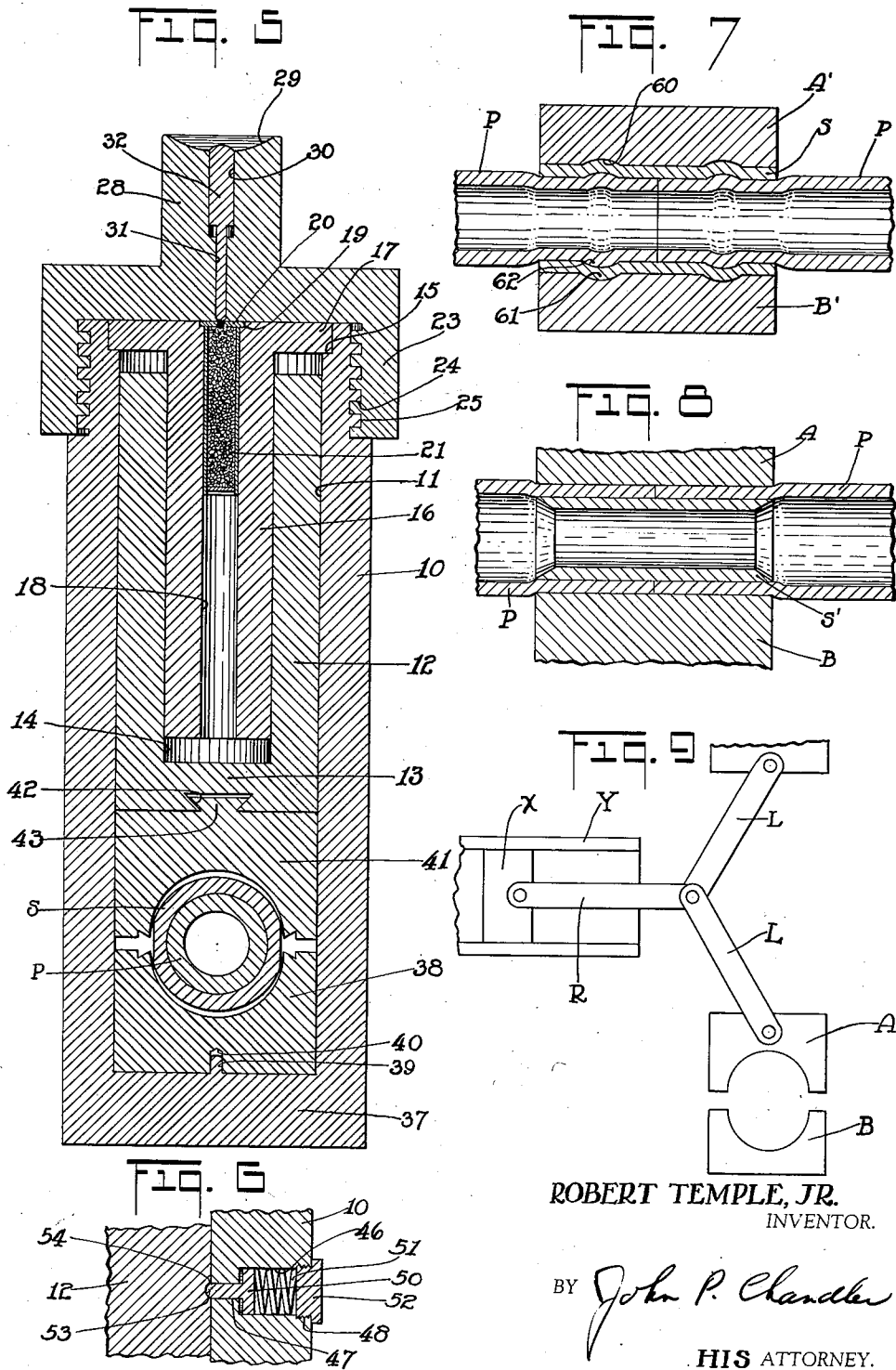
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3 Sheets-Sheet 2



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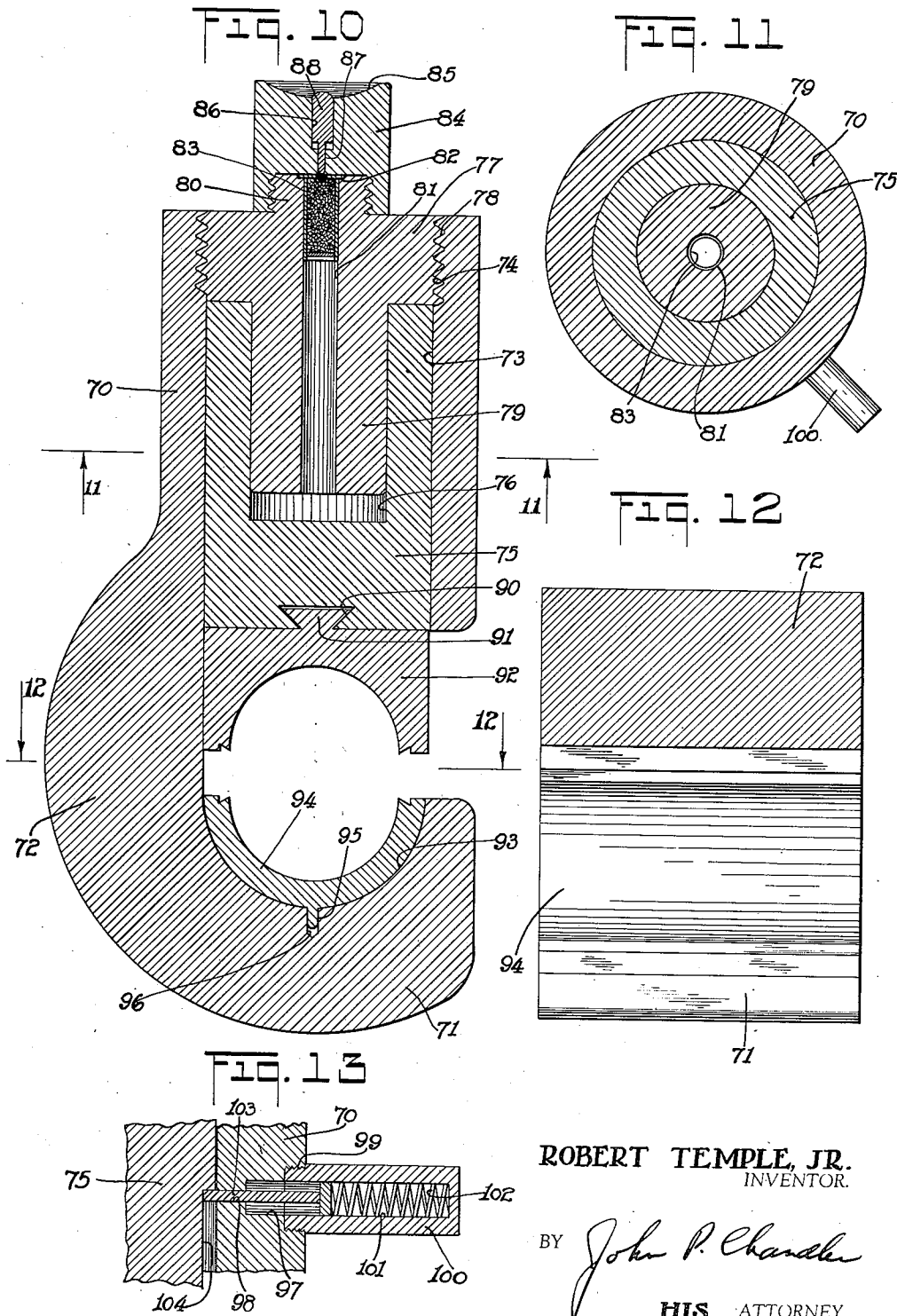
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METHOD AND APPARATUS FOR FORMING JOINTS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,064,129

METHOD AND APPARATUS FOR FORMING JOINTS

Robert Temple, Jr., Pittsburgh, Pa.

Application December 8, 1934, Serial No. 756,635

19 Claims. (Cl. 140—113)

This invention relates to a method and apparatus for forming joints between originally separated members and relates more particularly to a method for joining pipes, tubing, casings, rods, wires and the like, through the application of pressure created by the explosion of a confined explosive charge.

In my Patent Nos. 2,003,843 and 2,030,803, I described a number of embodiments of an explosively actuated power press for bonding wires, cables, rods and the like, said press including a structure having complementary die elements, one of said elements being movable relative to the other, and a piston adapted to engage the movable element with a powerful blow, the explosion of an explosive charge being employed to actuate the piston. To employ the device, the terminals of the wires, cables or other materials are inserted in the opposite ends of a cylindrical sleeve or coupling having a longitudinal bore therein of substantially the same diameter as the diameter of the wires. The coupling is then inserted between the die elements, and, upon actuation of the piston, the coupling and the wires contained therein are compressed into one solid mass which forms an intimate bond and an electrically perfect connection between the two wires.

In the preferred method of carrying out the invention, as is illustrated in another application, Serial No. 562,574, relating more particularly to precise construction of the coupling, the movable die element is provided with a plurality of offset or male portions, which, when they come in contact with the sleeve under an impact blow, form a series of flattened areas on the upper surface of said sleeve, and, likewise deform the wires contained therein, thereby giving the coupling added tensile strength.

The present invention is directed to certain changes and improvements in the explosively actuated press and is directed more particularly to the method of forming permanent joints, especially in pipes, tubes, casing and the like.

The difficulties and expense of installing pipes of all kinds are well known and although most pipe comes in various standard lengths, it has been found necessary to cut and thread much pipe in the field, the latter being either a laborious hand operation or an expensive field machine operation. It is also virtually impossible by any hitherto known method to effect a joint which will remain pressure tight and water tight during the entire life of the pipe.

One of the objects of the present invention is the provision of an improved method for effect-

ing a permanent and relatively perfect pipe joint, the operation being carried out in a fraction of the time required for any of the previous methods, and also at a negligible cost.

Another object of the invention is the provision of a method for joining pipes by the use of an explosively actuated compression device, in the operation of which there is no appreciable noise or recoil and wherein, although the diameter of the terminals of the pipe may be reduced by a fraction of an inch by virtue of the tremendous compression thereof, the structure of the metal, although slightly changed, is nevertheless unweakened.

A further object of the invention is the provision of an improved explosively actuated compression device for carrying out the aforesaid method as well as for joining cable, wires, rods or other similar articles.

To this end the method comprises the steps of inserting the terminal portions of the pipes to be joined within the opposite end portions of a sleeve or coupling having a longitudinal bore therein of such diameter as to closely fit the pipes. In many operations it is not of any great importance whether the sleeve be made of the same material as that of the pipes nor even that it have the same coefficient of expansion. For instance, a copper sleeve serves very well with iron pipe. It is desirable, however, to have the sleeve of metal having a lower coefficient of expansion than the pipe. The sleeve is then inserted within the complementary die elements of the aforesaid explosively actuated press. Each of the die elements are desirably of substantially the same length as the length of the sleeve, the die elements being formed with complementary longitudinal semi-circular or other shaped grooves which, when the adjacent surfaces of the die elements come together, form a perfect circle or other desired shape. The total diameter of the circle formed by the die elements should be slightly less than the diameter of the undeformed sleeve. Thus, when the explosive charge is detonated and the die elements are moved together, the sleeve is firmly compressed about the pipe, causing a perfect and permanent bond, all as will be explained more in detail hereafter.

Another object of the invention is the provision of the method for the joining of pipes or tubes which are under tension, wherein virtually the full strength of the pipes will be preserved and wherein increased tension of the pipes creates a more perfect joint.

Another object of the invention is the provision

of an improved method of installing elbows, joints or other pipe fittings as well as for repairing leaks in pipes.

A still further object of the invention is the provision of an improved method for the joining of pipes, tubes and the like, wherein the joint is relatively invisible.

Yet another object of the invention is the provision of a method for joining pipe by explosively actuated means wherein there is an absence of noise and recoil by virtue of confining the explosive gases after the detonation.

In the drawings:

Fig. 1 is an exploded view illustrating the various elements employed in carrying out the method.

Fig. 2 is an end elevation of the die elements and the pipe and sleeve before the latter have been compressed.

Fig. 3 is similar to Fig. 2, but shows the relation of the parts after the sleeve and pipe have been compressed.

Fig. 4 is a side elevation, partially in section, of one of the improved explosively actuated presses employed in carrying out the herein described method of pipe joining.

Fig. 5 is a section taken on line 5—5 of Fig. 4.

Fig. 6 is a broken section of a part of the device, showing one method of retarding the initial movement of the piston of the apparatus until the explosive gases have built up a predetermined pressure.

Fig. 7 is a longitudinal vertical section taken through the die elements and the sleeve and pipes, illustrating the preferred method of pipe joining in cases wherein the pipes are under tension or under exceedingly high pressure.

Fig. 8 is a broken longitudinal section taken through the completed joint wherein the sleeve has been placed within the pipes.

Fig. 9 is a diagrammatic view showing one means of multiplying the pressure in cases wherein pipes of large diameter are bonded.

Fig. 10 is a vertical section taken substantially through the center of a C clamp type of compressing device.

Fig. 11 is a transverse horizontal section taken on line 11—11 of Fig. 10.

Fig. 12 is a transverse horizontal section taken on line 12—12 of Fig. 10.

Fig. 13 is a broken section showing another method of retarding the movement of the piston until the explosive gases have built up a substantially maximum pressure.

The herein described method of joining pipes, tubes, casings and the like is illustrated generally in Fig. 1. The two terminals of the pipe P are inserted within the ends of a sleeve S having a longitudinal bore therein of such diameter as to closely fit the pipes, the latter meeting midway between the ends thereof.

The sleeve and the pipes are then placed between die elements A and B having complementary, longitudinal grooves G therein, the total diameter of the complementary grooves slightly less than the external diameter of the sleeve. The dies, which are desirably of the same length as the length of the sleeve, are then brought forcibly together under the impulse created by a confined explosive charge, thereby effecting a permanent bond between the sleeve and the pipes.

It is desirable, although not essential, in carrying out this method that the perfect round of the pipes be preserved after the joint has been completed, since by employing the quick com-

pression achieved by the explosive means there is practically no danger of the walls splitting or cracking.

This substantially perfect round is, however, preserved in the following manner: Both the pipe P and the interior of the sleeve S are perfect rounds. The exterior of the sleeve is, however, flattened on opposite sides as at F. The complementary longitudinal grooves in the dies likewise constitute a perfect round having a diameter somewhat less than the external diameter of the sleeve. If desired, the grooves may be formed with cutting edges as at C to prevent the formation of fins on the sleeve after the compression thereof. When the sleeve is inserted within the grooves prior to the compression, the dies are separated a short distance and there is also a space between the upper and lower surfaces of the sleeve and the adjacent portions of the die.

The dies are now moved forcibly together under the impulse created by the explosion of a confined explosive charge with the result that the sleeve has become a substantially perfect round of slightly less diameter than originally and the pipes have likewise been uniformly compressed.

Whereas only round pipes are illustrated in the drawings, it will be appreciated that the same method may be employed for joining pipes, tubes, rods and the like, of any conceivable shape.

The several types of apparatus which may be employed in carrying out the invention will now be described. In my earlier patent, to wit, No. 2,030,803, previously mentioned, I described a device having complementary die elements which are normally separated, and between which the work to be compressed is placed. The lower of these die elements is stationary, and the upper or movable element is separated from the lower end of an explosively actuated piston by means of a small shear pin. This shear pin retards the initial movement of the explosive gases until the latter have built up a substantially maximum pressure at which time the shear pin collapses, thereby bringing the piston into forcible engagement with the movable die. This arrangement has been highly satisfactory, particularly in cases wherein exceedingly high pressures were required, as is the case in the bonding of stranded cables. In the bonding of pipes and the like, however, the pressure need not normally be as high, and accordingly, in the first embodiment of the apparatus for carrying out this method, I do not provide any stroke for the piston beyond the amount required to merely bring the dies together. Another reason for avoiding a longer stroke is to preserve the alignment of the two sections of pipe which show a marked tendency to "whip" under the influence of the sudden blow.

This apparatus which is illustrated in Figs. 4 and 5, includes a substantially cylindrical frame 10 having a longitudinal bore 11 therein in which a piston 12 is accurately fitted. This piston is likewise cylindrical in shape and is closed at its lower end as indicated at 13, and is provided with a longitudinal bore 14 extending downwardly from its upper end. The upper end of the bore 11 in the frame is formed with a seat indicated at 15. A barrel 16 having a relatively wide annular flange 17 at its upper end resides in this seat 15, said barrel passing downwardly through the bore 14 of the piston. The barrel is

further provided with a longitudinal aperture 18 having a seat 19 at its upper end for the reception of the head 20 of a conventional blank cartridge 21.

The frame 10 is closed at its upper end by means of a cap 23 which is provided with threads 24 which engage the externally formed threads 25 at the upper end of the frame 10, said upper end being of slightly reduced diameter. The threads 24 and 25 are preferably of the interrupted or gun breech type which are adapted to secure the cap in place by a one-quarter turn. The cap 23 is further provided with an upwardly extending portion 28 having a concave depression 29 at its upper end, and a vertical bore 30, the lower half of which is reduced as at 31. Within this aperture, a firing pin 32 is positioned, and is adapted for longitudinal movement therein. The lower end of this firing pin engages the detonating cap of the cartridge 21, and when it is desired to actuate the device, the firing pin is tapped at its upper end with a small hammer, thereby detonating the explosive charge.

It is well known that exploding gases expand equally in all directions, and in the instant device there is a complete absence of recoil due to the fact that the explosive gases are confined within the explosion chamber after the explosion has taken place. In a few seconds thereafter, the gases are condensed, leaving only a small trace of moisture within the explosion chamber. This confining of the gases is effected by providing an accurate fitting between all of the parts of the device, particularly between the barrel and the piston, between the flange at the upper end of the barrel and the seat in which it resides, and between the cartridge and the breech element.

After each actuation of the device, the joined pipe must, of course, be removed from the apparatus, and for this purpose, the frame is provided with a vertical slot 36 extending from the upper end thereof to its lower wall which is designated as 37, all as shown in Fig. 4. Thus, after the cartridge has been detonated, the cap 23 is removed, as well as the barrel, the piston and the die. The pipe is then moved upward through the slot 36.

The lower die element 38 rests upon the upper surface of this lower wall 37 and is held in place by means of a small pin or dowel 39 which passes into an aperture 40 in the lower surface of said die element. The upper die element 41 is carried at the lower end of the piston by means of a slot 42 formed in the piston which receives a dovetailed projection 43 formed in the upper surface of the die.

As previously stated, in my earlier patents, a substantial stroke is provided for the piston, and the initial movement thereof is retarded until a substantially maximum pressure of the explosive gases have been built up. In the embodiment illustrated in Figs. 4 and 5, however, no substantial stroke is provided, and the effect is more one of rapid compression or squeezing. In joining pipes of larger diameter, however, it may be found expedient to provide a stroke in order to secure a greater compressing effect, and accordingly the press may be modified to provide a suitable retarding device, the one shown in Fig. 6 having given excellent results. In this instance, any desirable portion of the frame 10 is formed with an aperture 46 having a reduced portion 47 at its inner end, the opposite end of the aperture having threads 48. A headed pin 50 is posi-

tioned within the aperture and is urged inwardly by means of a compression spring 51 which is held in place by means of a screw plug 52. The inner end of the pin is rounded as at 53 and resides in a depression 54 in the piston when the latter is in its starting position. By providing a compression spring of sufficient strength, the pin is capable of retarding the initial movement of the piston until the explosive gases have built up a predetermined maximum pressure, at which time the piston moves at a tremendous velocity, thereby giving a far more powerful blow.

In the method just described, both the external surfaces of the pipes and the internal surface of the sleeve are smooth which is satisfactory in virtually all cases wherein the pipe is used as a fluid conduit. In the event, however, that the pipe is under tension or under exceedingly high pressure, it is desirable to employ the method illustrated in Fig. 7.

In this instance, the complementary grooves in the dies A' and B' are formed with two or more annular recesses 60 which are desirably arcuate in cross-section. Thus, when the dies are brought forcibly together, there is formed on the outer surface of the sleeve annular ridges 61, and there is further formed on the external surface of the pipe the ridged portions 62 which closely fits the recess on the inner surface of the sleeve. It will be obvious that as tension is applied to pipes, the joint will become the more firm by virtue of the pressure exerted between these offset portions.

By way of modification, the complementary grooves in the dies may be formed with annular ridges rather than recesses with much the same result.

This method may be further modified by merely forming a plurality of annular grooves in the outer surface of the pipe terminals previous to the joining operation, or even by merely roughening this surface, since under the tremendous compression of the dies the inner surface of the sleeve will be forced into intimate contact with all of these non-smooth portions.

The internal sleeve construction shown in Fig. 8 illustrates a further modification in the method of carrying out the present invention. Pipes are used to a large extent in the construction of household articles such as beds and chairs, as well as for many other purposes. In these instances, it is highly desirable to make the joint as neat and invisible as possible, and to effect this end the sleeve S' is inserted within the terminals of the pipes and the dies A and B brought together as previously described, resulting in what appears to be a weld, except, of course, for the slightly reduced diameter of the pipes. By judiciously tapering the end portions of the grooves in the dies, this depression can be rendered largely invisible.

In the event that pipes or other articles of large diameter are to be joined, the toggle principle of multiplying the pressure illustrated in Fig. 9 is employed. In this instance, instead of connecting the piston directly with the movable die A, the piston X moving within the cylinder Y is connected with a piston rod R which is operatively joined at its opposite end to the links L, the lower one of which is pivotally connected with the movable die A. Thus, it is possible to secure the exceedingly high pressure required to join large members without constructing a machine of unwieldy size.

The C clamp embodiment of the compressing device illustrated in Figs. 10 to 13 inclusive, al-

though not structurally as strong as the previous embodiment, by virtue of its providing support for the lower die element on one side of the frame only, is nevertheless a highly effective tool for the bonding of lighter pipes, and can be operated more rapidly by virtue of the fact that it is not necessary to remove the piston and the barrel after each joining operation.

This embodiment includes a frame 70 having a lower die supporting portion 71 and outwardly flared side portions 72 to provide additional strength, and is formed with a longitudinal aperture 73 having a threaded portion 74 at its upper end. The piston 75 is of substantially the same shape as the piston in the preferred embodiment, and is of such external diameter as to accurately fit the bore or aperture 73 in the frame. The piston is further provided with a central aperture or bore 76 extending downwardly from the upper end thereof.

A plug 77 having an externally threaded portion 78 is positioned within the threaded portion 74 at the upper end of the bore 73 in the frame, said plug having a downwardly extending or barrel portion 79 accurately fitted within the bore in the piston, and is further provided with an upwardly extending externally threaded portion 80. A longitudinal vertical aperture 81 extends from the upper to the lower end of the plug, said aperture having a seat portion 82 at its upper end to receive the flange of the blank cartridge 83. The breech element 84 is formed with an internally threaded recess at its lower end which engages the threaded portion 80 integral with the plug, said breeching element having a concave depression 85 on its upper surface and a longitudinal aperture 86 with a reduced portion 87, the firing pin 88 being positioned within this aperture. Each time the device is to be actuated, the breeching element is unscrewed, a blank cartridge inserted in the aperture 81, and the element returned to its place.

The lower end of the piston is formed with a transverse dove-tailed slot 90 which receives the integrally formed dove-tailed portion 91 on the upper surface of the upper die 92. The upper surface 93 of the lower die supporting element 71 is concave and supports the lower die 94 which is held in place by means of a pin 95 extending into an aperture 96. To insert the pipe in the device, the upper die 92 is first removed to admit said pipe and the sleeve between the opening of the frame, after which the die is returned to its place.

This embodiment of the compressing device is provided with a retarding mechanism illustrated in detail in Fig. 13. At any suitable point in the barrel portion of the frame an aperture 97 is formed, said aperture having a reduced portion 98 at its inner end and an enlarged threaded portion 99 at its outer end. A cylindrical plug 100 having a bore 101 is secured within the threaded portion of the aperture 97, said plug having positioned therein a compression spring 102. A shear pin 103 is positioned within the reduced portion of the aperture, said pin being urged inwardly by means of the spring 102.

The external surface of the piston is formed with a small vertical slot or elongated aperture 104, the upper end of which is engaged by the inner end of the shear pin 103. Thus, when the detonation occurs the initial movement of the piston is retarded until the explosive gases have built up a sufficiently high pressure to sever the end of the shear pin. The length of the slot 104 will, of course, be dependent upon the length of

stroke required of the piston. In the normal pipe joining operation, this stroke is desirably very short.

After the length of the shear pin has been sufficiently reduced it is removed and a new one inserted in its place.

It will be appreciated that the hereindescribed method and apparatus may be considerably modified without departing from the invention. For instance, three or more dies having complementary grooves may be employed instead of two dies, as shown in the drawings, particularly in cases wherein larger pipes are being joined. In these instances, any suitable means may be used for actuating the movable dies at the same instant. Furthermore, the dies may be formed in any desired shape, depending upon the shape of the work to be compressed. In many instances, also, a substantially uniform pressure on all parts of the work will not be required, and in these cases the work may be merely deformed in suitable areas.

What I claim is:

1. The method of bonding pipes and the like which consists in inserting the terminals thereof into a sleeve having a longitudinal bore therein of substantially the same diameter as the diameter of the pipes, placing the sleeve between a plurality of dies having complementary grooves shaped to fit the exterior surface thereof but of slightly less diameter than the diameter of the sleeve, and then compressing the sleeve between the dies under the impulse created by the explosion of a confined explosive charge.

2. The method of bonding pipes, tubes, rods, wires and like members which consists in inserting the members into a sleeve and then compressing the sleeve around at least part of the members by means of dies acting under the impulse created by the explosion of a confined explosive charge.

3. The method of securing originally separated members together which consists in placing the ends thereof in telescoping relation with a cylindrical sleeve, and then applying substantially equal pressure to the external surface of the telescoped parts by means of dies acting under the impulse created by the explosion of a confined explosive charge.

4. The method of joining pipes and the like which consists in inserting a sleeve into the adjacent end portions of said pipes, and then compressing the pipes around said sleeve by means of dies acting under the impulse created by the explosion of a confined explosive charge.

5. The method of joining tubular members which consists in inserting the terminals of said members into a cylindrical sleeve having a longitudinal bore therein, then placing the sleeve in complementary grooves in a pair of dies, and then compressing the sleeve between said dies under the impulse created by the explosion of a confined explosive charge.

6. The method of joining originally separated members together which consists in inserting the terminals thereof within a sleeve having a longitudinal bore therein of substantially the same size and shape as the exterior surface of the member, then placing the sleeve between complementary dies and moving said dies forcibly together under the impulse created by the explosion of a confined explosive charge.

7. The method of joining tubular members which consists in inserting the ends of said members within the end portions of a sleeve

having a longitudinal bore therein of substantially the same diameter as the diameter of the sleeve and causing the terminals thereof to meet substantially midway between the ends of the sleeve, then placing the sleeve within semi-circular, complementary grooves formed in a pair of dies of substantially the same length as the length of the sleeve, the diameter of the circular groove formed by the dies being less than the external diameter of the sleeve, then forcibly moving said dies together under the impulse created by the explosion of a confined explosive charge, the initial movement of said dies being retarded until the explosive gases have built up a predetermined pressure.

8. A compressing device comprising a frame having a longitudinal bore therein, an apertured piston slidably supported within said bore, a barrel member positioned within said piston and being supported at the upper end of the frame, said barrel member having a longitudinal bore to receive an explosive charge, the lower end of the bore communicating with the aperture in the piston, a movable die element associated with the lower end of said piston, and a stationary die element positioned at the lower end of the frame.

9. A compression device comprising an apertured piston having an explosion chamber at the lower end thereof, a frame for supporting said piston, a cylindrical member passing into said piston and having a detonation chamber communicating with said explosion chamber, complementary die elements supported in said frame, and adapted to receive work therebetween, one of said die elements being operatively connected with the piston.

10. A compressing device comprising a frame having a longitudinal bore therein, a longitudinally apertured piston positioned within said bore, the upper end of said piston being open and the lower end thereof being closed, a cylindrical member supported at the upper end of the frame and extending downwardly into said piston, said cylindrical member having a bore extending the full length thereof, an explosive charge carried at the upper end of said bore and being adapted, upon detonation, to drive said piston downwards, a movable die element carried at the lower end of said piston and a stationary die element supported at the lower end of the frame.

11. The method of bonding pipes and the like which consists in inserting the terminals thereof into a sleeve having a longitudinal bore therein of substantially the same diameter as the diameter of the pipes, placing the sleeve between a plurality of dies having complementary grooves shaped to fit the exterior surface thereof but of slightly less diameter than the diameter of the sleeve, and then compressing the sleeve between the dies under the impulse created by the explosion of a confined explosive charge, the compression between the dies being multiplied by toggle means.

12. A compressing device comprising a frame, a transmission member movably mounted within and by the frame, said transmission member having an explosion chamber therein, means fixed to the frame and positioned slidably within said explosion chamber to receive an explosive charge, and means operable upon the explosion of the charge for retarding the initial movement of the transmission member until a pre-

determined maximum pressure has been built up behind the transmission member.

13. A compressing device comprising a frame, a piston movable in said frame, slidably supported thereby in substantially gas tight relation, and having a cylindrical longitudinal aperture therein extending downwardly from the upper end thereof, a cylindrical member having a longitudinal aperture therein slidably but in substantial gas tight relation positioned within the piston and being supported at the upper end of the frame, means within said member for receiving an explosive charge and complementary die elements, one of which is movable by said piston.

14. A compressing device comprising a frame, a plurality of die elements positioned within the frame and means for moving said die elements together under the impulse created by a confined explosive charge, said means comprising a piston longitudinally movable within the frame, and in substantially gas tight relation therewith a member positioned slidably within the piston but in substantially gas tight relation therewith and supported at an end of the frame, means within said member for receiving an explosive charge to act upon the piston and means operable upon the explosion of the charge for retarding the initial movement of the piston until a substantially maximum pressure has been built up behind the piston.

15. A compressing device comprising a frame, a plurality of die elements positioned within the frame and means for moving said die elements together under the impulse created by a confined explosive charge, said means comprising a piston longitudinally movable within the frame, a member positioned within the piston and supported at an end of the frame, means within said member for receiving an explosive charge to act upon the piston and means for retarding the initial movement of the piston after the charge has been detonated until the exploded charge has built up a substantially maximum pressure, said means comprising a spring pressed member in the frame, the piston having a recess to receive said member.

16. A compressing device comprising a frame, a plurality of die elements positioned within the frame and means for moving said die elements together under the impulse created by a confined explosive charge, said means comprising a piston longitudinally movable within the frame, a member positioned within the piston and supported at an end of the frame, means within said member for receiving an explosive charge to act upon the piston and means operable upon the explosion of the charge for retarding the initial movement of the piston until a substantially maximum pressure has been built up by the exploded charge, said means comprising a spring pressed member in the frame, the piston having a recess to receive said member, a shearable member positioned between the frame and the piston.

17. In combination a frame having a cylindrical bore, a cup-shaped piston slidably received in the bore in substantially gas tight relation therewith, a cylindrical member fixed to the frame and extending into the interior of the cup-shaped piston and having a substantially gas tight seal therewith while permitting movement of the piston, said member having a longitudinal aperture adapted to receive an explosive charge, means for detonating the charge and work engaging means carried by the frame and piston, respectively, with the frame means being sub-

stantially in alignment with the movement of the piston means.

18. In combination a frame, a hollow piston mounted in the frame for sliding gas tight movement therein, means carried by the frame and sealing between the interior surface of the piston and the frame during movement of the piston whereby a double seal between the frame and piston is provided, means for subjecting the back side of the piston to the forces of a detonated

charge of explosive and means on the frame in alignment with the piston movement to transmit the piston movement into useful work.

19. The method of bonding pipes, tubes, rods, wires and like members which consists in inserting a member into a sleeve, and then compressing the sleeve around at least part of the member by means of dies acting under the impulse created by the explosion of a confined explosive charge.

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