This invention relates to an improved perforating gun for use in wells, such as oil wells, and one object of the invention is to provide a gun which may be lowered into a well to a desired position therein and then discharged so that bullets with which the gun is loaded will be fired through the well casing and into walls of the well and thus serve to shatter the portions of the walls which have become clogged and cause oil to flow freely. Another object of the invention is to so form the gun that it may be freely lowered in the casing of the well and then manipulated by vertical movement which will cause gripping elements to be brought into engagement with the casing and mechanism then actuated to explode cartridges carried by the gun and discharge bullets through the well casing and into walls of the well.

Another object of the invention is to so construct the gun that it may be connected with the lower end of a string of tools ordinarily employed in an oil well when it is in use. It will thus be seen that no special apparatus is required for lowering the gun into the well and discharging the same and, therefore, a saving in equipment will be accomplished.

The invention is illustrated in the accompanying drawings, wherein Figure 1 is a longitudinal sectional view through the improved gun showing the same as it will appear while being lowered into a well, Figure 2 is a view similar to Figure 1 and illustrating the manner in which the gun is actuated in order to discharge the gun, Figure 3 is another view similar to Figures 1 and 2 and showing another position occupied by portions of the gun during firing thereof, Figure 4 is an enlarged fragmentary sectional view taken vertically through the gun, Figure 5 is a sectional view taken transversely through the gun along the line 5—5 of Figure 4, Figure 6 is a sectional view upon an enlarged scale taken through the gun and the well casing along the line 6—6 of Figure 3, Figure 7 is a view partially in side elevation and partially in vertical section and illustrating a gun of a modified construction, Figure 8 is an enlarged sectional view of a portion of the gun illustrated in Figure 7, Figure 9 is a view similar to Figure 8 illustrating a modified construction, and Figure 10 is a fragmentary sectional view taken longitudinally through a gun of a modified construction wherein bullets are discharged from opposite sides of the gun instead of from only one side thereof.

This improved gun is intended to be connected with the lower end of a string of well tools, one of which is indicated in general by the numeral 1, and it is to be understood that the string of well tools will be of a conventional construction and may include a jar which is also of a conventional construction and operated in the usual manner by reciprocating the string of tools vertically in the well. This string of tools and the gun will be forced downwardly through the well casing 2 which is of the usual tubular formation and consists of the usual series of pipe sections connected one with another.

The body portion 3 of the gun is in the form of an elongated metal bar having a neck 4 at its upper end carrying a head 5 from which projects a threaded shank 6 adapted to be secured into the lower end of the lowermost one of the string of tools. The head 5 constitutes a wrench-engaging member by means of which the shank 6 may be screwed tightly into the well tool. This metal bar or body of the gun will be of such diameter that it will slide freely through the well casing 2, and at one side the body is formed with a longitudinally extending groove or recess 7 which is of an even width throughout its length and has its upper portion 7a of gradually increasing depth and formed at its inner wall with side extensions or recesses 7b. A groove or recess 7c of less width than the inner wall of the groove or channel 7 is formed along the upper portion of the channel or there may be provided a series of these grooves 7d in vertical spaced relation to each other.

Threaded sockets 8 which may be of any number desired are formed transversely of the body from one side thereof, and into these sockets are screw barrels 9 for receiving cartridges 10, it being understood that, in order to apply the cartridges, the barrels must be unscrewed, the cartridges thrust into the barrels from their ends thereof, and the valves then again screwed into the socket. The cartridges will thus be supported, as shown in Figures 1, 2 and 4, and each have its primer disposed in position for engagement by a firing pin 11. The firing pins are slideably received through openings 12 extending between the sockets and the inner wall of the upper portion of the groove or channel 7 and are engaged by the inner edge face of a firing bar 13 which is slideably received in the upper portion of the channel 7 and held in engagement with...
an abutment bar by leaf springs. These springs extend longitudinally of the channel and each has one end portion secured in one of the grooves and its free end position bearing against the inner edge face of the firing bar. Confronting faces of the bar and the firing bar are formed with teeth and, from an inspection of Figure 4, it will be readily understood that, when pressure is applied to the lower end of the stem or shank at the bottom of the firing bar to force this bar upwardly in the channel, a cam action will take place between the sloping edge faces of the teeth and to shift the firing bar toward the inner wall of the channel and thus apply pressure to the firing pin which will force the firing pin into the primers of the cartridges and thus explode the cartridges. When the cartridges explode, the bullets will be forced from the shells and through the well casing into the walls of the well and the walls of the well will be shattered to such an extent that flow of oil which has been stopped by clogging will be restored.

A block is slidably received in the lower portion of the slot and extends transversely therein, as shown in Figures 1, 2 and 3. The block tapers towards its upper end and along its inner side edge is formed with side extensions or ribs which engage in the grooves and prevent this block from dropping through the open side of the slot when the device is not in use. The outer side edge of the block is beveled from opposite side faces of the block to form a cutting edge which intersects the lower edge of the slot and will cause the pins or plungers to be forced into engagement with the carnets. This action will cause the pins or plungers to be forced into engagement with the primers of the cartridges and, as shown in Figure 3 and in Figure 6, from an inspection of Figures 1, 2 and 3, it will be seen that, when the block is in a lowered position, it will be entirely housed in the lower portion of the slot, whereas, when it is shifted upwardly, it will be caused to project from the open sides of the slot and have biting engagement with the well casing, after which it will be forced through the well casing as the body of the gun moves downwardly and it will eventually make contact with the lower end of the shank to shift the firing bar upwardly and cause the pins or plungers to be forced into engagement with the primers of the cartridges and, as shown in full lines in Figure 1, that indicated by dotted lines, and in addition also serves as a hanger or carrier for a set of springs. These springs are formed from strips of resilient sheet metal and each has a vertically extending portion and upper and lower arms extending therefrom toward the rod. The ends of the arms are disposed in overlapping relation to each other and formed with aligned openings through which the rod passes. The arms are of such a length that, when the device is in use and thrust into a well casing, the vertically extending portions of the springs will have frictional binding engagement with the walls of the casing. By this arrangement the gun may be lowered into a well until reached a predetermined depth, at which time the string of tools will be drawn upwardly a sufficient distance to cause the rod to be drawn upwardly from the position shown in Figure 1 to that shown in Figure 2, and these springs will have tight binding engagement with walls of the well casing and also have tight binding engagement with the rod. The string of tools and the gun may be again lowered and, when the head at the upper end of the rod engages the lower end of the shank in block, the block will be shifted upwardly and the rod will be shifted against further downward movement in the well casing. The string of tools and the gun may be shifted vertically and the cam action which takes place between the block and the diagonally extending inner edge wall of the slot will cause the block to be gradually shifted radially of the gun and well casing and the block and the sharpened outer side edge of the block forced through the wall of the well casing. The weight of the string of well tools and the gun may depend upon the point of the block through the well casing to the position shown in Figure 3 and the constructional construction can be provided between the gun and the lower one of the string of well tools. It will be understood that the springs will be carried downwardly in the well with the gun during movement of the block to the position shown in Figure 3. Further reciprocating movement of the string of tools will cause the lower end of the shank to engage the upper end of the block and the firing bar will then be forced upwardly and the cam action which takes place between the bar and the cam bar will move the firing bar transversely and force the firing pins into engagement with the primers of the cartridges. The cartridges will then be exploded and the bullets discharged through the well casing and into the wall of the well to break up portions of the wall of the well and thus cause the well to flow freely. Instead of discharging bullets from only one side of the gun, they may be discharged from opposite sides thereof, in which case a construction such as shown in Figure 10 will be employed. Referring to this figure, it will be seen that the upper portion of the slot will extend through the body of the gun axially thereof and barrels to receive the cartridges will be mounted in diametrically opposed side portions of the body. The firing pins which are slidably mounted in the pocket extend into the slot for engagement with the firing bar. These bars are yieldably held against opposite side edges of a bar by springs which correspond to the springs and contact portions of the bar and the firing bars are formed with a tooth or serrated portion defining cooperating cam members and. The lower end of the actuating bar will extend into the widened lower portion of the slot and terminate in a shank corresponding to the shank so that, when the device is in use and the lower end of the actuating bar is engaged by the block, the actuating bar will be shifted upwardly and the firing bar shifted transversely to force the firing pins into engagement with the primers of the cartridges and explode the cartridges. It will be obvious that additional sets of cartridges may be provided for the gun.

In Figures 7, 8 and 9, there has been shown another modified construction wherein the block is eliminated and the firing bar is slidably mounted in a slot corresponding to the slot 7 but having its lower end communicating with a pocket formed in the lower portion of the
tools actuated to shear the pin 45 and the body of the gun may then slide downwardly along the rod 38 to bring the head 45 into engagement with the slot 18 of the firing bar 13 and effect discharge of the cartridges.

Having thus described the invention, what is claimed as new is:

1. A well-shooting device comprising a body adapted to be lowered into a well casing, the body being formed with a longitudinally extending slot 30 and with transverse pockets, barrels in said pockets for receiving cartridges equipped with projectiles, firing pins for the cartridges carried by the body and extending into said slot, a firing bar mounted in said slot, said bar being slidable longitudinally in said slot and shiftable transversely therein towards and away from said pins, means for shifting the bar towards the pins and moving the pins in a direction to discharge the cartridges when the bar is moved longitudinally in one direction and cause the projectiles to perforate the casing, and means for sliding the bar in the said direction adapted to be actuated by reciprocating movement of the body in a well.

2. A well-shooting device comprising a body adapted to be lowered into a well casing, the body being formed with a longitudinally extending slot and at one side of the slot being formed with transverse pockets and reduced passages leading from inner ends of the pockets to said slot, means in said pockets for carrying cartridges equipped with projectiles, firing pins for the cartridges slidably received through the passages and projecting into the slot, a firing bar slidable longitudinally in said slot, a guide bar in said slot, the firing bar and the guide bar being formed with cooperating cam portions for shifting the firing bar towards the pins and effecting discharge of the cartridges when the firing bar is slid longitudinally in one direction whereby the projectiles will penetrate said casing, springs in the slot for urging the firing bar toward impactive position, and means carried by said body for effecting movement of the firing bar to operative position during reciprocation of the body in a well.

3. A well-shooting device comprising a body adapted to be lowered in a well casing, the body being formed with a longitudinally extending slot and a portion of the slot being formed with a diagonally extending inner wall, means for mounting in the body transversely thereof cartridges equipped with projectiles, firing pins for the cartridges slidably carried by the body and extending into the slot, a firing bar slidable longitudinally in said slot, a cam member for shifting the bar towards the pins and moving the pins in a direction to fire cartridges when the bar is slid upwardly in the slot and cause the projectiles to penetrate said casing, a block slidable longitudinally in the portion of the slot having the diagonally extending inner wall and normally disposed at the lower end of the slot and entirely housed in the slot, means carried by the body for initially moving the block upwardly in the slot whereby the inclined wall will force the block out of the slot and into biting engagement with a well casing and hold further downward movement of the block with the body, further downward movement of the body serving to bring the block into engagement with the lower end of the firing bar and shift the bar upwardly to effect discharge of the cartridges.

4. A well-shooting gun comprising a body to be reciprocated within a well casing and having a longitudinally extending slot 30 along one
side of the body and having a lower portion formed with a diagonally extending inner wall, a barrier for the lower end of the slot, means for mounting in the body cartridges equipped with projectiles, firing pins extending into the upper portion of the slot through the inner wall thereof, a firing bar slidably longitudinally in the upper portion of the slot and shiftable transversely therein toward the firing pins whereby said firing pins will discharge the cartridges so that the projectiles will penetrate the casing, a guide bar mounted in the slot and having cam members for shifting the firing bar towards the pin when the firing bar is slid upwardly, a block slidable longitudinally in the lower portion of the slot, the block being housed in the slot when at the lower end thereof and being gradually movable outwardly through the open side of the block as it is moved toward the upper end of the tapered lower portion of the block, said block being formed at its outer end with a tooth for biting into a well casing and having a sharpened edge for cutting through the well casing as the block is moved toward the upper end of the slot into position for engagement with the lower end of the firing bar to effect upward movement of the firing bar, a rod extending through said barrier and depending from the lower end of said body, and springs loosely carried by the rod and extending laterally therefrom for engagement with walls of a well casing whereby the rod may be drawn upwardly through the springs as the body is drawn upwardly and maintained in the elevated position to engage the block and shift the block upwardly into biting engagement with the well casing as the body is again moved downwardly.

5. A well-shooting device comprising a body formed with a longitudinally extending slot, means for mounting in the body transversely thereof cartridges equipped with projectiles, firing pins for cartridges carried by the body and extending into the slot, a firing bar slidable longitudinally in the slot, said body having its lower portion formed with a pocket and said bar having its lower portion extending into the pocket, a closure for the lower end of the pocket, a plunger slidable vertically through the closure and having a head at its upper end disposed within the pocket, means for releasably holding the plunger against movement relative to the body, the plunger when released being movable relative to the body whereby the body may be shifted downwardly along the plunger to move the head of the plunger into engagement with the lower end of the firing bar and shift the bar upwardly into position to force the firing pin transversely of the body into position to discharge cartridges and expel the projectiles therefrom, and means for engaging walls of a well casing and supporting the plunger in a stationary position in the well casing.

6. A well-shooting device comprising a body, means for mounting in a body transversely thereof cartridges equipped with projectiles, a firing bar slidable longitudinally of the body and having its lower end extending into a pocket formed in the body, a plunger slidably carried by the body with its upper end extending into the body and formed with a head for engaging the rod and shifting the rod upwardly when the plunger is held stationary, a wedge carried by said plunger and tapered downwardly, a cylindrical guide extending downwardly from said wedge and formed with side slots, a rod slidably carried by said guide with its upper end portion extending into the guide and provided with ears extending outwardly through the slots, gripping dogs slidably carried by said wedge, links connecting the dogs with said ears, and springs loosely carried by said rod and extending radially therefrom for engaging walls of a well casing and holding the rod stationary.

7. In a well shooting gun, a body to be reciprocated in a well casing and having a slot, cartridge supporting means in the body, a cartridge carried in the cartridge supporting means, said cartridge having a projectile, a firing bar movable in the slot, a firing pin for the cartridge, said firing bar being engageable with the firing pin for discharging the cartridge and perforating the well casing with the projectile, a block movable in the slot and having a tooth for biting into a well casing, a rod slidable through the lower end of the body and being engageable with the block for urging said block into engagement with the firing bar for discharging the cartridge and causing the tooth to bite into the well casing upon reciprocation of the body.

8. In a device of the class described, a body adapted to be lowered into a well casing, said body being provided with means for holding a cartridge having a projectile therein, a firing bar, a firing pin engageable by the firing bar for engaging the cartridge and discharging said cartridge so that the projectile will penetrate a well casing, said firing bar being movable, a block movable on the body and having a tooth for biting into a well casing, a rod slidably connected with the body and engageable with the block for urging the block into engagement with the firing bar for discharging the cartridges and causing the tooth to bite into the well casing upon reciprocation of the body.

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