April 30, 1940. E. G. GARTIN 2,199,337

PERCUSSIVE MECHANISM

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Fig. 1.

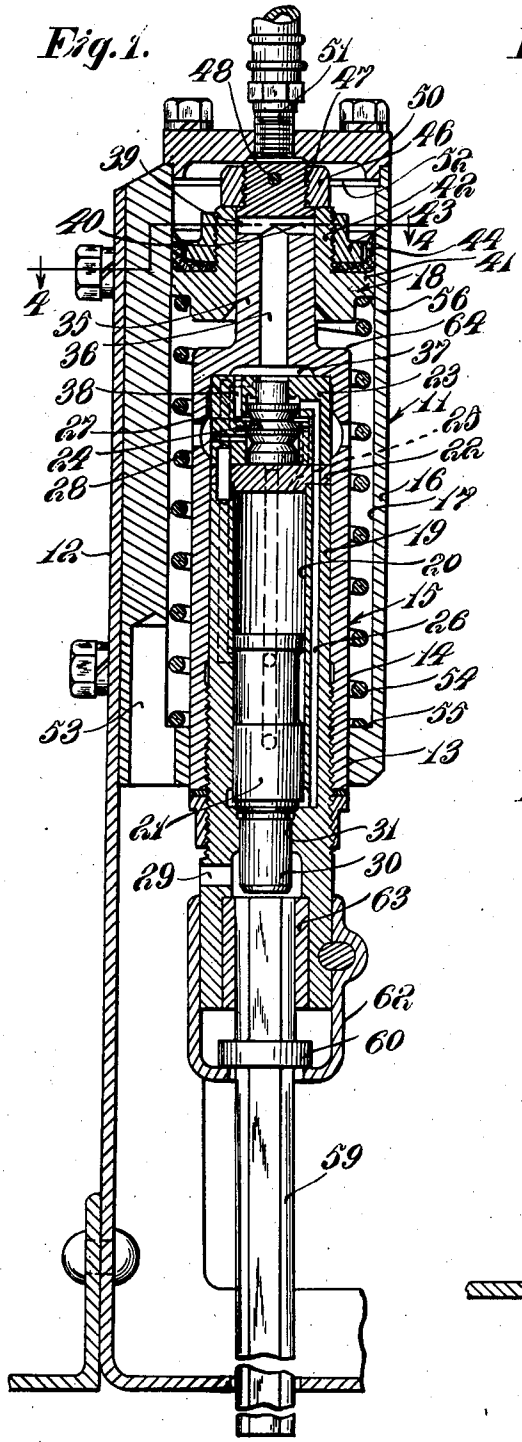
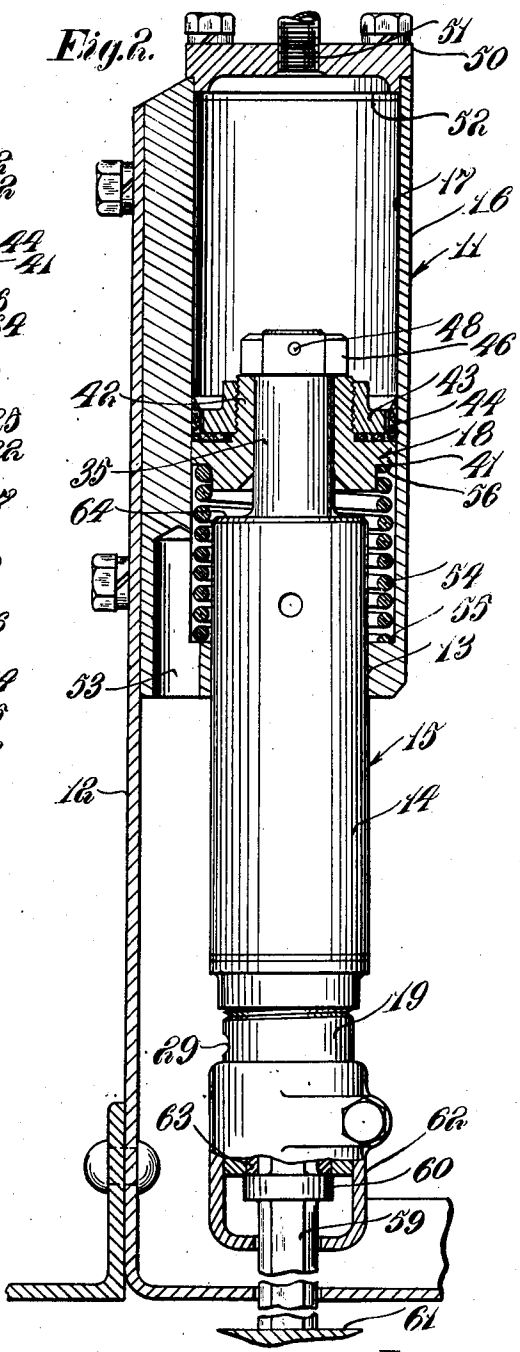


Fig. 2.



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April 30, 1940. E. G. GARTIN 2,199,337

PERCUSSIVE MECHANISM

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Fig. 3.

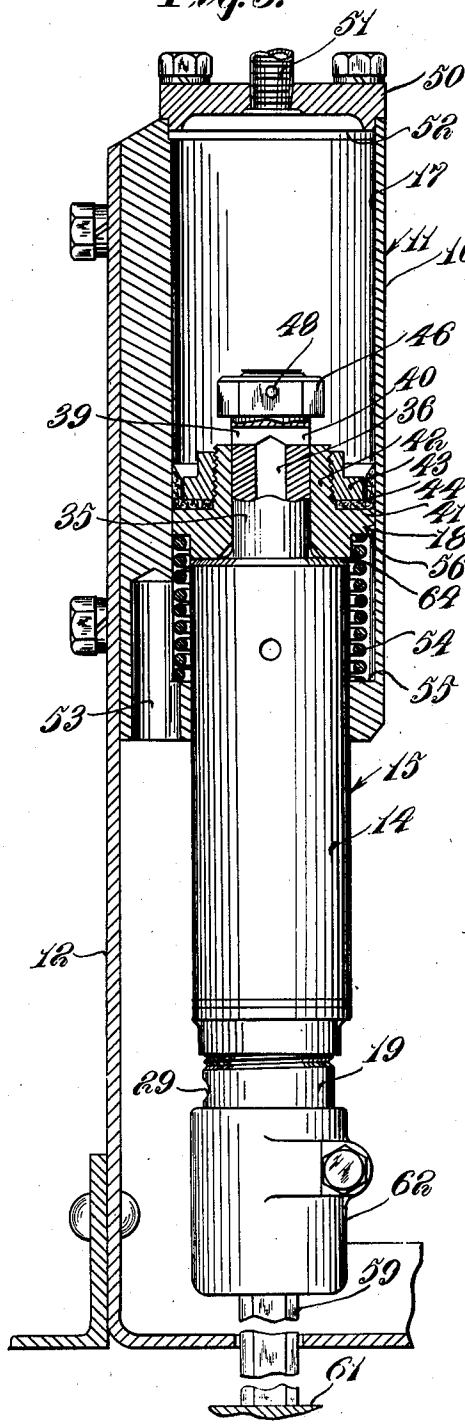


Fig. 4.

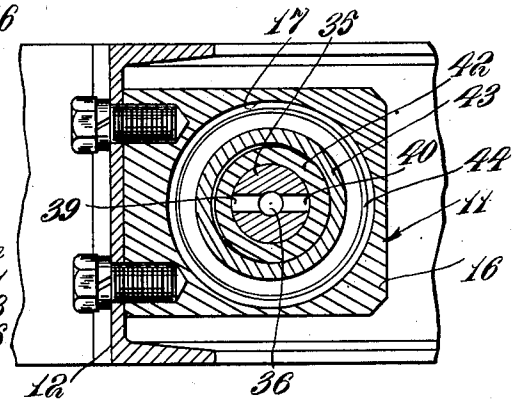
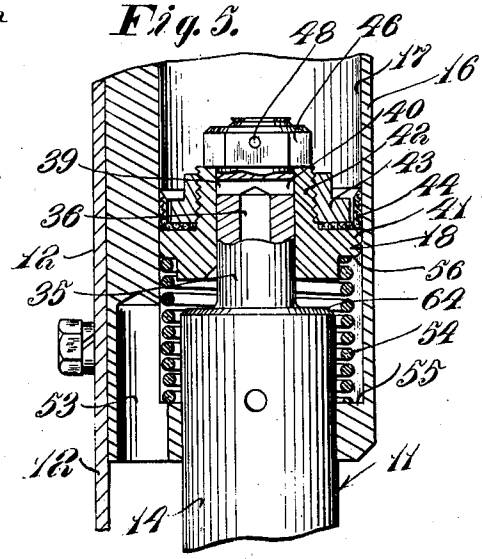


Fig. 5.



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April 30, 1940. E. G. GARTIN 2,199,337

PERCUSSIVE MECHANISM

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Fig. 6.

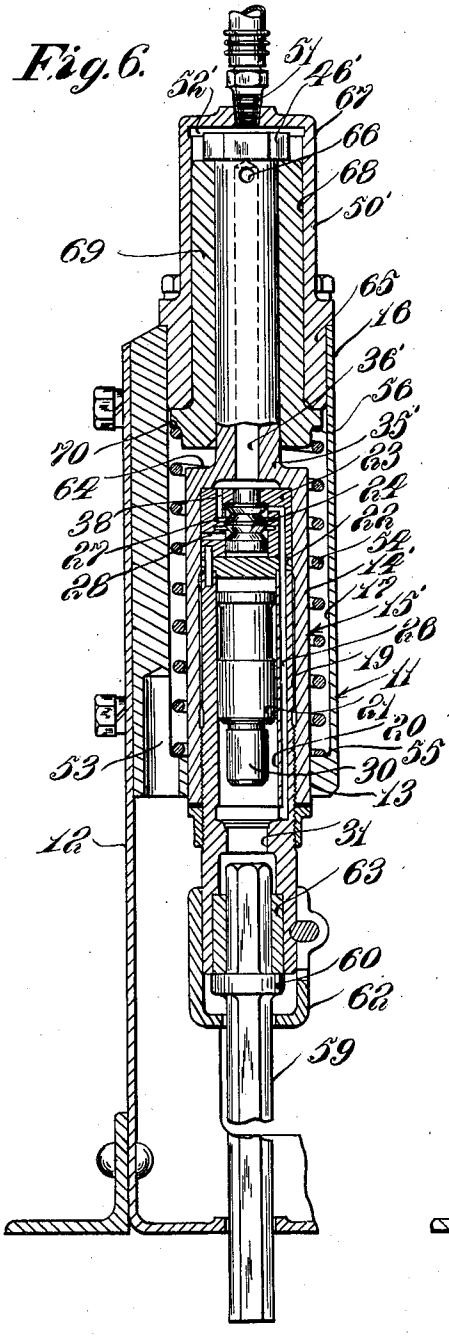
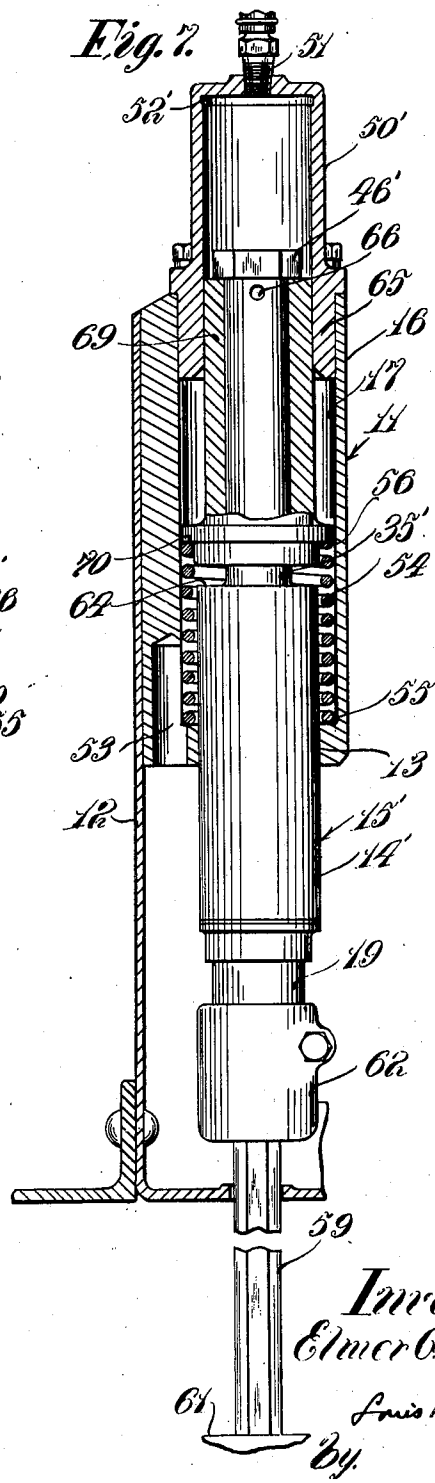


Fig. 7.



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April 30, 1940. E. G. GARTIN 2,199,337

PERCUSSIVE MECHANISM

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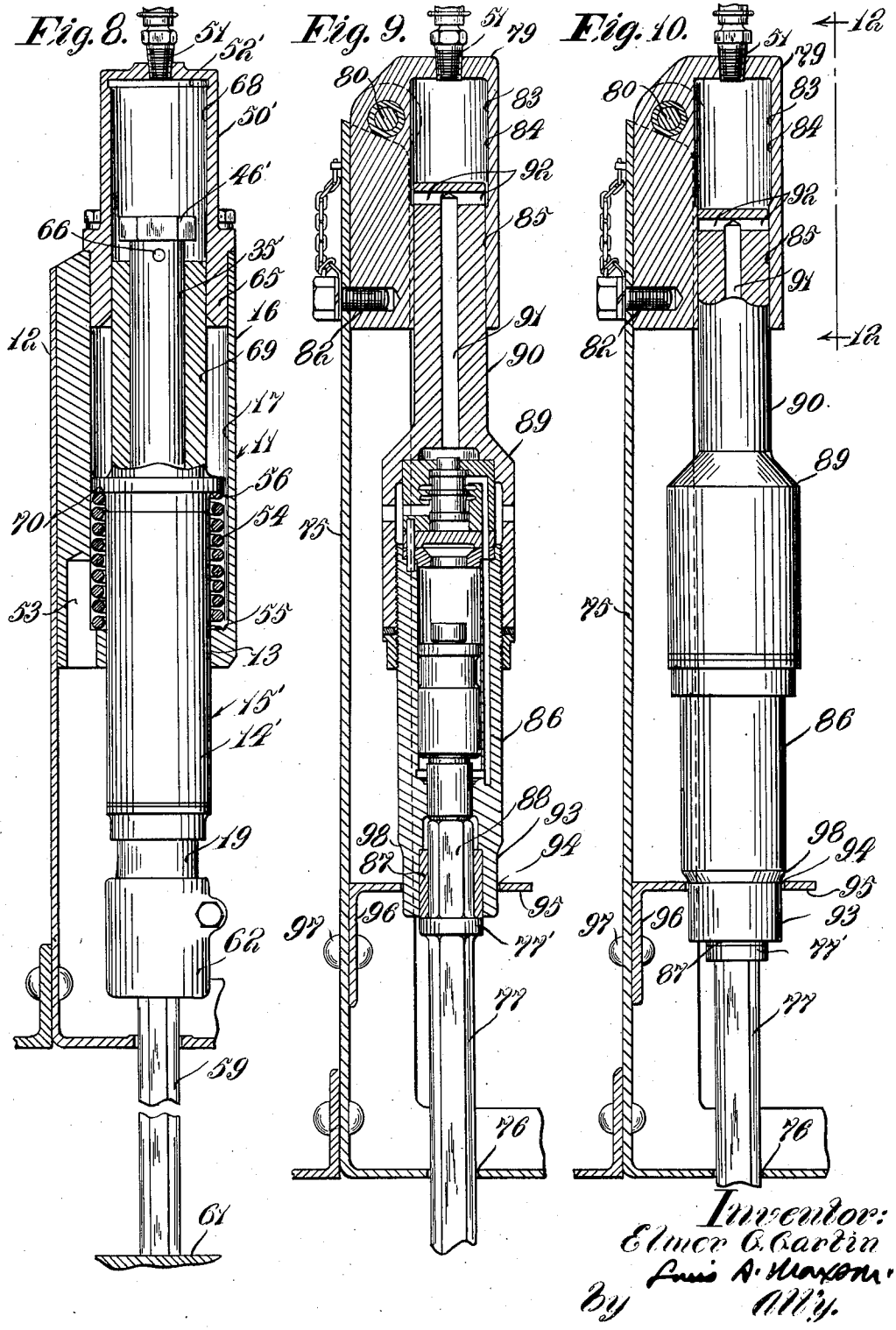

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April 30, 1940. E. G. GARTIN 2,199,337

PERCUSSIVE MECHANISM

Filed Nov. 9, 1937 5 Sheets-Sheet 5

Fig. 11.

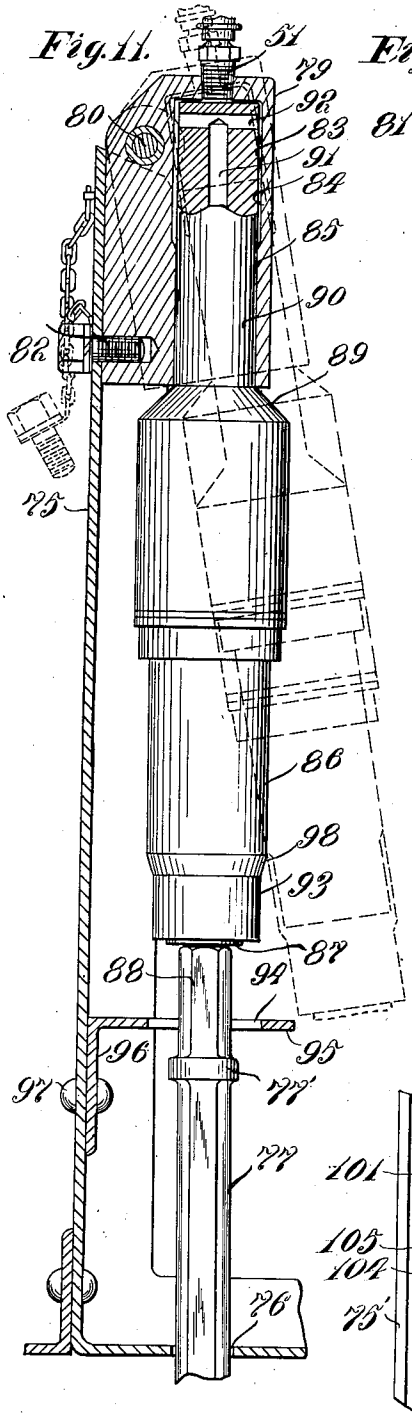


Fig. 12.

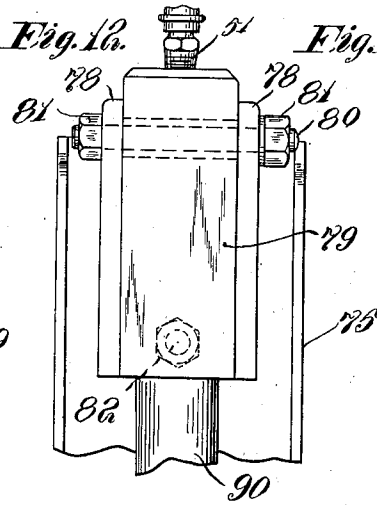


Fig. 13.

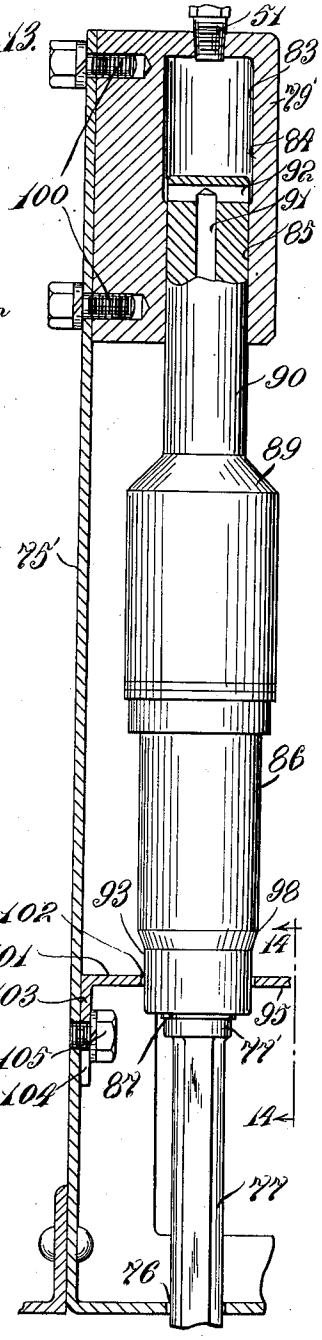
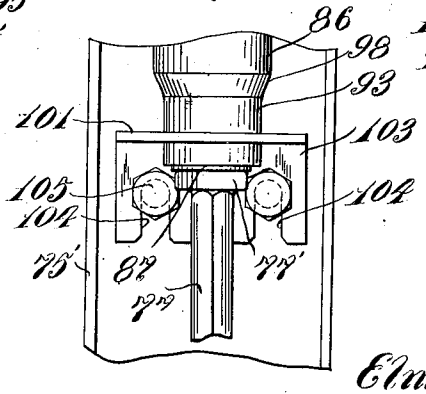


Fig. 14.



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Patented Apr. 30, 1940 2,199,337

UNITED STATES PATENT OFFICE

2,199,337

PERCUSSIVE MECHANISM

Elmer G. Gartin, Claremont, N. H., assignor to Sullivan Machinery Company, a corporation of Massachusetts

Application November 9, 1937, Serial No. 173,649

29 Claims. (Cl. 121—9)

This application is a continuation-in-part of my application Serial No. 89,696, filed July 9, 1936.

My invention relates to percussive mechanisms and, from different aspects, more particularly to percussive mechanisms having associated with them means for effecting their advance into and/or maintaining them in working position and for controlling their operation, to percussive mechanisms having associated with them improved means for automatically effecting a discontinuation of their operation in the event of breakage or displacement of the implements actuated thereby, and to percussive mechanisms having improved mountings facilitating their removal and replacement so that these operations can be performed in very short intervals of time.

The provision of mechanism for automatically advancing a percussive motor into cooperative relation with its work, only then initiating the percussive action of said motor, and so arranging the controlling mechanism for said motor that in the event of breakage of the implement which it actuates, or displacement of the work from cooperative relation with the implement, or of the implement from the work, the operation of the motor will be discontinued, is very desirable; but so far as I am advised this combination of functions has not previously been made possible in any apparatus with which I am acquainted. One place where such an arrangement would be of particular utility is in connection with so-called Cottrell hammers, where it is undesirable to begin hammering upon the steels which vibrate the plates until the steels have been brought into engagement with the plates, and in which, in the event of breakage of a steel during the period of supply of operating medium to a large number of hammers, such breakage may go undetected for a material period, with possible serious damage under some conditions, and with a certainty of the wasting of the motive fluid supplied to the hammer, which no longer vibrates its plate, unless there be provided a protective arrangement of the character herein disclosed.

In installations such as those of the Cottrell type, it is important, whether there be automatic feeding of the hammer mechanism into cooperation with the plates or whether there be continuous cooperation of the blow-transmitting devices with the plates to be vibrated thereby, that means be made available for effecting the automatic interruption of motive fluid supply to the hammer motors in the event of implement breakage or other derangements which terminate the delivery of blows to the desired points. Accordingly, for both "hot" and "cold" sides of such implements, I propose to provide automatic shut-down means of improved construction.

It is further important with devices such as the so-called Cottrell hammer installations, that the hammering implements (motors) shall be quickly removable and replaceable so that should there be a derangement thereof they may be removed very quickly and replaced by others; and from that aspect of my invention there are herein disclosed improved mounting devices for hammer motors, enabling quick replacement thereof, there being embodied therewith also others of the inventive features hereinabove described, such as the automatic shut-down feature.

It is an object of my invention to provide an improved percussive mechanism. It is another object of my invention to provide an improved percussive mechanism having improved pressure fluid feeding means therefor. It is a further object of my invention to provide an improved pressure fluid operated percussive mechanism having improved fluid supply controlling means. It is still another object of my invention to provide an improved pressure fluid operated percussive mechanism having improved combined feeding and pressure fluid supply controlling means. It is yet a further object of my invention to provide an improved apparatus for feeding a percussive motor into cooperative relation with its work, for thereupon, and only thereupon, admitting operating fluid thereto to cause initiation of percussive action, and to provide means whereby, in the event of breaking of the implement actuated by the percussive motor or interruption of the cooperative relation between said implement and an element to which it transmits the blows of the percussive motor, there shall be an automatic interruption of the motive fluid supply to the percussive motor. It is another object of my invention to provide an improved combined fluid-supply and hammer-motor-mounting mechanism. It is a still further object of my invention to provide an improved hammer motor mounting mechanism having improved means for interrupting the fluid supply to the hammer motor in the event that the imparting of blows thereby to the desired point be prevented, said mechanism providing for the quick and easy dismounting of the hammer motor when desired. These and other ob-

jects and advantages of the invention will hereinafter more fully appear.

From one aspect of my invention, and in a preferred embodiment thereof, there may be provided a percussive motor guided for movement towards and from its work, and means for effecting advance of the motor towards its work, and, upon the attainment of cooperative relation with respect to the work, an initiation of fluid supply to the motor, said advance-effecting and fluid-supply-initiating means including means operative in the event of any occurrence which interrupts the delivery of blows struck by said hammer motor to the work, to shut down the hammer motor. More specifically, from this aspect of my invention, there may be provided a percussive motor guided for movement towards and from its work, means providing cylinder and piston elements cooperating to effect advance of the motor towards its work and, upon the attainment of cooperative relation with respect to the work, an initiation of fluid supply to the motor, and means whereby, in the event of any occurrence which interrupts the delivery of blows struck by said hammer motor to the work, relative movement between portions of said motor-advancing mechanism may be effected to shut down the hammer motor.

From another aspect of my invention, and in a simplified embodiment thereof, there may be provided a percussive motor guided for movement towards and from its work and normally maintained in cooperative relation therewith, and having fluid supply means so constructed that in the event that the cooperative relation between the motor and its work be terminated, bodily movement of such hammer motor relative to its guiding means may take place to interrupt automatically the fluid supply to said motor.

From still another aspect of my invention there may be provided a percussive motor appropriately positioned in cooperative relation with its work and having associated therewith means whereby the same may be readily removed bodily from its positioning means in a minimum of time.

In the accompanying drawings, in which for purposes of illustration four illustrative embodiments disclosing different aspects of my invention have been shown—

Fig. 1 is a central vertical section through a mechanism in which one illustrative embodiment is incorporated.

Fig. 2 is a view similar to Fig. 1 showing the parts in a different relative position, some of the parts shown in section in Fig. 1 being shown in elevation in Fig. 2.

Fig. 3 is a further view showing the parts in still another relative position, slightly more of the disclosure of this figure being shown in section than is the case in Fig. 2.

Fig. 4 is a transverse section on the plane of the line 4—4 of Fig. 1.

Fig. 5 is a fragmentary view, similar to Figs. 2 and 3, showing still another position the parts may assume, as in the event of steel breakage or the like.

Fig. 6, which together with Figs. 7 and 8 shows another modified embodiment of the invention from the aspects disclosed in Figs. 1 to 5, is a central vertical section through a mechanism in which this illustrative embodiment is incorporated.

Fig. 7 is a view similar to Fig. 6 showing the parts in a different relative position, some of the parts shown in section in Fig. 6 being shown in elevation in Fig. 7.

Fig. 8 is still another central vertical section showing still a different position of the parts shown in Figs. 6 and 7.

Fig. 9, which with Figs. 10, 11 and 12 shows another embodiment illustrating aspects of the invention, is a central longitudinal vertical section through a mechanism incorporating automatic fluid supply control and automatic pressure-fluid-actuated holding means, but lacking automatic feed and starting features common to the embodiments of the invention of Figs. 1 to 8 inclusive.

Fig. 10 is a view partially in central longitudinal vertical section, showing the structure of Fig. 9 with more parts in elevation, and with parts in different relative position from that of Fig. 9.

Fig. 11 is a further view partially in central longitudinal vertical section and partially in elevation, showing still a different relative position of the parts of the mechanism illustrated in Figs. 9 and 10.

Fig. 12 is a fragmentary front view of a portion of the mechanism of Figs. 9 to 12.

Fig. 13, which shows a fourth embodiment, is a view in central longitudinal vertical section through a controlling mechanism embodying certain aspects of the invention.

Fig. 14 is a fragmentary view, in front elevation, of a portion of the mechanism shown in Fig. 13.

Referring to the drawings, and first to Figs. 1 to 5 thereof, it will be observed that a guiding means for a percussive motor and a cylinder-forming means, herein provided by the same element and generally designated 11, are supported by a suitable frame 12. The guiding means portion 13 slidably guides the external cylinder body 14 of a percussive motor 15. The cylinder-forming portion 16 of this motor provides a bore 17 in which there is reciprocably mounted a composite piston 18, later described in more detail. Within the cylinder element 14 of the motor 15 there is arranged the primary cylinder 19 of the motor, within whose bore 20 a hammer piston 21 is reciprocably mounted. To the rear of the member 19 there are cooperating head and valve-chest-forming elements 22 and 23, providing a chamber in which a distributing valve 24 is reciprocably mounted. The distributing valve controls the connection of passage means 25 leading to the rear end of the cylinder bore 20, and passage means 26 leading to the front end of said cylinder bore, alternatively with the pressure fluid supply groove 27, and the distributing valve is further adapted to effect intermittent communication between the rear end of the cylinder bore 20 and an exhaust passage 28. A front exhaust passage 29 is provided to permit the venting of air from the forward end of the cylinder bore 20 when the striking nose 30 of the hammer piston 21 withdraws from the axial opening 31 formed in the cylinder member 19. The structure of this motor is well known in the percussive tool art, and a further description thereof is therefore unnecessary other than perhaps to state that the distributing valve is pressure-fluid-actuated. The rear end of the external cylinder element 14 is provided with a rearwardly projecting reduced portion 35 traversed by a longitudinally extending fluid supply passage 36 which opens into a chamber 37 in communication through a passage 38 with the supply groove 27 in the valve chest. The rearward end of the passage 36

branches laterally, as at 39, 40, and communicates with openings formed in the periphery of the reduced portion 35. The piston 18 is slidably mounted upon the periphery of the reduced portion 35 and comprises a forward element 41 having a rearwardly extending sleeve portion 42 which, in the rearward position of the piston relative to the projection 35, seals the passages 39 and 40; and the piston comprises, further, a follower element 43 which maintains a suitable packing, for example a cup leather 44, in sealing relation with the walls of the cylinder 16. A nut 46 threadedly connected, as at 47, and pinned, as as 48, against inadvertent loosening, limits the rearward movement of the piston element 41 relative to the reduced extension 35. The rear end of the bore 17 is closed by the head 50, to which a fluid supply connection 51 leads, said supply connection admitting pressure fluid, when fluid is admitted to said supply connection itself, to a space 52 above the piston 18. The space within the cylinder 16 below the piston 18 is vented to atmosphere, as at 53, and suitable means is provided for normally maintaining the piston 18 and motor 15 in retracted position when the fluid supply to the motor is cut off, such means herein being illustrated in the form of a helical spring 54 arranged between a shoulder 55 at the lower end of the bore 17 and an abutment 56 at the lower side of the piston 18. A piece of drill steel 59 having a collar 60 limiting its projection inwardly into the forward end of the hammer motor, is arranged to receive the blows of the striking nose 30 and transmit them to a part to be actuated, vibrated, or the like, at 61. A suitable retainer 62 is provided to preclude dropping of the element 59 out of the chuck 63 formed in the forward end of the motor when the parts are in retracted position. It should be noted that the annular surface at the lower end of piston element 41 will engage an annular surface 64 surrounding the base of the reduced rearward extension 35 carried by the motor 15, after a certain movement forward of the piston relative to the drilling motor, as shown in Fig. 3.

The mode of operation of the apparatus so far described will be readily understood. It will be appreciated that the weight of the hammer motor 15 and of the blow-transmitting element 59 is held suspended, by means of the rearward projection 35 and nut 46, by the piston 18 in the position of the parts shown in Fig. 1. It will be appreciated also, of course, that when pressure fluid is admitted to the space 52 there will be applied a substantial downwardly acting force to the rearward end of the projection 35, as well as to the upper surface of the piston 18. Accordingly, as the piston 18 moves downward, the hammer motor will move downward with it, and, as long as the hammer motor is free to move downward, no downward movement of the piston 18 will take place which is not accompanied by an equal downward motion of the hammer motor, and accordingly no air will be admitted from the space 52 to the passages 39, 40 and 36 until after downward movement of the hammer motor has been interrupted and downward movement of the piston 18 relative to the hammer motor takes place.

Let us now assume that pressure fluid is admitted through the connection 51 to the apparatus with the parts in the position shown in Fig. 1. There will then be concurrent downward movement of the hammer motor 15 and of the piston 18 together, until the parts reach the position shown in Fig. 2, at which point, the engagement of the forward end of the striking element 59 with the work 61 having caused the collar 60 to engage the forward end of the chuck 63, downward movement of the drilling motor will be interrupted. This will not stop downward movement of the piston 18, however, and the piston 18 will continue to move downwardly relative to the then-stationary hammer motor and rearward projection 35 until the position of the parts shown in Fig. 3 is attained. In this relative position of the parts, it will be noted that the passages 39 and 40 are in wide open communication with the space 52 above the piston 18, and accordingly motive fluid will enter passages 39 and 40 and pass through the passage 36 to the space 37, through the passage 38 into the fluid supply groove 27 of the motor valve chest, and cause operation of the motor 15. The position of the parts shown in Fig. 3 will be maintained until one of two things occurs: (*a*) discontinuation of fluid supply through the pipe 51, or (*b*) interruption of the holding of the hammer motor against further forward movement.

Let us consider the first of these causes of a rearrangement of the apparatus. Obviously, as soon as pressure supply through the pipe 51 is interrupted, the pressure maintaining the additional compression of the spring 54 will be discontinued and the spring will expand and first force the piston 18 upwardly against the forward side of the nut 46. Thereafter further expansion of the spring will not only continue rearward (upward) movement of the piston 18, but will cause the piston to raise with it the hammer motor and then the implement 59 until all the parts are brought back to the relative position of Fig. 1. The parts will then be ready for a renewed admission of fluid through the pipe 51 to effect again a forward feeding and an institution of hammering. It will be noted that there will be no hammering during retraction of the hammer motor.

Suppose now that while the parts are in the position shown in Fig. 3 and hammering is taking place, the contingency mentioned under (*b*) above takes place and something occurs which permits further downward movement of the drilling motor 15 from the position shown in Fig. 3. Suppose, for example, that the implement 59 breaks. If this occurred, the collar 60 would promptly drop down until it engaged the retainer 62, and if the motor continued to operate, there would be both a waste of air and, depending upon the design of the motor with respect to the nature of the blows desired, there might also be a hammering on the front head of the motor of an undesirable nature. This will not take place, however, for any material time, for immediately upon the freeing of the motor 15 for further downward movement, both gravity and the pressure acting upon an area equal to the cross sectional area of the reduced extension 35 will cause the motor to move downward again and the motor fluid supply will be immediately cut off, as the passages 39 and 40 are covered by the rearwardly projecting sleeve portion 42 of the piston 18. If the coils of the spring 54 have not been forced into contact with each other, some further downward movement of the piston 18 may also occur until the complete possible compression of the spring 54 has taken place, but this will, of course, for reasons similar to those explained above, not result in a re-starting of the motor. It may be noted that the forward movement of the piston 18

relative to the drilling motor is limited by the engagement of the forward portion of the piston element 41 with the shoulder 64 formed to the outside of the base of the reduced rearward extension 35.

If it be desired to remove the hammer motor and replace it with another one, either in order to effect a cleaning of the motor, an overhauling thereof, or for any other reason, it will be obvious that by merely detaching the retainer 62 from the lower end of the motor and removing the head 50 the entire motor and motor feed piston assembly can be very quickly removed and another similar unit put in place.

Referring now to Figs. 6, 7 and 8, it will be observed that a generically very similar embodiment of all the aspects of the invention shown in Figs. 1 to 5 is likewise disclosed in Figs. 6 to 8. In these figures, however, a somewhat different arrangement of the feeding devices for bringing the hammer motor into operative relation to the work is shown, and these, which dispense with the packings and built-up feed piston construction of Figs. 1 to 5, will be briefly described.

It will be observed that the external cylinder body 14' of the percussive motor 15' has an elongated, upwardly and rearwardly extending cylindrical reduced portion 35' traversed by an axial fluid supply passage 36' and having a transversely extending passage 66 which opens through the peripheral wall of the cylindrical extension 35' at the opposite sides of the latter. A rear head 50' is mounted in cooperative relation with the feed cylinder forming portion 16 and comprises an inwardly projecting portion 65 entering the rear end of the cylinder portion 16 and a rearward cylinder forming portion of its own, designated 67, having a bore 68 which receives, in close sliding relation, the elongated tubular member 69, whose lower end is engaged, as at 70, by the spring 54. A suitable nut 46' limits rearward relative movement of the member 69 relative to the member 35'. The feed supply connection 51 opens into the space 52' formed at the upper end of the cylinder bore 68.

The mode of operation of this construction is so similar to that of the embodiment illustrated in Figs. 1 to 5 inclusive that a detailed description is unnecessary. Upon the admission of air through the fluid supply connection 51, when the parts are in the position shown in Fig. 6, the pressure will act upon the rearward end of the tubular member 69 and upon the rearward end of the rearward extension 36', and move these parts down together, compressing the spring 54, to the relative position of the parts shown in Fig. 7, where it will be noted that the implement 59 engages the work 61. This will stop downward movement of the part 35', and the tubular member 69 will then move relative to the portion 35', further compressing the spring 54 until the lower end of the member 69 engages the shoulder 64 on the hammer motor. In the meantime, however, before this engagement takes place, the transverse fluid supply connection 66 will have been uncovered and motive fluid will be admitted to the hammer motor to set the same into operation. The same operations occur upon the interruption of fluid supply and in the event of breakage of the implement 59 respectively, that were described in connection with the first illustrative embodiment of the invention.

It will be noted that in both of these illustrative embodiments I have provided devices simple, virtually proof against derangement, durable, and certain in operation, for effecting a cooperative relation between the hammer motor and its work prior to the starting of the percussive operation of the motor, but then automatically effecting an initiation of such percussive operation. It will be noted, moreover, that these mechanisms automatically preclude continued operation of the motor notwithstanding the availability of operating fluid supply, in the event that it becomes impracticable for the blows struck by the motor to be delivered to the intended work. It will be noted, moreover, that the parts of this apparatus automatically return to "off" position whenever fluid supply is discontinued, and that operation of the motor cannot recommence until after cooperative relation has been effected between the motor, the implement actuated thereby, and the work.

The remaining figures of the drawings show embodiments of certain aspects of the invention, but do not include the automatic feed and retraction upon initiation and interruption of fluid supply to the mechanism. They do, however, incorporate pneumatic means for forcing the implement, through pressure applied to the hammer motor, into cooperative relation with the work. The devices of Figs. 9 to 14 inclusive further provide modified and simplified means for enabling the dissociation of the hammering motor from its mounting, while also disclosing improved means for interrupting motive fluid supply to the hammer motor and operation of the latter when anything occurs which precludes the transmission of the blows of the hammer motor to the desired point.

Referring first to the embodiment of the invention shown in Figs. 9 to 12, it will be observed that a suitable supporting frame 75 is traversed at its lower portion by an opening 76 through which a blow-transmitting implement 77 having a collar 77' extends. Mounted between projecting flanges 78, welded or otherwise suitably secured to the rear of the herein-channel-like frame element 75, is a motive fluid supply and hammer-motor-positioning device 79. This is supported for swinging movement upon the transversely extending pivot bolt 80, held in position by nuts 81 at the outer sides of the flanges 78. The member 79 is swingable, upon release of the holding screw 82, to the dotted-line position shown in Fig. 11, or further outwardly if desired. The member 79 is provided with a fluid supply connection 51 opening into a bore 83 which comprises portions of different diameters, the upper portion 84 being of somewhat larger diameter than the lower portion 85. The hammer motor 86, which has a chuck 87 receiving the shank 88 of the implement 77, has its rear head member 89 provided with a rearwardly extending cylindrical portion 90, which is a close fit for the smaller of the two bores, 85. It will be observed that the members 79 and 90 constitute cylinder and piston elements of a pneumatic means for forcing the hammer motor towards the work and, through the hammer motor, pressing the implement into engagement with the work. A longitudinal fluid supply passage 91 extends through the projection 90 and is communicable through a transversely extending intersecting passage 92 with the space within the larger bore 84, this being so since the bore 84 is of greater internal diameter than the diameter of the rearward extension 90. The hammer motor 86 may be of any suitable construction, and

a construction which is well known has been illustrated and so requires no detailed description.

It will be observed that the forward end of the hammer motor is provided with a reduced extension 93 within which the chuck 87 mainly lies, and this reduced portion traverses the opening 94 is a fixed positioning plate 95, herein in the form of a piece of angle iron having one of its legs 96 riveted, as at 97, to the frame 75. A shoulder 98 limits the possible inward or downward movement of the hammer motor 86. It will be observed that the structure 79, and the dimensions thereof and of the rearward extension 90 of the rear head of the motor, are so related to the proportions of the reduced forward end 93 of the hammer motor and the position of the plate 95 that the hammer motor may be moved upward far enough to bring its forward end above the top of the steel shank 88 by further telescoping the extension 90 within the bore 84, as shown in full lines in Fig. 11.

Now, with this description, the mode of operation of this illustrative embodiment will be readily understood. With the parts in the position shown in Fig. 9, which is the normal working relation of the parts, upon the supply of operating fluid through the supply connection 51, the fluid will pass through the bore 84, through the transverse passage 92, through the axial passage 91, and cause the hammer motor 86 to operate. It will be observed that the cross passage 92 is very near the lower end of the larger of the two bores 84 in the member 79, and that if the rearward extension 90 were to move down only a short distance, motive fluid supply to the axial passage 91 would be interrupted. Let us suppose now that the implement 77 is broken, and that the motor 86 is no longer supported by the collar 77' upon the implement. Gravity and the pressure of the motive fluid upon the upper end of the rearward extension 90 will then cause further downward movement of the hammer motor 86 to the position shown in Fig. 10, and that will, as shown in the upper portion of Fig. 10, bring the cross passage 92 below the top of the smaller bore 85 and result in interruption of motive fluid supply to the motor 86 and stopping of the latter. The parts will remain in this position, irrespective of the turning on or cutting off of motive fluid supply through the connection 51, until a new implement 77 is put in place.

Now let us suppose that it is desired to remove the tool 86 for inspection or any other reason. The screw 82 may be withdrawn, as indicated in dotted lines in Fig. 11, thereby freeing the member 79 for swinging movement about the pivot bolt 80. By lifting the hammer motor 86 to the full-line position shown in Fig. 11, it may be freed from the shank 88 of the element 77, and then the motor 86 may be swung by tilting the member 79 as indicated in the dotted-line view of Fig. 11, to such a position that it may be freely withdrawn past the outer end of the shelf 95. Another ready implement may then have its rearward extension 90 slid into the bore 83 within the member 79 to such a position that it may be swung in over and into alinement with the element 77, and the parts may then again be moved to the position shown in Fig. 9, and upon the re-insertion of the screw 82 the parts will be locked as shown.

With reference to this construction it will be evident that I have disclosed an arrangement in which if hammering ought to be discontinued, due to derangement of parts, this will automatically be effected by the interruption of motive fluid supply, and I have also provided a very simple construction which enables the ready removal and replacement of hammering units.

In the event that it be not desired to employ a tilting mounting for the hammering motor, as shown in Figs. 9 to 12 inclusive, the arrangement shown in Figs. 13 and 14 may be adopted. Here it will be observed that the fluid-supply-connection-forming member and mounting member 79' is rigidly bolted, as at 100, to the upper end of the frame 75'. A bore 83 having an enlarged portion 84 and a smaller portion 85 is arranged as in the last described species of the invention, and a fluid supply connection 51 is also provided. The hammering motor 86 and its associated parts are all the same as in Figs. 9 to 12 inclusive. The shelf 95 of Figs. 9 to 11 is, however, replaced by another shelf-like member 101 having an opening 102 snugly to receive the lower reduced end 93 of the hammering implement 86. The member 101 is formed of a piece of angle iron, in the construction shown, and has a vertical portion 103, notched, as at 104, to permit sliding withdrawal by slightly backing off the holding screws 105. It will be observed that this embodiment of the invention, like the one last previously disclosed, includes pneumatic means for forcing the percussively actuated implement into engagement with the work, and that all the species of the invention disclosed by illustrative embodiments include cylinder and piston mechanism effective upon the supply of air thereto to force the hammering motor into cooperative relation with the implement which it actuates and to maintain the latter in cooperative relation with the work proper.

The mode of removing the hammer motor in the construction last described may now be explained. The screws 105 will be loosened. The motor 86 will be slid upwardly to its topmost position. The shelf member 101 may then be detached from the frame 75' by sliding the same upwardly, and as the implement 77 may be tilted far outwardly, it and the shelf may then both be withdrawn past the raised hammer motor. The hammer motor can then be lowered far enough downwardly so that the rearward extension 90 will clear the bottom of the bore 85 and the hammer motor can be withdrawn horizontally bodily from beneath the fluid supply connection and guide member 79. A new hammer motor can then be put in place with the extension 90 entering the bore 85. The hammer motor can be raised to its uppermost position. The implement with the shelf member 101 surrounding it may be repositioned, the shelf member brought into the desired position with respect to the screws 105, and fixed there, and the hammer motor then lowered down so that its chuck will receive the shank of the implement.

It will be evident that this illustrative embodiment of the invention, from the aspects thereof therein disclosed, also provides for the automatic shut-down of the motor in the event of breakage or displacement of the blow-transmitting implement, and that ready replacement of the hammer motor is possible, although perhaps with slightly more manipulation necessary than in the case of the structure of Figs. 9 to 12.

In all the species of the invention the feature of automatic shut-down is present, and the feature of ready replacement of the hammer motor. In some, additional features are also present, as above explained. In all cases, it will

be evident that simple and highly effective means for protecting the apparatus and for effecting and/or maintaining the desired relation of the hammer motor to the work, are disclosed.

While I have in this application specifically described several embodiments which my invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration and that the invention may be further modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In combination, a percussive motor, and feeding means therefor including feed effecting means operative only when feeding movement of said motor is interrupted by the establishment of cooperative relation between said percussive motor and its work for opening a fluid supply conduit to said motor and for always closing said conduit prior to the initiation of any retraction of said percussive motor.

2. In combination, a percussive motor, and feeding means therefor including a feeding element subjected to feeding pressure and operative only when feeding movement of said motor is interrupted by the establishment of cooperative relation between said percussive motor and its work for opening a fluid supply conduit to said motor and for always closing said conduit prior to the initiation of any retraction of said percussive motor.

3. In combination, a percussive motor, and feeding means therefor including a feeding element subjected on opposite sides to feeding pressure and to a constantly acting counterpressure and operative only when feeding movement of said motor is interrupted by the establishment of cooperative relation between said percussive motor and its work for opening a fluid supply conduit to said motor and for always closing said conduit prior to the initiation of any retraction of said percussive motor.

4. In combination, a hammer motor, a feed cylinder therefor, a feed piston in said feed cylinder comprising portions respectively rigidly and slidably connected with said motor, means cooperating with the latter portion for normally maintaining said motor in retracted relation to its work, and means operative upon relative movement of said portions under the action of feeding pressure, to admit operating fluid to the hammer motor.

5. In combination, a hammer motor, a feed cylinder therefor, a feed piston in said feed cylinder comprising portions respectively rigidly and slidably connected with said motor, means cooperating with the latter portion for normally maintaining said motor in retracted relation to its work, and means operative upon relative movement of said portions under the action for feeding pressure after said motor reaches working position, to admit operating fluid to the hammer motor.

6. In combination, a hammer motor, a feed cylinder therefor, a feed piston in said feed cylinder comprising portions respectively rigidly and slidably connected with said motor, means cooperating with the latter portion for normally maintaining said motor in retracted relation to its work, and means operative upon relative movement of said portions under the action of feeding pressure when cooperative relation of said motor with its work is established, to admit operating fluid to the hammer motor and to interrupt admission of operating fluid to said motor notwithstanding the continued existence of feeding pressure in the event that cooperative relation between said motor and its work be interrupted.

7. In combination, a percussive motor, guiding means therefor, a feed cylinder for said percussive motor, a feed piston portion rigidly connected with said motor and projecting into said feed cylinder, a feed piston portion having limited longitudinal movement relative to said first mentioned feed piston portion and also projecting into said feed cylinder, means operative on relative movement between said feed piston portions in one direction to establish a fluid supply connection between the percussive motor and the interior of the feed cylinder, means acting on said second mentioned feed piston portion to effect an opposite relative movement between said portions and to move the percussive motor rearwardly, and means for delivering fluid to said feed cylinder.

8. In combination, a percussive motor, guiding means therefor, a feed cylinder for said percussive motor, a feed piston portion rigidly connected with said motor and projecting into said feed cylinder, a feed piston portion having limited longitudinal movement relative to said first mentioned feed piston portion and also projecting into said feed cylinder, means including passage means formed in one of said feed piston portions operative on relative movement between said feed piston portions in one direction to establish a fluid supply connection between the percussive motor and the interior of the feed cylinder, means acting on said second mentioned feed piston portion to effect an opposite relative movement between said portions and to move the percussive motor rearwardly, and means for delivering fluid to said feed cylinder.

9. In combination, a percussive motor, guiding means therefor, a feed cylinder for said percussive motor, a feed piston portion rigidly connected with said motor and projecting into said feed cylinder, a feed piston portion having limited longitudinal movement relative to said first mentioned feed piston portion and surrounding the latter and also projecting into said feed cylinder, means including passage means in said first mentioned feed piston portion operative on relative movement between said feed piston portions in one direction to establish a fluid supply connection between the percussive motor and the interior of the feed cylinder, means acting on said second mentioned feed piston portion to effect an opposite relative movement between said portions and to move the percussive motor rearwardly, and means for delivering fluid to said feed cylinder.

10. In combination, a pressure fluid actuated work-performing motor, and feeding and controlling means for said motor including a feed cylinder and relatively reciprocable feed piston portions contained in said cylinder and cooperating to control pressure fluid supply to said motor and one portion movable relative to the other portion in one direction—to establish supply—on positive interruption of feeding movement of said work-performing motor by attainment of the latter to working position, and said first portion movable relative to said other portion in the other direction—to interrupt supply—upon cessation of feeding pressure, said feeding means so arranged that in the event of freeing of said motor for further feeding movement said other

feed piston portion will move relative to the first portion also to interrupt supply of pressure fluid to said motor.

11. In combination, a fluid actuated work-performing motor, and feeding and controlling means for said motor including a feed cylinder and coaxial relatively reciprocable feed piston portions contained in said cylinder and cooperating to control pressure fluid supply to said motor and one portion movable relative to the other portion in one direction—to establish supply—on positive interruption of feeding movement of said work-performing motor by attainment of the latter to working position and said first portion movable relative to said other portion in the other direction—to interrupt supply—upon cessation of feeding pressure, said feeding means so arranged that in the event of freeing of said motor for further feeding movement said other feed piston portion will move relative to the first portion also to interrupt supply of pressure fluid to said motor.

12. In combination, a fluid actuated work-performing motor, and feeding and controlling means for said motor including a feed cylinder and relatively reciprocable feed piston portions contained in said cylinder and cooperating to control pressure fluid supply to said motor and one portion movable relative to the other portion in one direction—to establish supply—on positive interruption of feeding movement of said work-performing motor by attainment of the latter to working position and said first portion movable relative to said other portion in the other direction—to interrupt supply—upon cessation of feeding pressure, and yielding means tending to effect said latter movement, said feeding means so arranged that in the event of freeing of said motor for further feeding movement said other feed piston portion will move relative to the first portion also to interrupt supply of pressure fluid to said motor.

13. In combination, a pressure fluid actuated work-performing motor, means providing a guideway on which said motor is guided for axial movement, and combined pressure fluid supply and feeding means for said motor for feeding the latter on said guideway to its work and also controlling the supply of pressure fluid thereto including a combined feed piston and fluid supply controlling element associated with said guideway-providing means and operative to cut off the fluid supply to said motor while the fluid supply to said feeding means remains unaffected.

14. In combination, a pressure fluid actuated work-performing motor, and combined pressure fluid supply and feeding means for said motor for feeding the latter to its work and also controlling the supply of pressure fluid thereto including a plurality of relatively movable combined feed piston and fluid supply controlling elements, said elements movable concurrently with said motor during feeding of the latter and operative upon relative movement to cut off the fluid supply to said motor while the fluid supply to said feeding means remains unaffected.

15. In combination, a work-performing motor and combined pressure fluid supply and feeding means therefor for feeding said motor to its work and also initiating the supply of operating fluid thereto including a plurality of coaxial combined feed piston and fluid supply controlling elements.

16. In combination, a work-performing motor, feeding means therefor, and means for controlling the supply of operating fluid to said motor including cooperating feed effecting portions operative upon a predetermined advance of said motor to initiate operating fluid supply to the latter, and in the event of further advance of said motor, to cut off said supply.

17. In combination, a work-performing motor, and means for feeding and for controlling the supply of operating fluid to said motor including cooperating feed effecting portions movable bodily with the motor and operative upon a predetermined advance of said motor to initiate operating fluid supply to the latter, and in the event of further advance of said motor, to cut off said supply.

18. In combination, a percussive motor having a distributing valve, and means for feeding said motor and for supplying operating fluid thereto including means movable with said motor during feeding movement thereof and axially relative thereto after feeding movement of said motor is interrupted by the establishment of cooperative relation between said percussive motor and its work, for supplying motive fluid to said distributing valve.

19. In combination, a percussive motor and means for feeding said motor and for supplying operating fluid thereto including relatively movable parts movable at like rates in a feeding direction when subjected only to pressure sufficient to effect feeding movement of said motor into cooperative relation with the work, and one movable with respect to the other in said feeding direction, upon the building up of a higher pressure in said feeding means when feeding movement is checked by the establishment of cooperative relation between the motor and its work, to open a conduit for operating fluid to said motor.

20. In combination, a fluid actuated hammering motor, an implement actuated thereby, means for forcing said hammering motor forwardly a predetermined distance into cooperative relation with said implement whereby the latter is hammered by said motor including relatively movable cylinder and piston elements, and means for supplying pressure fluid to said cylinder element, and means for supplying motive fluid to said hammer motor from said cylinder element through said piston element only when said motor is in said predetermined forward position including means operative upon relative movement between said cylinder and piston elements upon forward feeding movement of said motor beyond said predetermined position, in the event of implement breakage, for interrupting said fluid supply to said motor while the fluid supply to said cylinder element remains uninterrupted.

21. In combination, a fluid actuated percussive motor including a distributing valve, a guide for said motor relative to which said motor is guided for axial movement while said guide remains stationary, means for supplying operating fluid for said motor to said valve including coaxial, relatively movable parts, one of which is stationary and constitutes a portion of said motor guide, said parts providing a fluid-supply passage leading to said valve in one relative position of said parts when said motor is in a predetermined forward position on said guide, said parts, when said motor is maintained in forward position on said guide, movable axially relative to each other to cut off said fluid supply passage only when said motor moves beyond said predetermined position on said guide.

22. In combination, a support, a hammer mo-

tor, and means for removably supporting said hammer motor in operative relation to said support including a swingable element pivotally mounted on said support and providing a fluid supply conduit and having a bore communicating with said supply conduit, said hammer motor including an element receivable in and snugly fitting said bore and providing a motive fluid passage.

23. In combination, a frame member, a guide mounted thereon and providing an opening for receiving the forward end of a hammer motor, a hammer motor having its forward end received in said opening and positioned thereby, and means supported by said frame and cooperating with the other end of said hammer motor for maintaining the latter in alinement with the axis of said opening including a guideway supported by said framework and a reduced extension at the rear end of said motor slidably receivable in said guideway.

24. In combination, a hammer motor, an implement actuated thereby, and means for supplying operating fluid to said hammer motor only when the motor is in its normal operating position with said implement against the work and interrupting such supply automatically in the event the implement breaks and the motor assumes an abnormal position in advance of aforesaid predetermined normal position including cooperating relatively movable fluid conducting means of which one is fixed to said motor and provides a rearwardly extending fluid supply passage terminating in transversely extending passages, and the other is effective in a predetermined relation of said parts to occlude said transversely extending passages, and means for continuously supplying fluid to said other fluid conducting means irrespective of the relation of said first mentioned fluid conducting means with respect thereto.

25. In combination, a percussive motor, an implement actuated thereby, and means for supplying motive fluid to said percussive motor to effect operation thereof only when said motor is in normal cooperative relation to said implement whereby the latter is percussively actuated by said motor and for automatically interrupting fluid supply only in the event of cessation of such normal cooperative relation including relatively movable elements, one of which is connected in fixed space relation to said motor, for providing a motive fluid supply passage in one relative position of said parts and for interrupting said passage on forward movement of the element fixed to said motor relative to the other element, and means for continuously supplying fluid to said other element irrespective of the relation of said elements with respect to each other.

26. In combination, a fluid actuated hammer motor, an implement actuated thereby, and means for feeding and retracting said motor and controlling motive fluid supply thereto automatically, including a common feeding, retracting and controlling element for retracting said motor and shutting off fluid supply thereto, said element having opposed areas adapted to be subjected to actuating pressures, one area effective when subjected to an actuating pressure to feed said motor and an opposed area effective when it is subjected to an actuating pressure and the pressure on the other area is relieved, to retract said motor.

27. In combination, a pressure fluid actuated percussive motor adapted to actuate percussively a working implement, means providing a guideway on which said motor is guided for axial movement, means for feeding said motor axially on its guideway comprising a feed cylinder associated with said guideway-providing means and a feed piston reciprocable in said feed cylinder and operatively connected to said motor whereby movement of said piston relative to said cylinder effects axial feeding movement of said motor, thereby to hold the working implement in operative working relation against the work, means for supplying pressure fluid to said feed cylinder to effect forward feeding movement of said piston, means for supplying pressure fluid to said motor, and means automatically operative upon forward feeding movement of said motor beyond a predetermined limit of forward feeding travel, in the event of breakage of the working implement, for cutting off the supply of pressure fluid to the motor.

28. In combination, a pressure fluid actuated percussive motor adapted to actuate percussively a working implement, means providing a guideway on which said motor is guided for axial movement, means for feeding said motor axially on its guideway comprising a feed cylinder associated with said guideway-providing means and a feed piston reciprocable in said feed cylinder and operatively connected to said motor whereby movement of said piston relative to said cylinder effects axial feeding movement of said motor, thereby to hold the working implement in operative working relation against the work, means for supplying pressure fluid to said feed cylinder to effect forward feeding movement of said piston, means including the bore of said feed cylinder and passages in a portion of said feed piston for conducting pressure fluid to said motor, and means automatically operative upon forward feeding movement of said motor beyond a predetermined limit of forward feeding travel, in the event of breakage of the working implement, for cutting off the flow of pressure fluid from said cylinder bore through said passages to said motor.

29. In combination, a pressure fluid actuated percussive motor adapted to actuate percussively a working implement, means providing a guideway on which said motor is guided for axial movement, means for feeding said motor axially on its guideway comprising a feed cylinder associated with said guideway-providing means and a feed piston reciprocable in said feed cylinder and operatively connected to said motor whereby movement of said piston relative to said cylinder effects axial feeding movement of said motor, thereby to hold the working implement in operative working relation against the work, means for supplying pressure fluid to said feed cylinder to effect forward feeding movement of said piston, means for supplying pressure fluid to said motor, means automatically operative upon forward feeding movement of said motor beyond a predetermined limit of forward feeding travel, in the event of breakage of the working implement, for cutting off the supply of pressure fluid to the motor, and constantly acting means opposing forward feeding movement of said motor for automatically moving said motor rearwardly on its guideway when the flow of pressure fluid to said feed cylinder is discontinued and the bore of said cylinder is vented to atmosphere.

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