Sept. 18, 1962 E. J. ONDECK 3,054,464

ELECTRIC HAMMER

Filed June 4, 1958

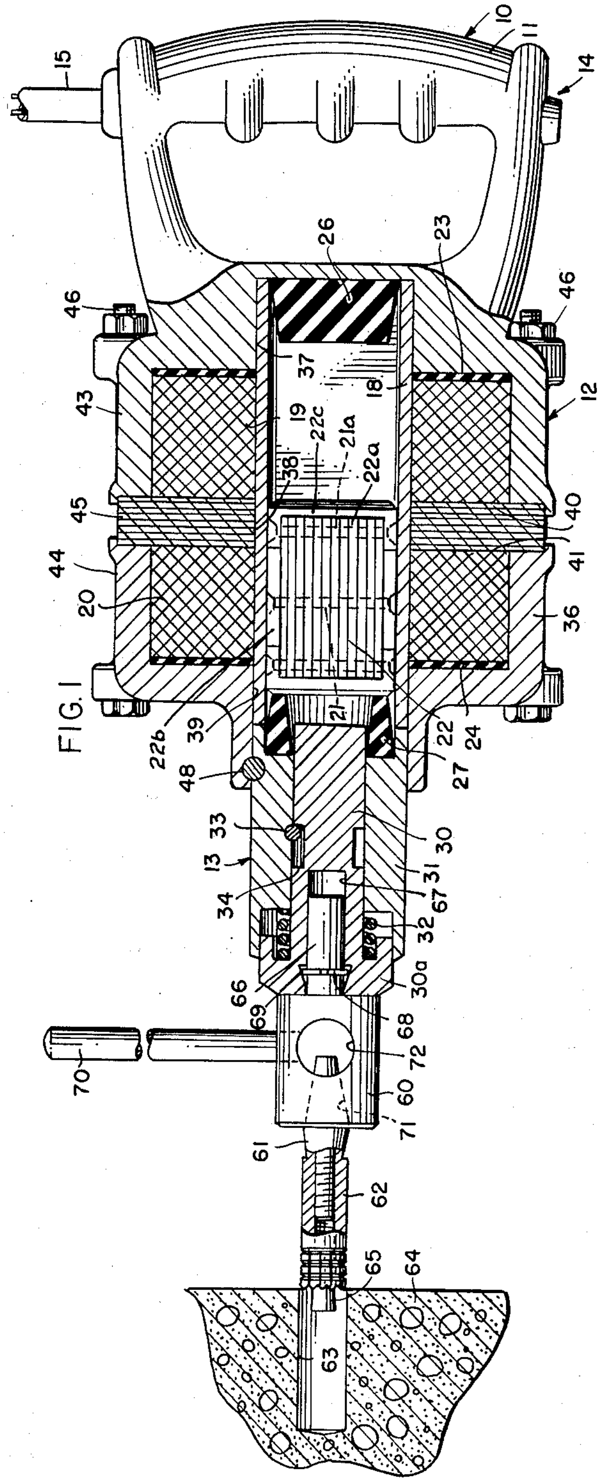

FIG. 1

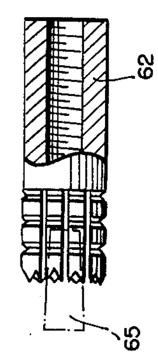

FIG. 3

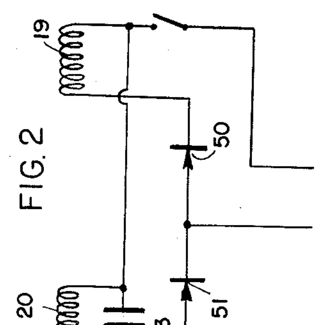

FIG. 2

INVENTOR:

ELMER E. ONDECK

BY Carlton D. Harbaugh

ATT'YS

United States Patent Office 3,054,464 Patented Sept. 18, 1962

1

3,054,464
ELECTRIC HAMMER

Elmer J. Ondeck, North Riverside, Ill., assignor to Supreme Products Corporation, Chicago, Ill., a corporation of Illinois

Filed June 4, 1958, Ser. No. 739,937
11 Claims. (Cl. 175—145)

The present invention relates to electric hammers. More particularly, it has to do with an electrically operated device for delivering a succession of blows to a member against which it is pressed.

Following the pneumatic or air-driven repeating hammer so often seen in use with a chisel for breaking hard surfaces, the art has witnessed the commercial introduction of smaller, usually lighter, more portable and less expensive electric hammers. Modern day repeating hammers have found a wide field of utility. Not only are they useful with chisels and the like for disrupting or breaking apart relatively hard materials, but they have become most useful for driving pins, nails and the like and for performing such heretofore laborious tasks as setting masonry anchors.

Wide utility is to be had with an electric hammer of substantially complete portability; that is, an electric hammer of perhaps the same general size as that of the ordinary portable power drill. However, as size and weight are reduced sufficiently to render such a hammer truly portable and capable of being operated by one man, it is still necessary that maximum impact be delivered corresponding to the maximum available source of operating energy. In the usual case, the most readily available energy source is the conventional household power lines. It therefore becomes most desirable to obtain the greatest amount of impact from conventionally available power levels while at the same time keeping in mind the need for compactness, providing portability and economy of manufacture.

It is accordingly a general object of the present invention to provide a new and improved electric hammer which satisfies the aforementioned requirements.

It is a further object of the present invention to provide an electric hammer which is comparatively light weight, capable of being used for a variety of tasks and yet which is economical to manufacture.

Another object of the present invention is to provide an electric hammer which minimizes the number of moving parts required and in which the parts employed are capable of being manufactured with conventional factory machinery.

Still another object of the present invention is to provide an electric hammer which is capable of being operated by one man while yet delivering a maximum impact with regard to its size and weight.

A still further object of the present invention is to provide an electric hammer adaptable to employment in a wide variety of applications where an automatically-repeating succession of blows is required.

An electric hammer constructed in accordance with the present invention includes a non-magnetic sleeve encircled by a pair of solenoids spaced therealong. Movable within the sleeve is a magnetic armature of a length bridging individual ones of the solenoids. The hammer further includes resilient means defining armature movement limits at positions near the remote solenoid ends together with means for alternately energizing the solenoids with polarities establishing respective fields individually moving the armature in opposite directions. Finally, the armature is engageable by impact receiving means.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The organization and manner of operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

2

FIG. 1 is an elevational view, partially in cross-section, of an electric hammer constructed in accordance with the present invention;

FIG. 2 is a schematic wiring diagram associated with the hammer illustrated in FIG. 1; and

FIG. 3 illustrates a concrete anchor representing by way of an example a typical device to which impact delivered by the hammer may be utilized.

As illustrated in FIG. 1, hammer 10 conveniently has a shape somewhat similar to that of the ordinary portable electric drill, including a handle 11 joined to a body section 12 having a front section 13 from which the characteristic action of the device is delivered. A switch 14 is located in handle 11 in a position convenient to the thumb of an operator grasping the handle. Projecting away from handle 11 is an electric cord 15 for connection to a suitable supply source which may be the ordinary room-wall receptacle. While it will become evident that the device may be constructed to operate at various potentials from different energy sources, the greatest versatility in this country is achieved with devices operative from the usual 110 volt, 60 cycle, alternating-current supply.

Centered longitudinally within body section 12 is a sleeve 18 of non-magnetic material. Sleeve 18 preferably is of a rectangular cross section and of a readily available material such as brass.

Encircling sleeve 18 are a pair of solenoids 19 and 20 spaced along the sleeve. Solenoids 19 and 20 comprise multi-layer coils wound so that when energized they each produce a flux within sleeve 18 generally longitudinally thereof. For best magnetic coupling to the space within sleeve 18, solenoids 19 and 20 are wound closely about the sleeve with a minimum of insulation therebetween.

Slidable within sleeve 18 is a magnetic armature 22 of a length bridging each of the solenoids 19 and 20. Armature 22 thus is movable back and forth along a path generally longitudinally of the sleeve and of the entire hammer. In this instance, armature 22 is made up of rectangular laminations 22*a* held together by side members 22*b* and rivet 21. Hardened steel end caps 22*c* are held in place by rivets 21*a*. The armature being rectangular sectionally, there is no tendency for it to rotate and therefore its clearances can be more closely held in manufacture.

Movement of armature 22 is limited in each direction at positions near the remote solenoid sides 23 and 24 by resilient means. The resilient means are a rubber bumper 26 disposed near the end of sleeve 18 toward handle 11 and a cushion 27 near the other end of sleeve 18. Bumper 26 may comprise simply a block of rubber while cushion 27 preferably is an annular ring tapering slightly toward armature 22 so that when engaged under force by the latter there remains a generally cylindrical opening through the cushion.

Movable across the armature movement limit established by cushion 27 is an impact-receiving means; the impact-receiving means is biased in a direction away from armature 22 so as to normally be disposed outside the corresponding armature movement limit. Thus, chuck 30 slides within journal 31 through the annular opening in cushion 27 into and out of engageability with hammer 22 disposed as shown against cushion 27. In this instance, journal 31 is conveniently an integral extension of sleeve 18. Journal 31 is counter-bored in its end away from cushion 27 to receive a spring 32 in compression between journal 31 and a lateral overhanging lip 30*a* projecting from chuck 30, spring 32 thereby urging chuck 30 in a direction away from armature 22 a distance limited by pin 33 secured in journal 31 and lying in a groove 34 cut into the side of chuck 30, groove 34 being elongated in the direction of chuck movement.

In order to establish a low-reluctance path closely along the side and outer faces of solenoids 19 and 20, a magnetic core or stator 36 is disposed about and between the solenoids, presenting pole faces 37, 38 and 39, from handle toward chuck, against the sleeve on both remote sides 23 and 24 and between the inner sides 40 and 41 of the solenoids. To reduce eddy current losses in the magnetic structure, the portion 45 of core 36 between solenoids 19 and 20 preferably is laminated. The remainder of the core comprises two half-shells 43 and 44 facing one another and clamped together about laminations 45 by through-bolts 46. Conveniently, magnetic core 36 also constitutes the housing of body section 12 and is integral with handle 11 projecting away therefrom. At its other end, core 36 is secured to journal 31 by an assembly pin 48. The axial core dimensions are such that armature 22 substantially bridges either adjacent pair of pole faces 37, 38 or 38, 39, thereby completing a comparatively low-reluctance magnetic path entirely around one or the other of the solenoids at the respective limit positions of armature movement.

Solenoids 19 and 20 are coupled to the external power source through switch 14 by means for alternately energizing the solenoids with polarities establishing respective fields individually moving the armature in opposite directions. That is, a commutator is utilized to feed one polarity energy to one solenoid and the opposite polarity energy to the other solenoid in alternation. While a vibrator may be utilized to alternately feed solenoids 19 and 20 with opposite polarity energy derived from a direct current source, the preferred embodiment of the present invention operates in response to the usual 110 volt, 60 cycle, alternating current. Accordingly, one side of each of solenoids 19 and 20 is coupled to one of the incoming A.C. lines while the other side of each of the solenoids is coupled so the other A.C. line individually through one of respective diodes 50 and 51 illustrated in FIG. 2. Diodes 50 and 51 have opposite poles connected to the other A.C. line side so that the polarity of the half cycle fed solenoid 20 is opposite that of the half cycle fed solenoid 19. Taking into account the particular direction in which each of solenoids 19 and 20 are wound, their lead wires are connected to diodes 50, 51 and the A.C. line so that when energized by the commutating means comprising diodes 50 and 51 the two solenoids established fields moving the armature in different directions. Solenoid 19 pulls armature 22 toward bumper 26, while solenoid 20 pulls the armature toward cushion 27.

In operation, closure of switch 14 causes armature 22 to be reciprocated back and forth between bumper 26 and cushion 27 at a rate established by the commutation frequency. In the present instance, this frequency of reciprocation is at the incoming supply frequency of 60 cycles. Each time armature 22 impinges against cushion 27 it compresses the latter to a point at which the resilience of the cushion determines the maximum limit of armature movement toward impacting engagement with chuck 30.

Preferably, chuck 30 is normally biased by spring 32 to a position out of engageability with armature 22. However, with armature 22 reciprocating, downward pressure upon handle 11 toward chuck 30 compresses spring 32 moving chuck 30 toward armature 22 and eventually into engagement therewith. Subsequently, the greater the pressure exerted downwardly upon handle 11, the greater the energy transferred from armature 22 into chuck 30; thus, the operator may determine the amount of impact force delivered by the hammer simply by varying the pressure he applies to the handle.

Ideally, movement of armature 22 is in exact phase with alternation of the applied energy from the commutator. In actuality however, the finite mass of the armature gives rise to an inertial lag in its movement so that it trails in phase the currents flowing in solenoids 19 and 20 and hence the phase of the flux developed thereby. To the end of giving maximum impetus to armature 22 in its downward stroke toward chuck 30, energy storage means coupled across solenoid 20, the driving solenoid nearest the impact receiver, is of a capacity retaining at least a portion of the peak energy of the corresponding half-cycle for a time approximating the inertial armature movement lag. Thus, capacitor 53 coupled across solenoid 20 delays peak energization of the latter relative to the alternating-current half-cycle fed to solenoid 20 through diode 51. That is, capacitor 53 charges under the applied potential of the corresponding half-cycle until the mid-point of the latter which point the applied energy begins decreasing. A substantial portion of this stored energy remains on capacitor 53, because of the impedence presented by coil 20 shunting the capacitor, until the lagging armature comes into its driving-limit position. At this limit, the armature bridges solenoid 20 and pole faces 38 and 39 thereby greatly lowering the magnetic flux-path reluctance with the result that capacitor 53 then discharges into the reduced solenoid impedence giving maximum impetus to armature 22 just as it hits cushion 27 on its way into engagement with chuck 30.

To illustrate one typical example of the use to which the electric hammer of the present invention is advantageously employed, it has been illustrated as employing an adaptor chuck 60 for holding a drive screw 61 threadable into a cement anchor 62 for the purpose of driving the latter solidly into a hole 63 drilled into a concrete slab 64. Anchor 62 is of a well known variety comprising a hollow lead cylinder having a knurled lower extremity and carrying a tapered plug 65 wedged into its lower bore endportion. Hammer 10, carrying anchor 62 and adaptor chuck 60, is positioned to dispose the latter at the entrance of hole 63. Switch 14 is depressed and pressure applied to handle 11 whereupon anchor 62 is driven rapidly to the bottom of hole 63 whereupon plug 65 is driven upwardly inside anchor 62 expanding the knurled portion of the latter into firm, anchoring engagement with concrete slab 64. In actual use with a tool constructed in accordance with the present invention, such anchors have been seated with a total elapsed time of no more than forty seconds per anchor, whereas a typical elapsed time for performing the same operation with the usual hand tools is better than ninety seconds. It will be readily apparent that in the course of the ordinarily encountered job which involves sinking a number of anchors, the time savings becomes substantial, not to mention the ease with which the job is accomplished and the insurance that the anchor is sunk with a driving force sufficient to securely lock the anchor in place.

While adaptor chuck 60 may take various forms, it preferably includes an upwardly projecting spindle 66 receivable within a bore 67 inwardly of the end of chuck 30 away from armature 22. Spindle 66 is circumferentially grooved to receive a resilient split ring 68 to retain spindle 66 within an upwardly and outwardly tapering enlargement 69 of bore 67.

Projecting laterally to one side of adaptor 60 is a handle 70 by means of which adaptor 60 and hence anchor 62 may be rotated to circumferentially "rock" anchor 62 as it is being set, if necessary, and to permit ready disengagement of drive screw 61 from anchor 62 after the latter has been set.

To receive drive screw 61, which tapers inwardly and upwardly in the form of a truncated cone, a mating opening 71 extends inwardly from the bottom of adaptor 60. Aligned with this opening is a hole 72 projecting laterally through adaptor chuck 60 and communicating with mating opening 71 into which screw 61 is inserted. A drift pin may be inserted through hole 72 after sinking of the anchor to dislodge drive screw 61 from adaptor chuck 60 when desired.

Not only is the electric hammer of the present invention every bit as portable as the usual hand drill, but it employs only components of extreme simplicity of manufacture and assembly with a minimum of moving parts, thereby prolonging its life and minimizing repairs and maintenance. In use, it finds great utility in a number of applications where the delivery of a succession of blows is required. Being readily operated from conventional alternating current mains, it requires no special energizing apparatus and is utilized like any other power hand tool. By maximizing the delivery of energy to the impact delivering members at a time substantially coinciding with actual delivery of the impact and correlated to account for inertial lag in the impact delivering system, the full energy available from the external power source is converted to delivered mechanical energy, thus permitting highest efficiencies. In consequence, the greatest amount of impact is delivered for a given size and weight of the hammer.

While a particular embodiment of the present invention has been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects. Accordingly, the aim in the appended claims is to cover all such changes and modifications as follows in the true spirit and scope of the invention.

I claim:

1. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids closely encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature disposed within said sleeve and of a length approximately bridging adjacent pole face pairs; a resilient bumper in a position limiting armature movement adjacent one remote pole face; a resilient cushion in a position limiting armature movement adjacent the other remote pole face, said cushion having an annular opening therethrough; an impact receiver disposed near said other pole face in said annular opening and movable into and out of engageability with said armature, the inner edge of the impact receiver confined within said cushion; spring means biasing said impact receiver out of engageability with said armature; a commutator responsive to alternating-current energy for feeding one polarity half-cycles to one of said solenoids and opposite polarity half-cycles to the other of said solenoids, said solenoids being wound to establish respective fields individually moving said armature in opposite directions; and energy storage means coupled across the solenoid nearest said impact receiver and of a capacity retaining at least a portion of the peak energy of the corresponding half-cycle for a time approximating inertial armature movement lag.

2. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature of a length bridging individual ones of said solenoids and movable within said sleeve along a predetermined path; means responsive to alternating-current energy for energizing one of said solenoids with one polarity and the other of said solenoids with the opposite polarity thereof, said solenoids being wound to establish respective fields individually moving said armature in opposite directions; means coupled to said one solenoid for delaying peak energization thereof relative to the corresponding other alternating current energy peak; resilient means defining armature movement limits at positions near the remote solenoid sides; impact-receiving means received within said resilient means movable across the one of said limits near said one solenoid, the innermost edge of said impact receiving means confined within said resilient means; and spring means biasing said impact receiving means outside said one limit.

3. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature of a length bridging individual ones of said solenoids and movable within said sleeve along a predetermined path; means responsive to alternating current energy for energizing said solenoids individually with opposite polarity half-cycles of said energy, said solenoids being wound to establish respective fields individually moving said armature in opposite directions; means for delaying peak energization of one of said solenoids past mid-point of the corresponding half-cycle; resilient means defining armature movement limits at positions near the remote solenoid sides; impact-receiving means received within said resilient means movable across the one of said limits nearest said one solenoid, the innermost edge of said impact receiving means confined within said resilient means; and spring means biasing said impact-receiving means outside said one limit.

4. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids closely encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids, the core portion between said solenoids being laminated radially; a magnetic armature disposed within said sleeve and of a length approximately bridging adjacent pole face pairs; a resilient bumper in a position limiting armature movement adjacent one remote pole face; a resilient cushion in a position limiting movement adjacent the other remote pole face; an impact-receiver disposed within the cushion near said other pole face and movable into and out of engageability with said armature, the inner edge of said impact receiver confined within said cushion; spring means biasing said impact-receiver out of engageability with said armature; and a commutator feeding opposite polarity energy alternately to said solenoids, said solenoids being wound to establish respective fields individually moving said armature in opposite direction.

5. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids closely encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature disposed within said sleeve and of a length approximately bridging adjacent pole face pairs; a resilient bumper in a position limiting armature movement adjacent one remote pole face; a resilient cushion in a position limiting armature movement adjacent the other remote pole face; an impact-receiver disposed within said cushion near said other pole face and movable into and out of engageability with said armature, the inner edge of said impact-receiver confined within said cushion; spring means biasing said impact-receiver out of engageability with said armature; a commutator responsive to alternating-current energy for feeding one polarity half-cycles to one of said solenoids and opposite polarity half-cycles to the other of said solenoids, said solenoids being wound to establish respective fields individually moving said armature in opposite directions; and energy storage means coupled across the solenoid nearest said other pole face and of a capacity retaining at least a portion of the peak energy of the corresponding half-cycle for a substantial portion of one quarter-cycle.

6. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids closely encircling and spaced

along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature disposed within said sleeve and of a length approximately bridging adjacent pole face pairs; a resilient bumper in a position limiting armature movement adjacent one remote pole face; a resilient cushion in a position limiting armature movement adjacent the other remote pole face; an impact receiver disposed within said cushion near said other pole face and movable into and out of engageability with said armature, the inner edge of said impact receiver confined within said cushion; and spring means biasing said impact-receiver out of engageability with said armature.

7. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids closely encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature disposed within said sleeve and of a length approximately bridging adjacent pole face pairs; a resilient bumper in a position limiting armature movement adjacent one remote pole face; a resilient cushion in a position limited armature movement adjacent the other remote pole face; an impact-receiver disposed within said cushion near said other pole face and movable into and out of engageability with said armature, the inner edge of said impact receiver confined within said cushion; spring means biasing said impact-receiver out of engageability with said armature; and a spring chuck rotatably carried on an end of said impact-receiver remote from said armature.

8. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids closely encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature disposed within said sleeve and of a length approximately bridging adjacent pole face pairs; a resilient bumper in a position limiting armature movement adjacent one remote pole face; a resilient cushion in a position limiting armature movement adjacent the other remote pole face; an impact-receiver disposed within said cushion near said other pole face and movable into and out of engageability with said armature, the inner edge of said impact receiver confined within said cushion; spring means biasing said impact-receiver out of engageability with said armature; and a releasable chuck carried on an end of said impact-receiver remote from said armature.

9. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature of a length bridging individual ones of said solenoids and movable within said sleeve along a predetermined path; resilient means defining armature movement limits at positions near the remote solenoid sides; impact-receiving means disposed within said resilient means movable across one of said limits for variable engagement by said armature, innermost edge of said impact receiving means confined within said resilient means; and a commutator feeding opposite polarity energy alternately to said solenoids, said solenoids being wound to establish respective fields individually moving said armature in opposite directions.

10. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature of a length bridging individual ones of said solenoids and movable within said sleeve along a predetermined path; resilient means defining armature movement limits at positions near the remote solenoid sides; impact-receiving means disposed within said resilient means engageable with said armature, the innermost edge of said impact receiving means confined within said resilient means; a commutator responsive to alternating current energy for feeding one polarity half-cycle to one of said solenoids and opposite polarity half-cycles to the other of said solenoids, said solenoids being wound to establish respective fields individually moving said armature in opposite directions; and energy storage means coupled across the solenoid nearest said impact-receiver and of a capacity retaining at least a portion of the peak energy of the corresponding half-cycle for a time approximating inertial armature movement lag.

11. An electric hammer comprising: a non-magnetic sleeve; a pair of solenoids closely encircling and spaced along said sleeve; a magnetic core disposed about and between said solenoids to present pole faces against said sleeve on both remote sides of and between said solenoids; a magnetic armature disposed within said sleeve and of a length approximately bridging adjacent pole face pairs; a resilient bumper in a position limiting armature movement adjacent one remote pole face; an annular resilient cushion in a position limiting armature movement adjacent the other remote pole face; an impact-receiver movable through said annular cushion into and out of engagement with said armature, the inner edge of said impact receiver confined within said cushion; and spring means biasing said impact-receiver out of engageability with said armature.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 20,537	Miller	Oct. 19, 1937
1,467,677	Lake	Sept. 11, 1923
2,100,660	Greiner	Nov. 30, 1937
2,182,014	Clark	Dec. 5, 1939
2,268,687	Young	Jan. 6, 1942
2,438,777	Dean	Mar. 30, 1948
2,519,477	Kind	Aug. 22, 1950
2,613,241	Weyandt	Oct. 7, 1952