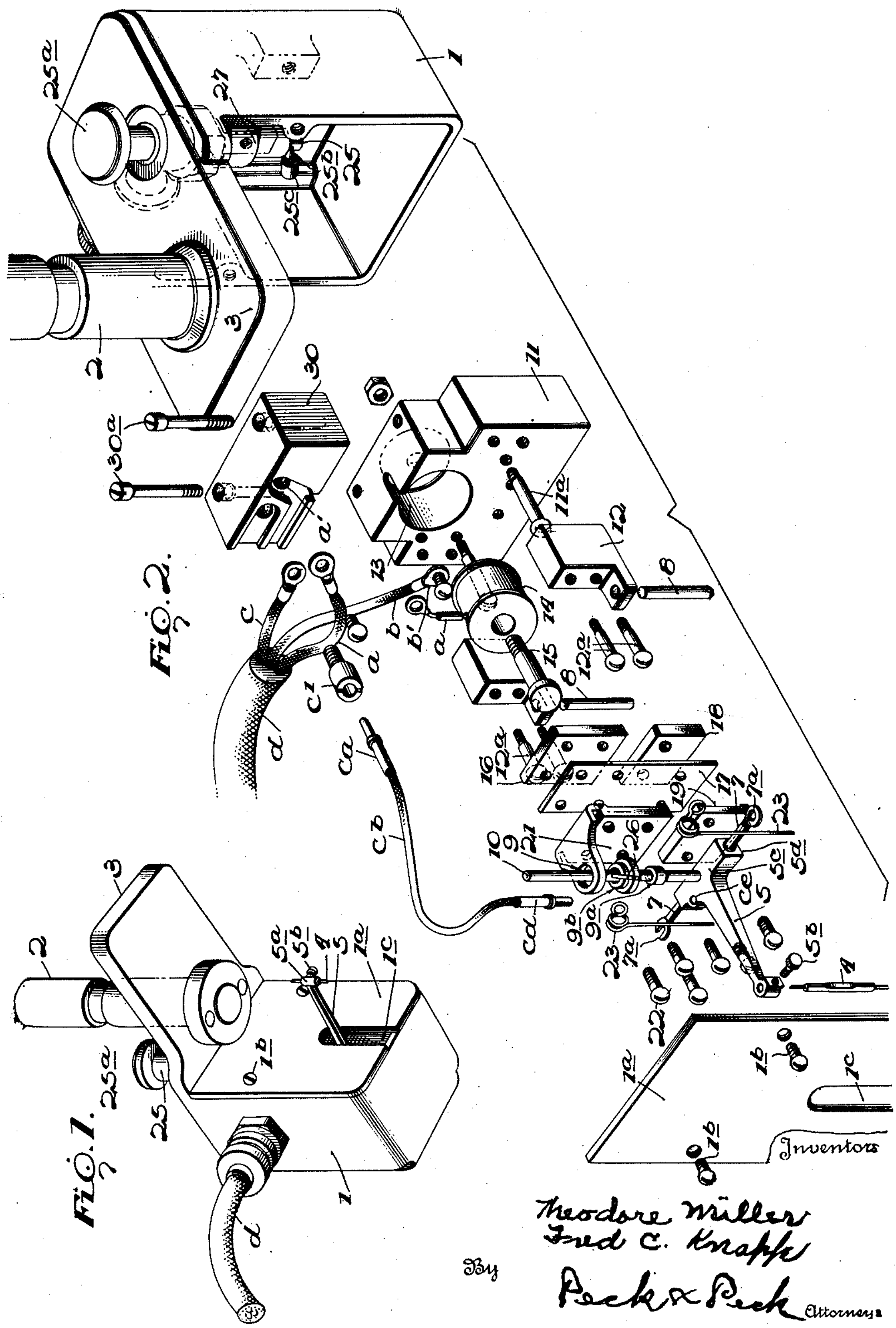
Dec. 21, 1943. T. MILLER ET AL 2,337,341

ELECTRIC ETCHER AND ALLIED DEVICES

Filed Aug. 25, 1942 4 Sheets-Sheet 1



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ELECTRIC ETCHER AND ALLIED DEVICES

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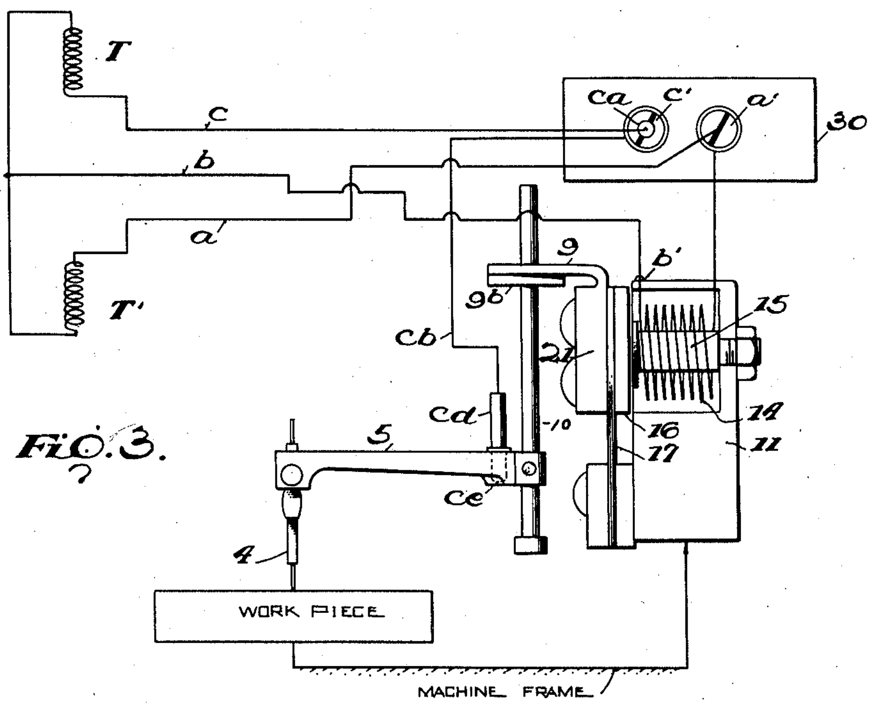

Fig. 3.

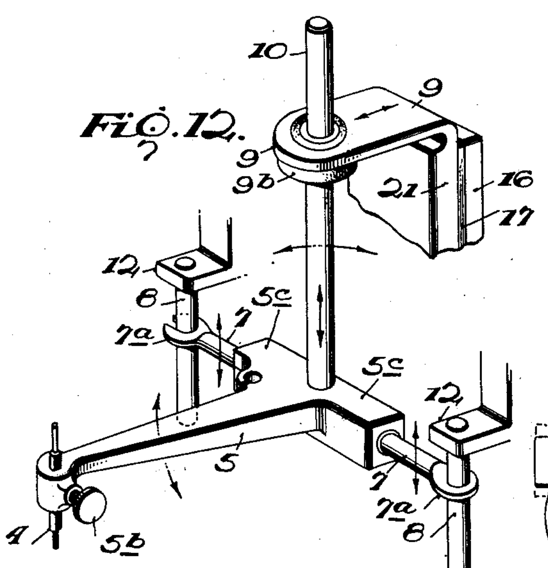

Fig. 12.

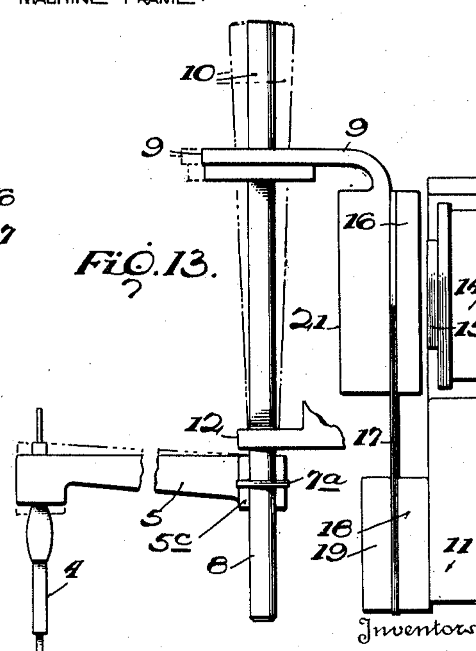

Fig. 13.

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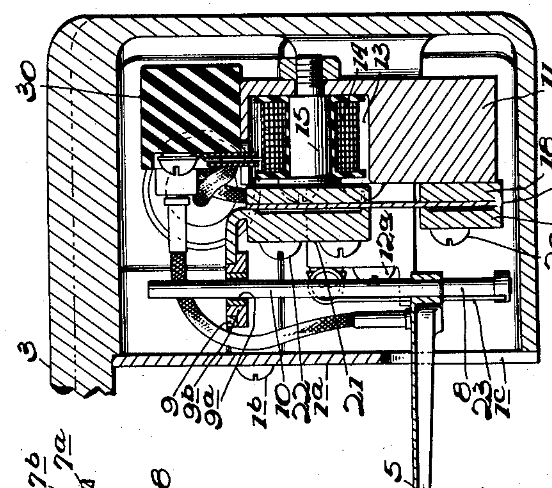

FIG. 5

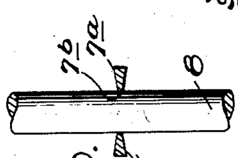

FIG. 10

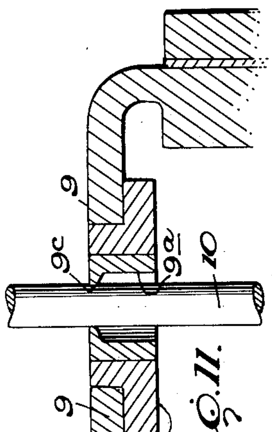

FIG. 11

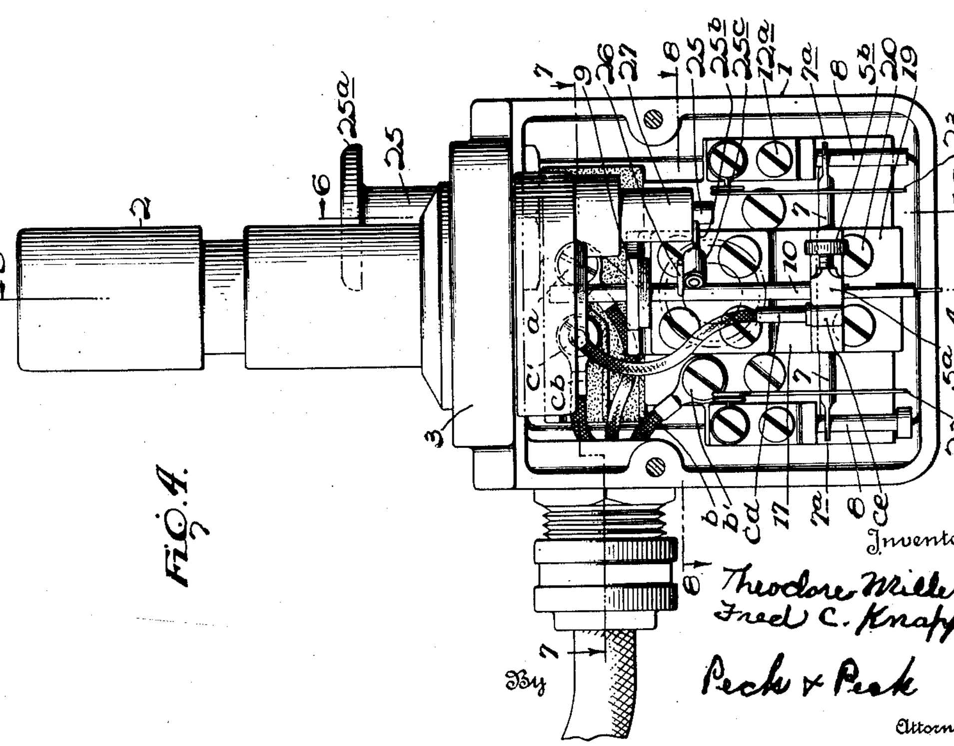

FIG. 4

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FIG. 6.

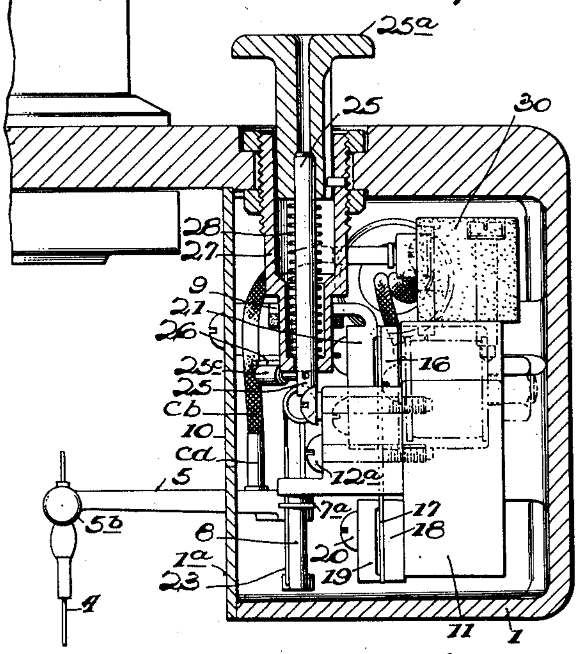


FIG. 7.

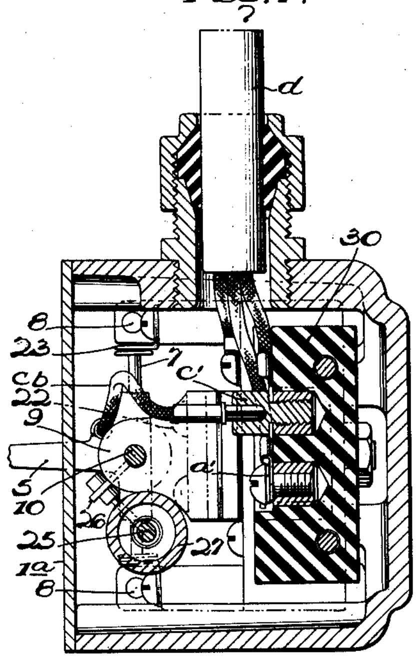


FIG. 8.

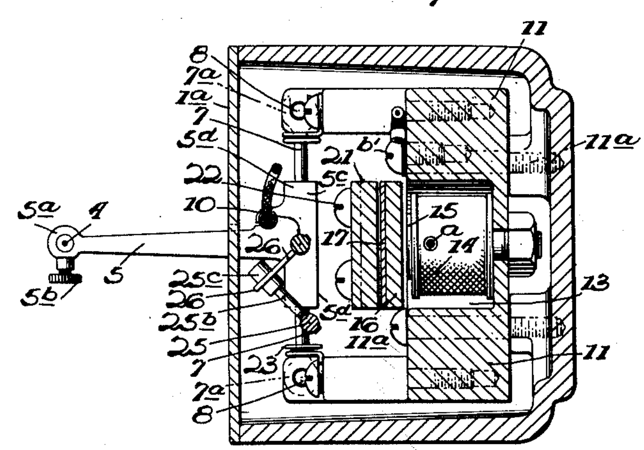
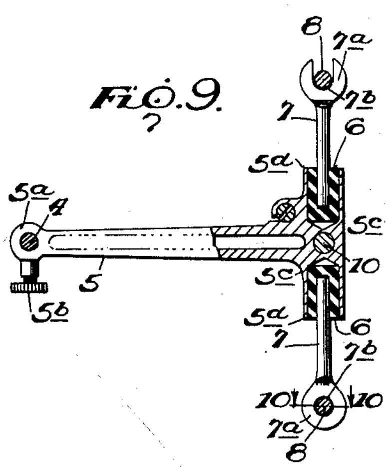


FIG. 9.



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UNITED STATES PATENT OFFICE

2,337,341

ELECTRIC ETCHER AND ALLIED DEVICE

Theodore Miller and Fred Christian Knapp, Racine, Wis., assignors to George Gorton Machine Co., Racine, Wis., a corporation of Wisconsin

Application August 25, 1942, Serial No. 456,074

25 Claims. (Cl. 219—15)

This invention concerns electric etchers and allied devices; and the following description of the accompanying drawings that disclose a preferred mechanical expression or example embodiment of the invention, from among others within the spirit and scope of the invention, will enable those skilled in the art to understand the objects and nature of the invention.

The invention more particularly relates to electric arc etchers designed to permanently mark indicia or the like in metallic or other conducting surfaces, by the surface-burning action of electric arcs established and extinguished or quenched by a rapidly-vibrating consumable electrode contacting and receding from such surface to make and break an etching circuit that includes said electrode and surface, during lateral relative movements between the surface and vibrating electrode; and an object of the invention is to so improve such electric arc etchers as to increase the efficiency and usefulness thereof.

Electric arc etchers in the past have employed an oscillating or vibrating electrode, either fixedly or slidingly attached to the free end of a cantilever spring. This spring usually being vibrated or oscillated by an electro-magnet. In the case of the cantilever spring with an electrode fixedly attached to the free end thereof, direct current is used for energizing the electro-magnet and the electro-magnet circuit is in series with the etching circuit. Thus, in order to initiate the oscillations or vibrations of the spring, the electrode must be brought into contact with the workpiece, which is also in the series etching and electro-magnet circuit, thus closing the series circuit. The electro-magnet being energized retracts the spring and hence the electrode from the workpiece a distance great enough to quench the resultant arc, thereby breaking the series circuit and de-energizing the electro-magnet whereupon the electrode is again projected into contact with the workpiece by the spring, and the foregoing cycle is repeated. The frequency of these cycles is dependent in a great measure upon the natural frequency of the cantilever spring with its associated electrode and other parts. Since frequencies of the order of 100 to 200 cycles per second are necessary to produce satisfactory arc etching, one difficulty which arises with this structure and method is that to obtain a natural frequency in a cantilever spring of the order of 100 to 200 cycles per second the spring must be fairly stiff, thus subjecting the electrode to a too heavy blow when striking the workpiece. In order to conserve the life of the electrode these pressures should be kept to a minimum consistent with forming a good electrical connection between the electrode and workpiece. If a spring of lesser stiffness is used the natural frequency is reduced, and consequently the speed of oscillation of the spring and the electrode is reduced considerably below the desirable range. Then too, the lighter spring is much more susceptible to transverse deflections and oscillations which cause the tip of the electrode to wander from its true directed path, which wandering causes undesirable distortions of the etched indicia or the like. Also, since the electrode is fixedly held on the free end of the cantilever spring with its longitudinal axis substantially perpendicular to the longitudinal axis of the cantilever spring and since the cantilever spring is rigidly anchored by its opposite end to a horizontally fixed support, the free end of the spring and the electrode when set in oscillation or vibration will follow a substantially arcuate path. Now, as the spring supporting means is traversed in a horizontal plane and while the surface of the workpiece traverses an undulating path, intersecting several horizontal planes, the end of the electrode contacting the workpiece will traverse a series of vertical planes intersecting the workpiece at greater or lesser distances from the vertical plane of the true directed path of the electrode, hence, causing the indicia formed by the electrode to deviate from the true directed path, thus causing distortions of the indicia the extent of these deviations and distortions being dependent upon the distance the end of the electrode is forced by the workpiece from its true vertical plane while following the arcuate path.

The structure embodying the cantilever spring with an electrode longitudinally slidingly attached to the free end thereof presents the serious limitation of not having the electrode rigidly held against lateral and/or longitudinal movement. It is the general practice to use an electrode formed of metal or metals of high melting point preferably of small cross section, such as, for example, tungsten wire of .010 diameter. When performing an etching operation where it is necessary to burn away from .001" to .003" of the surface metal, it has been found that if the current density is increased to the point where this amount of metal will be removed with a minimum number of arcs the electrode wire exhibits a marked tendency to become fused with the metal of the workpiece. This characteristic is more pronounced with some workpiece metals than with others but it is always exhibited to a greater or lesser degree. Therefore, with an electrode longitudinally slidable and laterally displaceable, attached to the free end of the reed or spring the electrode is displaced laterally if lateral motion of the support is maintained after fusing of the electrode wire to the workpiece. If lateral motion is discontinued after such fusion, the electrode being fused to the workpiece no longer oscillates with the spring; instead the electrode holder carried by the spring oscillates longitudinally of and in sliding engagement with the electrode body. Since this occurs when relatively large current densities are being employed, the small electrode wire usually completely fuses and is totally destroyed before the operator can open the etching circuit or dislodge the electrode from the workpiece by mechanical means. Also with this structure where the sudden stoppage of motion of the electrode holder projects the electrode, under the influence of kinetic energy, forwardly into contact with the workpiece, it is required that one-half the product of the mass of the electrode times the velocity squared, (i. e. $E=\frac{1}{2}mv^2$) equals the required force necessary to project the electrode through the holder into contact with the workpiece. In practice, with this structure, it is found that with an electrode of suitable size (mass), at a frequency of 120 cycles per second, the amplitude (which determines the velocity when the frequency is constant) is of the order of .125''.

It will be noted that at a frequency of 120 cycles per second, with an amplitude of .125'' the average speed of movement of the electrode is of the order of 60'' per second and that with an arc of a length of .005'' occurring while the electrode travels 60'' per second the mean time duration of the arc is of the order of .000083 second.

A further object of the invention is to provide an electro-mechanical organization that will successfully overcome and surmount the aforesaid defects and limitations inherent in the hereinbefore described old electric arc etchers.

Another object of the invention is to provide an electric arc etcher wherein the electrode is oscillated or vibrated to and from the workpiece at a frequency suitable to produce satisfactory etching and wherein the electrode is not subjected to destructive pressures and impact forces; and of such a structure that undulating surfaces may be traversed by the electrode while the holding means of the electrode holder is traversed in a horizontal plane and while the longitudinal axis of the electrode substantially coincides with parallel vertical planes during such traverse of undulating surfaces and of such a structure that the electrode is rigidly held against relative movement by the electrode holder and cannot be displaced therefrom during the normal operation of the device, and to provide means whereby each contact of the electrode with the work surface determines the limit of the electrode holder movement toward such surface.

And from a more specific standpoint, it is an object of the invention to provide an improved electric arc etcher wherein the speed of the etching operation at any suitable frequency of oscillation of the electrode is increased by increasing the time duration of the individual etching arcs, thereby increasing the surface burning power of such arcs, and wherein, to effect this increase of time duration of such arcs, the amplitude of the vibrations or oscillations of the electrode is reduced to a minimum for a given range of voltages and current densities of the etching circuit.

With the foregoing objects in view, as well as other objects explained in the following specifications, the invention comprises certain advantageous features, arrangements, and/or structures, combinations and sub-combinations, not all of which are necessarily limited for use in electric arc etching, as more fully hereinafter explained and specified by the appended claims.

Referring to the accompanying drawings, forming part hereof:

Fig. 1 is a detached perspective view of an example embodiment of the invention in the form of a portable removable and applicable arc etching head for attachment to a pantograph or other suitable machine.

Fig. 2 is an exploded perspective view, showing the embodiment of Fig. 1 with the example parts thereof shown detached and separated.

Fig. 3 shows an example electrical diagram which can be employed among others, diagrammatically indicating various working parts.

Fig. 4 is an enlarged front elevation of the head of Fig. 1 with the cover plate removed.

Fig. 5 is a vertical section taken in the plane of the line **5—5**, Fig. 4, the top hand-supporting arm of the box or case being partially broken away.

Fig. 6 is a vertical section taken in the plane of the line **6—6**, Fig. 4.

Fig. 7 is a horizontal section taken substanstantially in the plane of the line **7—7**, Fig. 4.

Fig. 8 is a horizontal section taken substantially in the plane of the line **8—8**, Fig. 4.

Fig. 9 is a detail enlarged horizontal section of an example vertically and/or rotatively vibratory electrode holder.

Fig. 10 is an enlarged cross section on the line **10—10**, Fig. 9.

Fig. 11 is an enlarged detail vertical section of that portion of Fig. 5 that includes the vibratory motor propelled arm and the portion of the upright lever arm of the vibratory electrode holder where it passes through the vertical bore of said motor propelled arm.

Fig. 12 is a diagrammatical detached fragmentary enlarged perspective view of the bell crank holder fixedly carrying the depending tool or element that controls the operation of applying marking indicia to the work surface, and certain parts associated with said holder.

Fig. 13 is a diagrammatical fragmentary enlarged detail side elevation of the bell crank tool holder and certain parts associated therewith, showing in an exaggerted manner by dotted lines the amplitudes of the vibrations of certain parts.

The electric arc etcher of this invention, is preferably, although not necessarily, used in connection with suitable mechanism capable, usually under manual control and/or propulsion, of causing relative lateral movements between the etching electrode and the surface of the work to be etched, so that the required indicia can be etched in the required area of the work surface. The instant electric arc etcher can be built in or as a part of such mechanism, or an embodiment of the instant invention can be in the form of an accessory or attachment applible to and removable from such suitable mechanism. For example, a pantograph machine such as an engraving machine or the like, can be employed to constitute the above mentioned suitable mechanism. Such pantograph engraving or milling machine generally provides a cutter head universally laterally movable over the normally fixedly held work in a plane parallel to the work surface, through the medium of the pantograph usually manually actuated to cause its stylus to trace the pattern usually fixed to the copy or pattern holder. The pantograph is usually set or adjusted to enlarge, reduce or duplicate the copy on the work surface.

The example embodiment hereby disclosed, without however, wishing to so limit the instant invention, provides a portable so-called electric arc etching head that includes a supporting, preferably enclosing box or case 1, provided with a supporting hanger or stud 2, rigid with said box and arranged exteriorly thereof. If so desired, said stud can upstand from a rigid top arm 3, laterally projecting from and fixed to said box.

In this particular example, without intending to so limit the invention, the longitudinally and/or rotatively vibratory electrode 4, perpendicular to the work surface, is located at the exterior of the lower portion of the box 1, with a portion 5, of the electrode holder also exposed at the exterior of said box. Thus, the etching head 1, and parts carried thereby, can be employed as an accessory or attachment applicable to and removable from the pantograph machine. To operatively attach this etching head to such machine, the machine cutter spindle is removed from the machine cutter head, and then the upstanding supporting stud 2, of the etching head or box 1, is inserted in said cutter head and rigidly clamped therein, with box 1, depending from said stud below the cutter head, and with the electrode 4, in cooperative relation to the work surface to be etched.

In this particular example embodiment, it so happens that the etching electrode 4, is located a substantial distance below the lateral supporting arm 3, with the longitudinal axis of the electrode 4, approximately in alinement with the longitudinal axis of the supporting stud 2, all so arranged that when in lowered operative vibratory position, the lower operative end of the electrode is located a substantial distance below the horizontal plane of the bottom of box 1.

The box 1, in this example, preferably forms a closed rigid strong housing, except for its vertical side below the arm 3, which is closed by a removable cover plate 1*a*, normally secured in place by screws 1*b*, or the like. This plate 1*a*, is formed with a vertically elongated slot 1*c*, through which the portion 5, of the electrode holder extends and in which said portion is freely movable in a vertical plane, preferably out of contact with said plate.

The electrode holder includes a laterally-projecting vibratory arm 5, mounted within the box 1, and extending to the exterior thereof, and at its outer free end extremity provided with means for normally rigidly securing an electrode 4, thereto with the electrode vertically arranged preferably with the longitudinal axis of the electrode perpendicular to the longitudinal axis of the vibratory holder arm 5.

For example, the outer free end of said arm can be formed with a vertical tubular socket 5*a*, into which an electrode 4, can be longitudinally slipped, and from which it can be longitudinally withdrawn for replacement. The holder socket can be provided with any suitable means for normally fixedly securing the electrode in the socket and to the arm against relative movement. For instance, we happen to show a headed finger clamping screw 5*b*, threaded into the socket for locking and releasing the electrode to and from the vibratory arm.

This arm 5, is mounted on any suitable support for relative, preferably vertical straight line movement, and for slight relative rotative movements to render the electrode carrying end of the arm substantially vertically and/or rotatively oscillatory to carry the electrode substantially longitudinally toward and from the work surface through oscillations of very short vertical amplitude. This electrode holder mounting is of any suitable organization or structure that during the vibrations of the electrode holder, permits or causes downward feeding of the holder as the electrode is gradually consumed or reduced by the rapid succession of established arcs, which necessitates successive downward shifting of the transverse axis or fulcrum on which the electrode holder oscillates vertically and/or rotatably.

For instance, in the particular example illustrated, the metal electrode holder arm 5, is stiff and, preferably, straight from its electrode-clamping socket 5*a*, to its inner, rear or fulcrum end, which if so desired, can be in the form of a rigid cross head 5*c*, in a horizontal plane perpendicular to the vertical plane of the socket 5*a*.

The opposite ends of this horizontal cross head 5*c*, can be formed with longitudinally-alined sockets 5*d*, open at their outer ends, and containing fixedly located insulating plugs 6, through the medium of which oppositely-projecting horizontal longitudinally-alined stub shafts 7, are rigidly fixed to the opposite ends of the cross head 5*c*, to establish the straight line cross axis on which the electrode holder arm is vertically and/or rotatively oscillatory. In this particular example, the alined shafts 7, are thus electrically insulated from the laterally extending electrode holder arm 5, that is included in the etching electric circuit.

The cross head 5*c*, of the electrode holder arm 5, and the two end longitudinally-alined shafts 7, preferably, constituting rigid parts of said cross head and the arm 5, are guided and confined to limited straight line vertical movements, and/or limited rotary movements about the longitudinal axis of cross head 5*c* and shafts 7 in any horizontal plane defined by the limits of the straight line vertical movement, by straight parallel laterally spaced rigidly supported vertical guide rods 8, between which said cross head is located, and to which the outer ends of said horizontal shafts 7, are confined in limited vertical slidable and/or limited rotative engagement.

The outer ends of said stub shafts 7, are suitably formed to straddle said guide rods 8, respectively, to confine said cross head of electrode holder arm 5, against objectionable lateral looseness, while permitting free limited vertical straight-line sliding movements and/or limited rotary movements of the cross head on said rods, as hereinafter more fully explained.

Said outer ends of the shafts 7, are also so formed with respect to the preferably smooth exterior slide surfaces of the usually cylindrical guide rods 8, as to permit slight limited rotative movements of said shaft ends on said rods, on or about the common longitudinal axis of the cross head and its shafts 7, to permit the slight rotary movements of the cross head on its said fulcrum or axis, needed to produce the short amplitude substantially vertical oscillations or vibrations of the electrode 4, required to establish and extinguish the etching arcs.

For example, the outer ends of the stiff stub shafts 7, that are freely vertically slidable on the guide rods, can be formed of flat relatively thin eyes 7a, that encircle or straddle and partially encircle the guide rods 8, respectively. These eyes 7a, have almost knife-like thin sharp arcuate or surrounding inner surfaces or edges 7b, that contact and slidably engage the guide rods, and permit the aforesaid limited rotation of the eyes relative to said rods, on said axial or fulcrum line of the electrode holder cross head 5c.

The radius of these internal arcuate walls or edges 7b, of eyes 7a, is preferably but very slightly greater than the radius of the usually cylindrical guide rods 8, to permit vertical sliding movement of said eyes on said rods with friction reduced to the minimum and to reduce to the minimum reative lateral movements of the eyes radially of the rods, but not to limit the relative rotary movement of the eyes on the axial or fulcrum line of the electrode holder cross head 5c, since these relative rotary movements of the eyes are limited by the movements of the driving member 9, as hereinafter explained.

Although not of the essence of the invention, and merely as an example, without intending the same as a limitation, we have successfully employed an embodiment of the invention wherein the diameter of the short rigid guide rods 8, was approximately .100'' and the internal diameter of the complementary slide eyes 7a, was approximately .101''.

Any suitable motor can be employed with any suitable transmission mechanism for actuating the electrode holder on its desired short amplitude oscillations to rapidly establish and quench electric etching arcs that are of relatively long duration and of the desired power. A mechanical, hydraulic or electric vibratory motor can be employed for this purpose, although as at present taught by experience we prefer to employ an electric vibratory motor, although we do not wish to so limit all features of the invention.

It is understood that the actuating means for the rotatively oscillatory electrode holder may take any suitable form or construction. We prefer the use of an electro-magnetic motor that includes a cantilever spring system, arranged for impressing an intermittent magnetic disturbing force of suitable frequency on the said spring system.

Since the electrode holder 5, 10, is directly coupled to the vibrating spring system 16, 17, 18, 19, 21, it follows that the spring system be designed to vibrate at the frequency of the disturbing force when under the influence thereof, with a given substantially constant amplitude while the damping forces vary. In other words, the amplitude of the vibrations must be of suitable magnitude and it must not vary with variations of the damping forces imposed by the bell crank electrode holder on the spring system.

The laws governing this spring system insofar as they apply to this structure require that the amplitude of the vibrations, which we shall term the "total amplitude," be determined by:

The "basic amplitude"
The damping forces
The "magnification factor"

The "basic amplitude" is determined by the ratio of the magnitude of the deflecting force to the spring stiffness, so that with an increasing deflecting force the "basic amplitude" increases, and vice versa. Since in this case the deflecting forces and the spring stiffness do not vary the "basic amplitude" will not vary.

The damping forces with which we are most concerned here are imposed on the spring system by the bell crank electrode holder and when certain conditions obtain in the spring system, as disclosed hereinafter, these damping forces may sharply effect the "total amplitude."

For purposes of exposition, while foregoing mathematics, it may be stated that the "magnification factor" will, with any given condition of the spring system, exert one of the following "forces":

A "force of minimum influence"
A "force of maximum influence"
A "force of diminution"

The "force of minimum influence" is exerted when the disturbing force has a very low frequency compared with the natural frequency of the spring system. This "force" has very little influence on the "basic amplitude" and while acting the damping forces have but slight influence on the "total amplitude." That is, the "total amplitude" substantially equals the "basic amplitude."

The "force of maximum influence" is exerted when the frequency of the disturbing force is equal to or nearly equal to the natural frequency of the spring system. This "force" greatly increases the "total amplitude" over the "basic amplitude." And while this force is acting the damping forces have the maximum effect on the "total amplitude."

The "force of diminution" is exerted when the frequency of the disturbing force is very high compared with the frequency of the spring system. This "force" greatly diminishes the "basic amplitude" as determined by the deflecting force and the spring stiffness. In other words, the deflecting force moves so rapidly that the spring simply has no time to follow, and the amplitude is very small. While this "force" is acting the damping forces have little or no effect on the amplitude, and the "total amplitude" is nearly zero.

Obviously, we cannot utilize the "force of maximum influence" due to the variations of "total amplitude" when the damping forces of the electrode holder are applied. That is, we cannot employ a spring system the natural frequency of which equals or nearly equals the frequency of the disturbing force.

To utilize the "force of diminution" would require that the natural frequency of the spring system be much less than the selected disturbing frequency of 120 cycles per second. To construct a system having a natural frequency of 4 cycles per second, while being capable of storing sufficient energy to overcome all damping forces when the disturbing force is not acting, would require relatively massive parts, which would be entirely unsuited to this application.

By utilizing the "force of minimum influence," that is, by constructing a spring system the natural frequency of which may be approximately 960 cycles per second, being much greater than the selected disturbing force of 120 cycles, per second, we arrive at a condition where the amplitude is determined by the deflecting force, the spring stiffness being constant; and where the "magnification factor" has little or no effect on the "basic amplitude" as determined by the deflecting force; and where the variable damping forces cause a minimum of variation of the "total amplitude"; and where the stiffness of the spring enables the storing of sufficient energy to overcome any damping forces imposed when the deflecting forces are not acting, and while the parts are relatively small in size. Where we employ a disturbing-force electric current of 60 cycles per second, energizing the electro-magnet, the force assumes one full positive and one full negative value 60 times per second and is termed "one cycle." But the magnetic motor does not choose between these positive and negative values as such. Each full value, positive or negative, induces a full cycle of movement in the spring system of the motor. Therefore, we have 120 applications of the disturbing force per second, that is 60 positive and 60 negative, which makes 120 cycles of vibration in the spring system. While the natural frequency of the spring system is 960 cycles per second, or sixteen times faster than the "cycles frequency" of the force, the spring system operates under forced vibrations at two times the frequency of the disturbing force, or 120 cycles per second, or eight times slower than its natural frequency.

It is this relationship of "induced forced vibrations" to the "natural frequency" which brings the "force of minimum influence" to bear causing the short amplitude vibrations.

Also when the "force of minimum influence" is acting the vibration of the spring system lags behind the disturbing force, thus permitting the amplitude of the disturbing force to approach the maximum value while the amplitude of the spring system passes through zero value. Thus, since the alternating etching current is in phase with the disturbing force, the electrode will not be lifted from the workpiece when the etching current passes through zero.

In practice, with the disclosed structure, the etching arc is initiated at about 45 time degrees from zero, and is quenched at about 75 time degrees from zero, and again initiated at about 225 time degrees from zero, and quenched at about 260 time degrees from zero, per cycle of disturbing force.

In the instant example embodiment, we disclose a vertically and/or rotatively oscillatory electrode holder that is limited in its oscillations toward the work surface by the contact of the electrode with such surface, and that automatically feeds down toward said surface as the electrode is consumed. As one example of suitable vibration transmission means, actuated by any suitable vibratory motor, for actuating said electrode holder, we show a horizontally disposed substantially longitudinally-oscillated or vibrated member or arm **9**, driven by the vibratory motor and operatively coupled to said electrode holder to actuate the same and to permit downward feeding of said holder by gravity in whole or in part, as the electrode is consumed. For example, this vibratory member **9**, can be operatively coupled to said holder **5**, through the medium of a stiff upstanding lever **10**, radially arranged with respect to the transverse axis on which holder arm **5** oscillates, and rigid with said arm.

Where a lever **10**, is employed as the operating transmission from vibratory driving member **9**, we prefer to locate lever **10**, in the vertical plane of holder arm **5**, with the longitudinal axis of lever **10**, substantially perpendicular to the longitudinal axis of cross head **5c**. In this example the lower end of said stiff lever **10**, is rigidly secured to or in the central portion of cross head **5c**, of arm **5**.

The lever **10**, thus rigid with the arm **5**, provides, in effect, a bell crank or angle lever electrode holder **5**, **10**.

The stiff vertically-elongated upstanding lever arm **10**, is usually exteriorly smooth to form a slide surface, which is preferably cylindrical. The vibratory member **9**, for driving the lever **10**, in its vibratory movements, is supported and held to a fixed substantially horizontal path of longitudinal oscillations of usually fixed amplitude, under the driving action of a suitable vibratory motor.

The driven vibratory member **9**, is arranged transversely of the lever **10**, and substantially perpendicular to the longitudinal axis thereof, and said member is provided with a vertical bore **9a**, extending therethrough, and this bore slidably receives the lever **10**, in such manner that the lever is freely slidable longitudinally and vertically through such member, as the electrode holder rises and descends, yet the lever and member are preferably closely coupled together for instant response of the lever to lateral push or pull of the member, and against lateral lost motion or looseness that might result in chatter.

The vertical bore of the vibratory member **9**, arranged transversely with respect to lever **10**, is preferably formed by a hard metal vertical tubular bushing **9a**, rigid with the preferably strong metal arm **9**, forming said member, and this bushing is rigid with and extends through a plug **9b**, that also extends vertically through and is rigid with said arm **9**. This plug **9b**, is preferably formed of insulating material to electrically insulate the metal bushing **9a**, and the lever arm **10**, from the vibratory driving arm **9**, where a vibratory electric motor is employed to drive arm **9**, with said motor actuated by a power circuit, while the lever arm **10**, may be included with the electrode holder and electrode in an etching circuit.

The bushing **9a**, is in this particular example preferably formed with a narrow internal concentric annular lever-arm-contacting edge **9c**, of reduced diameter with respect to the remaining bore of the bushing. The internal diameter of this circular edge **9c**, is but slightly greater than the external diameter of the lever arm **10**, to maintain sliding contact between said edge and said arm against undue lateral looseness or lost motion, yet permit free longitudinal movement of the arm through said edge. This circular narrow contraction within the bushing bore provides an almost knife edge **9c**, that permits limited lateral rocking movement of the lever arm **10**, within bushing **9a**, and with respect to vibratory driving arm **9**, as said vibrating arm slightly rotates the bell crank electrode holder and the electrode about the fulcrum **7**, to make and break the etching arcs.

Where the instant invention is driven and actuated by an electromagnetic vibratory motor, and where the instant invention is employed in connection with a portable head, for instance box **1**, we usually employ any suitable motor block, for instance, a preferably upright metal supporting block **11**, suitably secured within the box **1**, preferably at the rear thereof opposite the removable cover plate, as by screws **11a**.

In this example, the block **11**, carries laterally-spaced forwardly-projecting fixedly located brackets **12**, secured by screws **12a**, to which the upper ends of the vertical guide rods **8**, are fixed and from which said rods depend, with the bell crank electrode holder and its cross head located between and vertically and/or rotatively movable on said guide rods.

This block 11, also, in the instant example, carries the vibratory members of the motor and the vibratory electrode driving arm 9, which is carried and driven by said vibratory members. Also, said block 11, at its upper central portion is formed with a transverse socket 13, open at its front end, and in this socket is fixedly located the electromagnetic coil 14 and its core 15, with the front end of the core exposed at the open front of said socket. The core 15, carrying the coil, can be normally fixedly secured to the rear wall of the socket.

The armatures 16, 21, and its reed or spring 17, are, in this particular example, located centrally and vertically in front of the motor block 11, and between the two spaced brackets 12, and behind and spaced rearwardly from the bell crank vibratory electrode holder.

The strong flat straight steel spring 17, is arranged vertically and spaced forwardly a distance from the front side of block 11, and at its lower end is rigidly secured to the lower end of said block 11, between spacer block or plate 18, and outer clamping plate 19, with clamping screws 20, or other securing means, passing transversely through the plate, the spring, the spacing block, and into the block 11.

This spring extends upwardly from the rigidly secured clamping plates 18 and 19, and at the front and rear side of its upper end carries the substantially flat metal blocks 21 and 16 respectively, that constitute the armature, situated in operative relation to the front end of the magnet core and its coil, and in front thereof, and suitably spaced forwardly therefrom. The armature member 21 in this embodiment is integral with and rigidly supports and actuates the vibrator arm 9, for the bell crank electrode holder.

The armature members 21 and 16, are, in this example, located at opposite sides of the upper free end of the armature spring and are rigidly clamped against the spring by suitable means, such as machine screws 22, passing through the armature member 21, and the spring 17, and into the armature member 16.

In this instance, without so limiting the invention, the electrode holder vibrating arm 9, is formed by a relatively thin plate extension of and rigid with the armature member 21, extending up from the top thereof and then extending forwardly substantially horizontally to a point forwardly beyond the lever arm 10, of the bell crank electrode holder.

In this particular example the armature spring 17, when at rest is in its normal straight, flat form substantially at its median point of forward and rearward movement, holding the armature members 21 and 16 and hence the arm 9 and lever arm 10 at their substantially median point of forward and rearward movement. When under the momentary influence of one-half cycle of the magnetic field, the armature is drawn rearwardly to its limit of movement toward the core against the tension of the spring 17, the arm 9 being drawn rearwardly rotates the bell crank electrode holder about its fulcrum axis 7b thereby elevating the electrode to establish and then extinguish the etching arc. Upon the magnetic field approaching and passing through zero the armature and arm 9 under the influence of the stored energy of spring 17 snap forwardly to their limit of forward movement to carry the electrode down to contact with the work surface, during which movement the electrode holder slides down on guide rods 8, the slight distance necessary to compensate for the length of the electrode consumed by the preceding arc. Then this oscillatory cycle of the electrode arm and associated parts is repeated with the next one-half cycle of the magnetic field, thus producing 2 cycles of electrode oscillation to each cycle of magnetic oscillation or 120 cycles of electrode oscillation with a 60 cycle single phase input current.

As the fulcrum axis of the bell crank electrode holder is free to drop vertically along the guide rods to permit downward feeding of said holder while the electro-magnetic vibratory motor is operating at high speed, it is sometimes desirable to provide light spring means to yieldingly hold the eyes 7a laterally against the rods 8 and to reduce chatter to the minimum when the electric vibratory motor is running at high speed, and to damp out vagrant vertical vibrations of the electrode holder, and also to establish sufficient light friction between such parts as will hold the electrode holder against gravity in any elevated position to which said holder has been moved, when said vibratory motor is at rest.

For this purpose we can employ for either or both stub shafts 7 of the holder fulcrum axis one or more vertically disposed straight smooth spring wire lengths 23, free at their lower ends, and exerting rearward yielding pressure against one or both of said shafts, for the purpose above explained. As the electrode holder descends, said shafts will slide downwardly along said spring lengths. Each such spring can be fixedly secured at its upper end to a bracket 12, fixed to the motor block 11, and if so desired the upper portion of the spring can be coiled or otherwise bent to yieldingly hold its length 23 pressed inwardly against a shaft 7.

Although not desiring to so limit all features of the instant invention, yet advantageous results are gained by the provision of suitable means constantly acting to yieldingly elevate the electrode and its holder and thus uphold the electrode from its normal lowered operative position with respect to the work surface. This, with the end in view of requiring the machine operator to manually actuate such means to permit gravity to depress the electrode holder to bring the electrode into its depressed operating position, and to thus constantly hold such means against yieldingly applied force constantly tending to lift the holder and its electrode from said lowered operative position. Where such electrode holder lifting means is employed, it is necessary for the machine operator, so long as he desires the electric arc etching operation to proceed, to maintain hand or other pressure on such lifting means against the constantly acting spring or other holder lifting force thereof, to maintain the electrode holder down to operating position. Thus, should the necessity suddenly arise, the operator can quickly stop the etching operation by releasing the downholding pressure on said means, and permit the lifting device to quickly lift the holder and its electrode from operative position.

As an example embodiment of such an electrode holder releasing and lifting means, a longitudinally slidable vertical plunger 25 is disclosed, extending down through the top wall of the etching head or box 1, and into the interior thereof in front of the motor block and laterally spaced from the electrode holder lever arm 10, and from the vibratory armature spring and parts carried thereby.

Above the top wall of box 1 this plunger is provided with an exposed accessible head 25*a*, or so-called feed button, formed for depressing and holding down by the hand or members thereof resting on or exteriorly grasping said box, or by other means.

The lower end portion of this depressing and lifting plunger 25 is provided with a laterally projecting lifting finger 25*b*, fixed thereto. The free end portion of this finger is located under a radially projecting toe 26, fixed to the lever arm 10, of the electrode holder and arranged in the vertical path of movement of the plunger 25*b*, located below said toe 26. The finger 25*b* is preferably provided with a sleeve 25*c* for contacting toe 26, and this sleeve is usually electrically insulated from the finger 25*b* and plunger 25.

In this particular embodiment, we happen to show a vertical tubular guide 27, for plunger 25, with this guide suitably secured to the top wall of the box 1, and depending therein. This guide forms the housing for a coiled electrode-holder-lifting expansion spring 28, at its upper end abutting the lower end of head 25*a*, of the plunger 25, and at its lower end abutting the bottom wall of the tubular guide 27.

This spring is constantly under tension to yieldingly maintain the plunger at its limit of upward movement, and through the lifting contact of finger 25*b*, with toe 26, to lift and yieldingly maintain the electrode holder and consequently the electrode in inoperative elevated position. When the vibratory motor is operating, depression of the plunger 25, to substantially its limit of downward movement, thus freeing toe 26, permits the electrode-holder to drop by gravity until its electrode strikes the work surface for carrying on its longitudinally vibrating operations.

In the particular example embodiment illustrated that discloses an electromagnetic vibratory motor 11, 14, 15, 16, 17, 21, we show an insulating terminal block 30 of electrical nonconducting material within the etching head or box 1, fixed on the upper end of the motor block 11, as by screws 30*a*, to receive the two wires *a*, *c*, from any suitable diagrammatically indicated transformers such as T′ and T, respectively. The wire *b* is preferably electrically attached at *b*′ to the motor block 11. Fig. 3 shows an electromagnetic vibratory motor circuit comprising the wire *b*, connection *b*′, motor block 11, coil 14, connection *a*′, on terminal block 30, wire *a*, transformer T′, and thence back to wire *b*. Also, an etching circuit comprising wire *b*, transformer T, wire *c*, terminal block plug or socket *c*′, fixed to the insulating block 30, to removably and electrically receive conducting plug *ca*, in electrical connection with the flexible conducting wire or pigtail *cb*, the opposite end of which is provided with conducting plug *cd*, normally, removably and electrically fitted in socket *ce*, in electrical conducting relation with the electrode arm holder 5, electrode 4, the workpiece, the machine frame, motor block 11, thence to wire *b*, at *b*′. This flexible wire *cb* is preferably exteriorly insulated and constitutes a removable and replaceable connection by which the vertically and/or rotatively vibratory feedable or floating electrode holder and its fixed electrode are included in the etching circuit.

The wires *a*, *b*, *c* are enclosed in the cable *d*, that enters the box 1, through a hole in a side wall thereof, in which the cable is secured by any suitable clamping means.

It will be noted that the contacting of the electrode on the workpiece shorts the etching circuit and that upon retraction of the electrode from the workpiece a suitable distance an arc is formed and broken between the electrode and the workpiece.

Without intending to so limit the instant invention, where the power supply for the transformer T′ is 110 volts, 60 cycle, single phase, the electromagnetic motor will actuate the driving arm 9, and consequently the electrode holder at a rate of 120 cycles per second.

Since, at a given frequency, the amplitude of movement of the spring 17 with the armature 16 and 21, and associated parts, is dependent upon the strength of the spring, weight of the armature, strength of the magnetic field and several other factors, as is well known to those familiar with the art, we have embodied in this structure the necessary mechanical and electrical conditions to produce and maintain a substantially constant amplitude of vibration of the spring system while the system is subjected to the variable damping forces of the bell crank electrode holder.

The amplitude we prefer to use is of the order of .015″. It will be noted that at a frequency of 120 cycles per second, with an amplitude of .015″ the mean speed of movement of the electrode is of the order of 7.2″ per second and that with an arc of a length of .005″ occurring while the electrode travels 7.2″ per second the mean time duration of each individual arc is of the order of .00069 of a second.

It will be further noted that while maintaining this extremely short amplitude of electrode oscillation and the consequent relatively great time duration of the arc the electrode is rigidly held against relative movement by the electrode holder, and that the longitudinal axis of the electrode at all times substantially coincides with the vertical plane coincident with the true directed path of the electrode.

The most desirable results are obtained by using low etching voltages, of the order of three to nine volts, with suitable current densities, from any suitable source such as transformer T.

Where the work surface is to be marked or etched through the medium of a pantograph machine, the etching head is applied to the machine cutter head in place of the cutter spindle, and hence the etching head, in scaled relation, will reproduce the master copy on the work surface through the medium of its etching arcs as the machine is operated by its stylus to trace the master copy on the machine copy holder. The rapid succession of etching arcs permanently mark the indicia of the master copy in the work surface without injuring or distorting the metal adjacent to the indicia, as each arc burns a minute pit or crater in such surface by decomposition of metal, and visible lines on or in the work surface can be formed by a close succession of slightly overlapping minute pits or craters, and the depth of each such pit or crater depends on the total time duration of the arcing and the etching current density employed. The width or diameter of each pit or crater is dependent on the diameter of the electrode employed. For example, for more or less light etching, we have employed electrode wires .0075, .010, and .015 of an inch in diameter without so limiting the instant invention. A suitable etching current density is required for an electrode wire according to the diameter thereof and depth of etch desired.

Merely as an example of one from among other electrodes that can be employed, the electrode 4, is reversible and replaceable and consists of a longitudinal body of electrical conducting material from the opposite ends of which longitudinally project small-diameter usually cylindrical wire ends of tungsten or any other high melting point hard metal or allow suitable for arc etching purposes.

In operating a pantograph machine carrying the instant example electric arc etching head, the vibratory motor circuit is closed to start the operation of said motor (the workpiece having been fixed in position below the etching head and included in the etching circuit). When all is ready to proceed with the etching operation, the machine operator can place the palm of his left hand, on the top extension 3, of the head 1, with the thumb and index finger partially encircling shank 2, so that the finger or thumb thereof can rest on the electrode-holder feed button or head 25a. This leaves the right hand of the operator free to operate the pantograph in tracing the master copy that is to be reproduced in the work surface by the etching head. The operator's left hand is thus conveniently arranged to depress the feed button or head 25a, by the thumb or finger and to thus hold said head depressed during the operation of etching an unbroken line. The depression of head 25a, while the vibratory motor is operating, permits the electrode holder to freely descend until stopped by the light contact of its fixedly held electrode with the work surface whereupon the rapid short length substantially longitudinal oscillations of the electrode causing arcing between the electrode and workpiece will produce the line of marks on the work surface, as the right hand of the operator propels the pantograph at a rate of speed that preferably causes the individual marks or craters to overlap, rather than a higher rate of pantograph movement that will produce a line of spaced dots or craters.

When the etching of a letter or other unbroken portion of the master copy is completed, the operator releases the feed button or head 25a, and the holder and its electrode are immediately lifted by spring 28, to the up or inoperative position with respect to the work surface. For instance, in some examples, when the holder is in its inoperative up position, the lower end of the vertical electrode is about three-sixteenths of an inch above the work surface.

When another portion of the copy is to be etched on the work surface, the operator again depresses the feed head or button 25a, thereby permitting the electrode holder to descend by gravity until stopped by the contact of its electrode with the work surface, which starts the rapid succession of etching arcs.

The transverse axis on which the bell crank electrode holder vertically and/or rotatively oscillates, rises and falls with the holder and electrode, with respect to the transverse vibrating arm 8, that drives said holder, so that the vertical distance between the horizontal plane of said axis and the substantially parallel fixed plane of said arm, decreases as said axis moves upwardly and increases as said axis drops.

The vibratory holder and its vertical electrode when released, drop by gravity, so long as the arm continues its vibratory movements, until the downward movement thereof is stopped by the electrode engaging the work surface, and then the electrode floats on the work surface under the action of gravity; thus as the lower end of the vertical electrode rides up or down as it advances over undulations in the work surfaces the holder is thereby elevated and drops by gravity, and during such operation the holder automatically feeds downwardly as the electrode is consumed.

The instant apparatus for marking or reproducing indicia on a work surface through the medium of a suitable replaceable vibratory tool, point or element in operative marking relation to said surface, is disclosed as a preferred example embodiment within our inventive concept. In this disclosed embodiment, such tool, point or element is represented by and takes the form of an electrode that strikes and recedes from a work surface of electrical conducting material to make and break and thus control an electric marking or etching circuit, but we do not wish to limit all features of our invention to the inclusion therein of a work surface marking instrument or tool that constitutes an electrode for electric arc marking or etching.

In the instant example embodiment, the holder 5, 10, is more or less forcibly rotatably oscillated on a transverse fulcrum line or axis to cause its fixedly held upright tool or element, for example 4, to strike and retreat upwardly from the work surface. When the normal operation is on a flat plane work surface perpendicular to the longitudinal axis of said tool or element, said element or tool, by reason of the fact that its lower end is in engagement with said surface, upholds said holder and limits each downward movement thereof, and hence said holder thus floats on said work surface.

Where the holder with its fulcrum axis, is bodily movable up and down as a unit, as well as rotatably oscillatory on said axis, the holder and its said axis will drop by gravity or otherwise during each oscillation cycle to compensate for each reduction in the length of the tool or element.

Where the floating holder is operating on a vertically undulating work surface, the holder and its fulcrum axis will rise and fall, while rotatably oscillating on said axis, in following said surface undulations, through the medium of the depending tool or element rigid with the holder that contacts and follows said surface undulations.

Specific sizes or dimensions and certain wiring and other details appear herein merely as examples, not as of the essence of the invention.

While a specific example embodiment has been disclosed in great detail, for purposes of explanation, it is to be understood that the instant inventive concept may be reduced to various other modified and mechanical embodiments within the spirit and scope of the following claims.

What we claim is:

1. Apparatus for producing indicia markings on work surfaces by the action of electric arcs established and extinguished between the work surface and a vibratory electrode where the surface and electrode are included in an electrical etching circuit, said apparatus including an electrode holder providing an arm extending laterally beside and spaced from said

surface; an electrode arranged transversely of said arm and fixed thereto and projecting laterally therefrom toward said surface to space the arm therefrom and limit the movement of the arm toward said surface; said arm being oscillatory toward and from said surface to contact said electrode therewith and to withdraw the same therefrom on each oscillation cycle; means rendering said holder bodily feedable toward said surface on each oscillation cycle to compensate for electrode consumption; and vibratory motor means operatively connected with said holder to oscillate the same.

2. An apparatus for marking indicia on a work surface, comprising a holder rotatably oscillatory on a transverse fulcrum line, a vertically-disposed tool or element radially remote from said line and fixedly secured to said holder against relative movements and depending therefrom to strike and retreat from said surface during said holder oscillations and to limit the movements of the holder toward the work surface; said holder having a fixed lever arm radially arranged with respect to said line; and a motor provided with and actuating an oscillatory member operatively coupled to said lever arm to actuate the same and oscillate said holder on said fulcrum line, said holder with its fulcrum line being relatively movable as a unit toward and from said surface with respect to said member.

3. An apparatus for marking indicia on a work surface, comprising a tool or element holder rotatably oscillatory on a transverse fulcrum line, a tool or element fixed to said holder transversely thereof and against relative movements; a vibratory motor including vibratory spring means; and an operative driving connection between said motor spring means and said holder for positively oscillating said holder on said line to force said tool against said surface and to raise the same therefrom on each oscillation cycle; said holder being floatable toward and from said surface through the medium of the tool engaging said surface, while said holder rotatably oscillates on said fulcrum line.

4. Apparatus for producing indicia markings on work surfaces, comprising a holder provided with an electrode normally fixed thereto against relative movements with its longitudinal axis maintained substantially perpendicular to the plane of the work surface to be operated on; means rendering said holder and its electrode bodily movable as a unit toward and from said surface, said holder being rotatably oscillatory on a transverse fulcrum line shiftable toward and from said surface with said holder; and actuating means for rotatably oscillating said holder on said fulcrum line to engage the electrode against and carry it from contact with said surface on each oscillation cycle.

5. Apparatus for permanently producing indicia markings on a work surface, comprising a bell crank holder rotatably oscillatory on a transverse axial line, said holder provided with a tool radially remote from said line and depending from said holder and fixed thereto to strike the work surface and thereby limit the movement of the holder toward said surface and uphold the same therefrom; a vibratory motor operatively coupled to said holder to rotatably oscillate the same on said axial line to cause said tool to strike said surface and recede therefrom on each oscillatory cycle, and means rendering said holder and its tool relatively floatable on said surface with respect to said motor.

6. An electric arc etcher for producing indicia markings on a work surface, comprising an electrode holder under constant urge to feed toward the work surface; a replaceable consumable electrode normally fixed to said holder and arranged transversely thereof and projecting therefrom toward the work surface to contact the same and limit the movement of the holder toward said surface, said holder being also oscillatory on a transverse fulcrum line radially remote from said electrode; vibratory motor means for oscillating said holder on said fulcrum line to contact said electrode with and withdraw the same from said surface, and means rendering said holder bodily feedable toward the work surface to compensate for reduction in electrode length during the oscillations of said holder on said line.

7. Apparatus for producing indicia markings on work surfaces, comprising vibratory electromagnetic motor means including a laterally oscillatory armature and its spring arranged substantially perpendicular to the work surface to be operated on; an electrode holder adapted to fixedly carry an electrode substantially perpendicular to said work surface and projecting from the holder toward said surface, said holder being oscillatory on a transverse axis to carry said electrode into contact with and away from said surface, said holder including a lever portion substantially parallel with said armature spring and operatively connected therewith to oscillate said holder on said axis.

8. Apparatus for producing indicia markings on a work surface, comprising a tool holder rotatably oscillatory on a transverse fulcrum line substantially parallel to the work surface to be operated on, a tool fixed to said holder radially remote from said line and projecting from said holder toward said surface to strike and recede from said surface during each oscillatory cycle of said holder, and vibratory electromagnetic motor means that includes a transversely oscillatory armature and its vibratory spring, said armature and spring when at rest being located at the median point between the amplitude limits of its oscillation cycles; and a direct operative cross connection from said armature to said holder to positively oscillate the holder in accordance with the oscillations of said armature.

9. An electric arc etcher for producing marks on work surfaces, comprising an electrode holder provided with an electrode fixedly held thereby and projecting therefrom toward and normally substantially perpendicular to the work surface to be operated on, said holder being oscillatory to carry said electrode endwise into holder-arresting contact with said surface and to lift the same therefrom for the formation and quenching of a succession of surface marking electric arcs; and vibratory motor means providing oscillatory cycles of constant frequency and amplitude for correspondingly oscillating said holder, and means cooperating with said holder and rendering the same bodily feedable toward said work surface with respect to said motor means, during said holder oscillations.

10. An electric arc etcher comprising a support; an oscillatory electrode holder movably confined to said support and provided with a normally fixed electrode movable with respect to said support to contact and retreat from the

work surface; an electromagnetic vibratory motor mounted on said support independently of said holder; vibration transmission means from said motor to said electrode holder; means rendering said holder relatively bodily movable as a unit toward and from said surface with respect to said motor and said transmission means; means for including said holder and its electrode in an electric etching circuit; and means for including said motor in a motor energizing electric circuit.

11. An electric arc etcher comprising an electrode holder rotatively oscillatory on a transverse axis, said holder providing arms substantially radial with respect to said axis; an electrode normally fixed to one of said arms, said rotative oscillations of said holder establishing and quenching etching arcs between the electrode and the work surface; vibratory motor means operatively associated with said holder to oscillate the same on said transverse axis; and mounting and controlling means rendering said holder relatively bodily movable vertically as a unit with its electrode and axial line with respect to said motor means, the downward bodily movements of said holder being limited by the contact of said electrode with the work surface.

12. The organization described by claim 11, where a vibratory motor fixedly mounted with respect to the oscillatory electrode holder is provided and operatively and slidably associated with an arm of said holder other than the arm to which the electrode is fixed, for rotatively oscillating said holder on its transverse axis, with means provided for relative movements of said holder toward the work surface with respect to said motor during holder oscillations.

13. An electric arc etcher, comprising a vertically-movable downwardly-feedable electrode holder provided with an electrode, the vertical movements of said electrode being coextensive with the vertical movements of the holder carrying the same, the contact of the electrode with the work surface to be etched limiting the feeding movement of said holder toward the work, said holder being oscillatory on a transverse axis to longitudinal vibrate said electrode to alternately contact and then lift from said surface for establishing and then quenching surface-etching arcs; a vibratory motor; and a transversely vibrating member actuated by said motor and operatively coupled to said holder to permit relatively vertical downward feeding sliding movements of the holder while said member rotatably oscillates the holder, said holder being free to feed downwardly with respect to said member to compensate for the electrode lengths consumed by said arcs.

14. An electric arc etcher, comprising an electrode holder bodily feedable downwardly toward the work surface and including a vertically-disposed lever arm and a laterally extending arm provided with a vertically disposed depending electrode normally fixed to said lateral arm against relative vertical movements to strike the work surface and thereby limit the downward movement of the holder, said holder being rotatably oscillatory on a transverse fulcrum line; and a vibratory motor provided with and actuating a holder vibrating member, said member vibrating transversely with respect to said lever arm and confined thereto to rotatably oscillate the holder on said fulcrum line.

15. Apparatus for producing indicia markings on work surfaces, comprising an element holder provided with a surface-contacting element normally rigid therewith and projecting therefrom toward said surface, said holder being oscillatory on a transverse fulcrum axial line to contact said element with the work surface and lift the same therefrom, means rendering said element holder with its element and said axial line flotable as a unit on said surface through the medium of said element contacting said surface and upholding said holder; and vibratory motor means for oscillating said holder.

16. An electric arc etcher, comprising a bodily vertically movable electrode holder that includes a cross head defining a transverse axis vertically shiftable with and on which said holder is rotatably oscillatory, arms fixed with respect to said cross head and substantially radiating from said axis, one of said arms provided with a fixedly-held depending vertically disposed electrode; vibratory motor means operatively coupled to another of said arms to oscillate said holder on said axis and to permit relatively bodily feeding movements of said holder toward the work surface; and guide means for said cross head confining the same to substantially straight-line bodily movements toward and from the work surface.

17. An electric arc etcher, comprising a bodily vertically-movable electrode holder adapted to fixedly carry a replaceable vertically-disposed electrode for striking the work surface and limiting the downward movement of the holder, said holder being rotatably oscillatory on a transverse axial line to carry said electrode into contact with and upward retreat from the work surface, said holder including a lever arm; a vibratory motor; and a member vibrated by said motor in a fixed path transversely with respect to said arm and provided with a bore through which said arm is relatively longitudinally slidable as said holder moves vertically, and in which said arm is confined to vibrate laterally with said transverse vibrations of said member.

18. An electric arc etcher, comprising supporting means; an electrode holder provided with a depending electrode; motor-actuated means for oscillating said holder to cause said electrode to contact and retreat from the work surface, said holder and its electrode being bodily movable as a unit to and from operative position with said electrode in operative relation to said surface, and to elevated inoperative position with said electrode raised from operative relation to said surface; lifting means to elevate and temporarily maintain said holder and electrode in said elevated inoperative position; and manually controlled means for releasing said holder from the lifting action of said lifting means, to permit return of the holder to operative position.

19. An electric etching head and the like, comprising a supporting housing; an electrode holder carried by said housing and provided with a depending electrode for operation on a work surface located below said housing; vibratory motor means for oscillating said holder to vibrate said electrode in operative relation to said surface; means carried by said housing rendering said holder and its electrode vertically movable as a unit toward operative position and upwardly from operative position; spring-actuated holder lifting means for elevating and yieldingly upholding said holder and its electrode in inoperative position, and manually operated means for

holding said lifting means depressed, while said holder and its electrode are in operative position.

20. The organization described by claim 11, where said electrode holder includes a transverse cross head the longitudinal axis of which is substantially coincident with said transverse axis on which said holder is rotatively oscillatory with said arms relatively fixed with respect to said cross head, with guide means confining said cross head to substantially straight line bodily vertical movements.

21. An etcher for producing indicia markings on a work surface, comprising a holder rotatively oscillatory on a transverse axis, said holder providing arms substantially fixed and radial with respect to said axis, one of said arms being arranged substantially longitudinally of the work surface and the other arm substantially perpendicular to said surface; holder-oscillating vibratory motor means operatively coupled to said perpendicular arm for relative movements longitudinally with respect to said perpendicular arm; a work-surface contacting element normally fixed to the other arm and held thereby normally perpendicular to said work surface to endwise contact and recede therefrom during said holder oscillations; and holder mounting and guiding means rendering said holder relatively bodily movable as a unit with said element and the axial line of said transverse axis, toward and from said surface.

22. An electric arc etcher comprising a support; an electrode holder mounted on said support and adapted to fixedly carry a depending vertically disposed electrode, said holder being rotatably oscillatory on a transverse axis, said holder and its axis and electrode being vertically movable as a unit; vertical laterally-spaced guides fixed to said support; said holder including a cross head arranged transversely between said guides and at its ends fitting the same to freely slide vertically thereon, said cross head establishing said axis on which said holder rotatably oscillates, the cross head ends that fit said guides being capable of limited rotative oscillatory movements thereon; and a vibratory motor operatively coupled to said holder to rotatably oscillate the same.

23. An electric arc etcher for producing indicia markings on metal work surfaces through the medium of surface-burning arcs established and extinguished by closing and breaking an electric etching circuit between the work surface and an oscillating electrode during relative parallel lateral movements between the electrode and said surface; said etcher comprising electromagnetic motor means including a coil, an armature and its oscillatory spring, and an alternating electric power current of a character to actuate said armature on short amplitude oscillations of an arc-etching-frequency of the order of 100 to 200 per second where the normal position of said armature when at rest is midway between the opposite amplitude limits of its oscillatory cycles; an electrode holder rotatably oscillatory on a transverse fulcrum line substantially parallel with the work surface; an electrode fixedly located on said holder at a point remote from said line and projecting therefrom toward said work surface to strike and recede from said surface during each oscillation cycle; and means operatively connecting said armature to said holder to correspondingly oscillate said holder on said fulcrum line.

24. An electric arc etcher for producing indicia markings on a work surface of electrical conducting material; comprising an electrode mounted for oscillation to contact and withdraw from said surface to establish and extinguish a surface marking arc during each oscillation cycle; vibratory means for oscillating said electrode on relatively short amplitude cycles with the formation of said arcs, said means including an energizing-electric-current actuated electro-magnet and a complementary oscillatory armature having a vibratory resilient supporting spring, said armature propelling said electrode on its oscillatory cycles and determining the speed and amplitude thereof, said oscillatory armature and its vibratory spring comprising a spring system, said spring system being characterized by a relatively high rate of natural frequency vibration cycles per second as related to the frequency per second of the energizing current of said electro-magnet; means for providing said magnet with said energizing electric current characterized by a low rate of frequency vibration cycles per second as related to said natural vibration rate per second of said spring system, for the production of relatively short amplitude electrode oscillation cycles with relatively long time duration arcs, said energizing current being also characterized by its substantially constant-amplitude frequency cycles, each of which passes through magnet energizing and magnet zero values; and circuit means for establishing an etching electric current that includes said electrode and said work surface.

25. An electric arc etcher for producing indicia markings on a work surface of electrical conducting material; comprising an electrode mounted for oscillation to contact and withdraw from said surface to establish and extinguish a surface marking arc during each oscillation cycle; vibratory means for oscillating said electrode on relatively short amplitude cycles with the formation of said arcs, said means including an energizing-electric-current actuated electro-magnet and a complementary oscillatory armature having a vibratory, resilient, supporting spring, said armature propelling said electrode on its oscillatory cycles and determining the speed and amplitude thereof, said oscillatory armature and its vibratory spring comprising a spring system, said spring system being characterized by a relatively high rate of natural frequency vibration cycles per second as related to the frequency per second of the energizing current of said electro-magnet; means for providing said magnet with said energizing electric current characterized by a low rate of frequency vibration cycles per second as related to said natural vibration rate per second of said spring system, for the production of relatively short amplitude electrode oscillation cycles with relatively long time duration arcs, said energizing current being also characterized by its substantially constant-amplitude frequency cycles, each of which passes through magnet energizing and magnet zero values, whereby during zero values the power of the magnet is less than the power of the spring system; and circuit means for establishing an etching electric current that includes said electrode and said work surface, with said electrode oscillation cycles so phased with respect to said etching current that said electrode will not be lifted from said work surface when said etching current is passing through zero value.

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