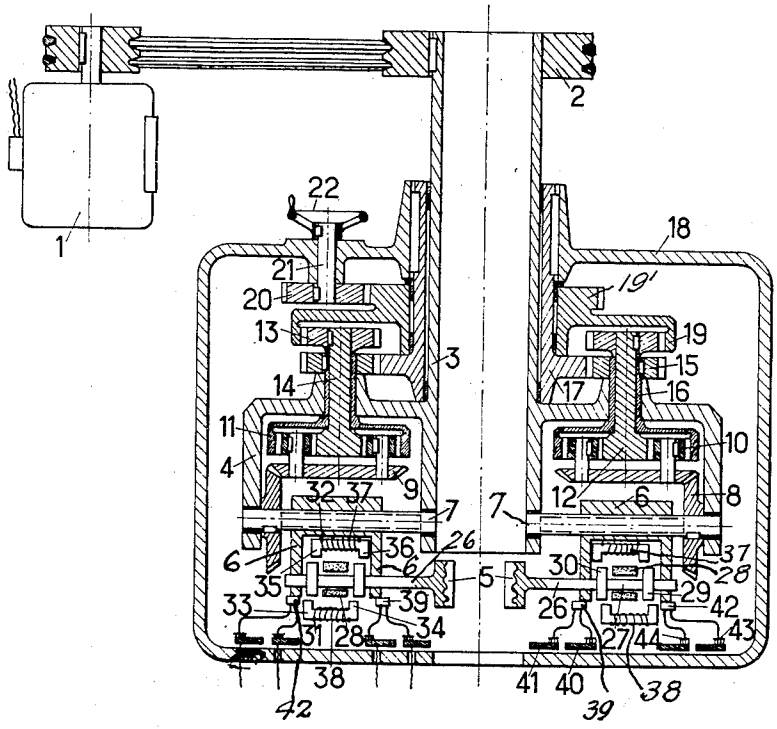
Dec. 4, 1962 P. BURNEL 3,066,555

REDUCING MACHINE

Filed Feb. 16, 1959 2 Sheets-Sheet 1

FIG_1

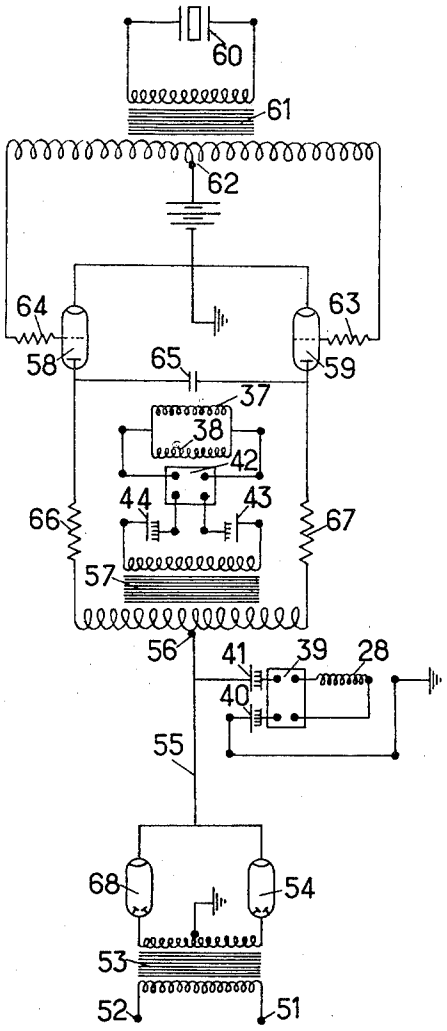


Dec. 4, 1962 P. BURNEL 3,066,555

REDUCING MACHINE

Filed Feb. 16, 1959 2 Sheets-Sheet 2

FIG_2



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REDUCING MACHINE

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7 Claims. (Cl. 78—24)

This invention relates, in general, to reducing machines of the type having vibrating hammers.

In the present state of the art, reducing machines, and in particular, median reducing machines, have vibrating hammers rapidly rotating around an axis perpendicular to the axis of strike, and receiving their impulses by impact against fixed rollers located on the periphery of a solid steel rim. It will be understood that the term "vibrating" as used herein means the stroke of the hammers toward and away from the work.

In this type of machine it is almost impossible to obtain deep median swagings, to hammer-out over a wide range of diameters, to achieve the high frequencies of strike which are called for when hammering-out thin-walled, flexible tubes, or to achieve the degree of automation and pilot operation necessary to enable these machines to be put to a wide variety of uses.

An object of this invention is the provision of a machine wherein the supports of the vibratory hammers are shifted in the radial direction.

Another object of the invention is the provision of an appliance which has structure to control the movements of approach and withdrawal of the vibrating hammers' supports in the radial direction, and to control the speed of these movements according to a pre-determined cycle.

Another object of the invention is to provide a reducing machine in which the frequency of hammer strike is independent of the speed at which the hammers rotate.

Another object of the invention is the provision, in a reducing machine, of an assembly to vary the frequency of hammer strike.

Another object of the invention is the provision of a reducing machine wherein the hammers or groups of hammers distributed around the work act either simultaneously or in accordance with multi-phase cycles.

With these objects in view the reducing machine disclosed herein consists essentially of a structure controlling the rotation of the hammers around the workpiece, an independent structure controlling the vibration of the hammers, and another independent structure controlling the radial movements of the vibrating hammers' supports.

The manner in which the invention is put into practice, given hereinafter by way of example, includes means or combinations of means which are new in themselves, without there being any intention on the part of the applicant that the generic scope of the invention be limited either to the employment of these means which may be substituted by equivalent means, or to the particularities which are specific to the example which has been selected for the purpose of illustration.

The invention will now be further described with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic representation, given in axial section, of the transmission of the movements.

FIG. 2 is a wiring diagram of the structure which enables the frequency of the vibratory movement to be fixed.

Reference character 1 designates an electric motor which, through the intermediary of a belt, drives the pulley 2 keyed on the hollow shaft 3. The rotation of shaft 3 drives the casing 4 which as represented is integral with shaft 3 and in which are fitted the supports for the vibrating hammers of which only two are visible in FIGURE 1, but which may be of any number and are evenly

distributed around the geometrical axis of the shaft 3. The gear trains and the mounting of the several hammers being identical, only one of them will be described.

The slide-rest of the vibrating hammer 5 is mounted in the rotary casing 4 and designated 6. This rest has an internally-threaded bore in which is screwed the worm 7. This worm freely rotates in the casing 4. The slide 6 is thus guided in such a way as to be capable of being propelled only translationally radially of the axis of shaft 3 by the movement of the worm 7. The bevel pinion 8 is keyed on the spindle of the worm 7 and meshes with the wheel 9 which is the satellite carrier of an epicycloid train which has satellites such as 10 which mesh respectively with the crown 11 and the solar wheel 12.

The pinion 13 is keyed on the shaft 14 of the solar wheel 12, while the pinion 15 is keyed on the hollow shaft 16 of the crown 11. The shaft 14 is lodged in the hollow shaft 16 which is rotatably mounted in the casing 4. The pinion 15 meshes with a fixed crown 17 integral with the main frame 18 in which the shaft 3 turns in bearings (not shown).

The pinion 13 meshes with an internally toothed crown 19 which is rotatably mounted on frame 18. The crown 19 provided with an external gear 19' which meshes with the pinion 20 which is keyed on the shaft 21 of the control wheel 22 which could be replaced by a motor which is automatically controlled.

In the rest 6 the stem 26 of a hammer 5 is mounted to slide freely; the stem 26 carries a soft iron core 27 with its poles 29, 30, and around which there is the winding 28.

Two cores 31, 32 are carried on the rest 6, the poles of which are, respectively, 33, 34, 35, and 36 and are the same distance apart as the poles 29, 30. The cores 31, 32 are mutually staggered by approximately the thickness of the poles and carry windings 37, 38 of reverse direction so as to reverse the polarity of the respective poles.

The winding 28 is supplied with direct current as from the terminal box 39 and the sliding contacts 40, 41.

The windings 37, 38 are fed in parallel with alternating current as from the terminal box such as the one marked 42 and sliding contacts 43, 44.

The manner of operation is as follows:

The work—not represented—is assumed to be arranged coaxially in relation to the shaft 3 and in position to be conveniently hammered by the hammers. It is assumed that it is either held in position or displaced in a continuous or discontinuous manner depending on the kind of reduction to be produced. On this point the invention makes use of equipment conforming to present-day engineering standards.

The electrical motor 1, when excited, causes rotation of the shaft 3 about its axis by means of the belt, hence rotary motion, about the axis of shaft 3, of casing 4, which is integral with shaft 3, hence rotary motion, about the axis of shaft 3, of hammer 5, which is supported by the slide rest 6, mounted on the rotary casing 4.

The rotation of casing 4 promotes the rotary motion of shaft 14 about the axis of shaft 3, and the rotary motion of pinion 15 about the axis of shaft 16. The rotary motion of pinion 15 keyed on the shaft 16, causes the rotation of said shaft and hence the rotation of crown 11 about the axis of shaft 16.

The rotary movement of wheel 22 about the axis of shaft 21 causes the rotation of shaft 21 and hence the rotation of pinion 20 about the same axis. The rotation of pinion 20, which meshes with external gear 19', causes the rotation of crown 19 about the axis of shaft 3. The rotation of crown 19 about the axis of shaft

3 causes the rotation of pinion 13 about the axis of shaft 14, hence the rotation of shaft 14 and of wheel 12 keyed on said axis.

The difference between the angular speed of wheel 12 and crown 11 causes the rotation of the satellites 10 about their own axis, and hence the rotation of wheel 9 about the common axis of shaft 14 and 16, as well known in the epicycloidal gears, such transmission of movement being the usual technique and does not constitute a part of the present invention. The rotary movement of wheel 9 causes rotary movement of bevel pinion 8 about the axis of worm 7, hence the rotary movement of said worm about the same axis. The rotary movement of worm 7 causes the translatory movement of rest 6, which is prevented from turning about the axis of worm 7 by the guide means (not shown). Such a transformation of a rotary movement to a translatory movement is usual in the art and does not form a part of the present invention.

Thus an object of the invention is attained: the shifting of the supports of the hammers in the radial direction, such shifting resulting from the combination of the rotary movement of the casing 4 about the axis of shaft 3 and the rotary movement of wheel 22.

According to the rate at which the die of the hammer 5 penetrates the work, the operator alters, with the aid of the handwheel 22, the relative position of the rests 6 without altering the rate of strike and the amplitude of oscillation of the hammers.

The description which now follows relates to the control of the hammers and the regulation of the rate of strike (FIG. 2).

This figure shows the winding 28 about the soft iron core 27 carried by one of the hammers, terminal box 39 to which the winding 28 is connected, the sliding contacts 40, 41 for box 39 and also the terminal box 42 and sliding contacts 43 for applying alternating current to the windings 37, 38 of the cores 31, 32 of FIGURE 1 in order to integrate the figures and show their interrelation.

Let it be assumed that the installation is supplied by the general network at 50 cycles for example, at the terminals 51, 52. The feed transformer 53 with center earth tapping supplies the two electronic rectifiers 54, 68. The practical wiring details of the rectifiers have not been given since these conform to usual practice. On lead 55 direct current is obtained and this is fed to the winding 28 on the core 27 of FIG. 1, through the intermediary of sliding contacts 40, 41 and terminal box 39.

The remainder of the circuit is an inverter circuit to transform back to alternating current, but of a higher frequency than the feed circuit current, as for example, a frequency of between 50 and 400 cycles. To this end, there is symmetrically fed, at 56, the primary of the transformer 57 in the circuit of which are located the two control thyratrons 58, 59. The grids of these thyratrons are controlled by means of a quartz pilot 60 or any other frequency generator which is in the primary circuit of a transformer 61, the center tapping 62 of which is connected to a biasing source which forms the cut-off tension of the grids of the thyratrons.

References 63, 64 designate the resistances for limiting the grid current, and reference 65 denotes the commutation condenser. 66 and 67 are resistances for limiting the anode current flow in the event of undue current surges.

The practical details relating to the wiring of the thyratrons have not been represented, as being of standard practice. As is well known, the frequency of the alternating voltage produced at the secondary of transformer 56 depends on the alternating tension to which the grids are subjected. The quartz pilots, then, control the alternate firing of control thyratrons 58, 59 which causes the D.C. to switch back and forth through primary 56 and thereby induce A.C. into the secondary at a frequency controlled by the quartz pilots. It will be possible, then, with a set of quartz pilots, to vary the frequency of strike.

Thus, there is fed an alternating current to windings on cores 31 and 32 through the intermediary of the contacts 43, 44 and the terminal box 42, the frequency of alternations being determined by the quartz pilot. If during one alternation, the pole faces 34 and 35 are of negative polarity and pole faces 33 and 36 are of positive polarity, and assuming that the pole of the core 27 closest to the hammer is of positive polarity, the core 27 and hammer will move away from the axis of shaft 3. On the next alternation, the polarities of pole faces 33, 34, 35 and 36 will be reversed so that the hammer moves toward the axis of the shaft 3. Thus, the core 27 starts to vibrate at the frequency determined by the quartz pilot, a frequency which is therefore wholly independent of the speed at which the hammers rotate. Reference is made to Vigoureux—Quartz Resonators and Oscillators, published by H.M. Stationery Office, London, England, for a description of the operation of a quartz pilot of this type.

The current transformation which has just been described relates, obviously, to one phase; with three phase current for example it is thus possible to de-phase the rate of strike of three groups of hammers, each group being supplied by a single phase. It will moreover be possible to obtain the phase displacement or displacements by means of methods of present-day technique, for example by means of phase convertors.

Numerous variations of inverter circuits are known, reference being made to Van Nostrand's Scientific Encyclopedia, 2nd edition, page 801, for the illustration and description of a basic self-excited inverter. There, as here, the control tubes conduct alternately causing the D.C. to switch back and forth through the primary of the transformer and this induces A.C. voltage in the secondary.

What we claim is:

1. In a forging machine, a series of hammers each having a stem and arranged annularly about a workpiece as a center, a housing supporting said series of hammers, means to rotate said housing whereby the hammers revolve about the workpiece, and means to independently move each respective hammer toward and away from the workpiece to forge the same, said means comprising a first electromagnet fixed to the stem of the hammer and having spaced poles, a pair of electromagnets fixed to said housing and each having poles directed toward the first recited electromagnet to attract the same when energized, a circuit to energize the first recited electromagnet with direct current and to energize the said pair of electromagnets with alternating current.

2. The invention as set forth in claim 1, wherein the said circuit comprises a source of alternating current energy having a first frequency, a pair of rectifiers connected to said source and to said first recited electromagnet, and an inverter circuit connected to said rectifiers and to the said pair of electromagnets and including a pilot device to thereby supply alternating current energy at a frequency higher than said first frequency to the said electromagnets.

3. A reducing machine having a rotatable head, means for rotating the head, a plurality of radially adjustable supporting members carried by the head and each supporting a radially reciprocable hammer for striking a workpiece located centrally of the head, power means carried by the head for individually reciprocating each of the hammers, and means on the head for moving the supporting members for adjusting the extreme radial positions of the hammers, the means for moving the supporting members for adjusting the extreme radial positions of the hammers including guides for the supporting members mounted on the head and each comprising a threaded spindle threadably engaging a respec-

tive support member for displacing it in a radial position upon rotation of the spindle.

4. A reducing machine as defined in claim 3, and including a housing for the rotatable head and epicycloidal transmission gears mounted on the housing for simultaneously rotating all of the spindles.

5. A reducing machine having a rotatable head, means for rotating the head, a plurality of radially adjustable supporting members carried by the head and each supporting a radially reciprocable hammer for striking a workpiece located centrally of the head, power means carried by the head for individually reciprocating each of the hammers, and means on the head for moving the supporting members for adjusting the extreme radial positions of the hammers, said power means for reciprocating the hammers including electromagnetic means mounted on said supporting members.

6. A machine as claimed in claim 5, in which the electromagnetic means includes a magnetized core having a pair of poles of predetermined width and respective fixed opposite polarities carried by each of the hammers and spaced from each other in the direction of hammer movement, a plurality of pairs of electromagnets carried by the head, one for each hammer, each electromagnet of a pair having a pair of pole faces, each pole face of the pairs being in magnetic coupling relation with a respective pole of the magnetized core, the pole faces of one electromagnet of each pair being spaced from the respective pole faces of the other electromagnet of the pair in the direction of hammer movement by an amount substantially equal to the width of a pole of the magnetized core, and means connecting all of the electromagnets to a source of alternating current to be simultaneously energized with the pole faces magnetically coupled to one pole being of opposite polarity.

7. A reducing machine having a rotatable head, means for rotating the head, a plurality of radially reciprocable hammers carried by the head in angularly spaced relation about the axes thereof for striking a workpiece centrally thereof, electrically operated means carried by the head and operative independently of the rotation of the head for reciprocating the hammers, movable means carried by the head and adjustable during rotation of the head for limiting the extreme radial positions of the hammers.

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