

March 9, 1965

C. J. HELMS

3,172,352

PRINTING HAMMER ASSEMBLY

Filed May 13, 1963

2 Sheets-Sheet 1

Fig. 1

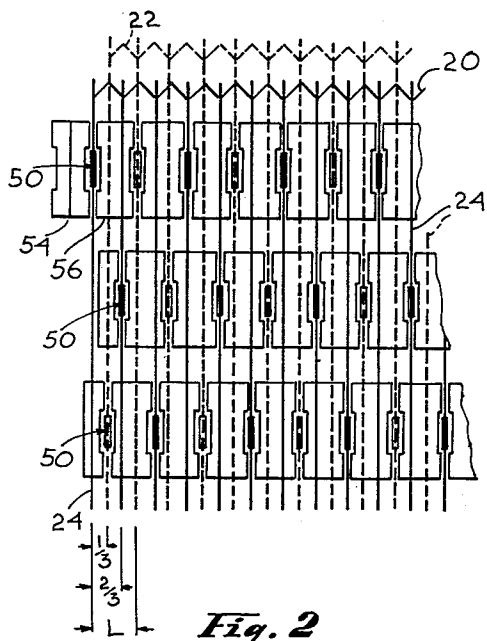
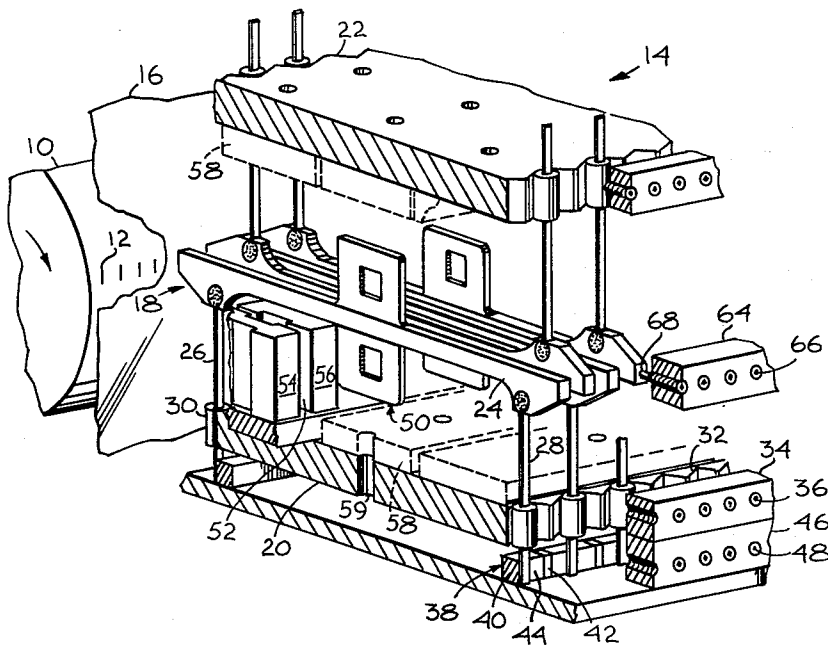


Fig. 2

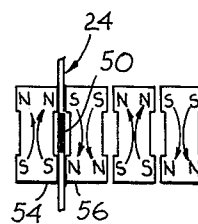


Fig. 3

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2 Sheets-Sheet 2

Fig. 6

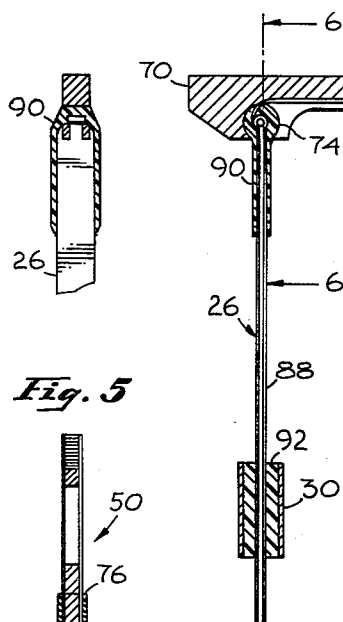


Fig. 5

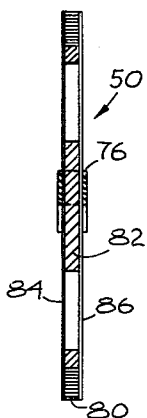


Fig. 4

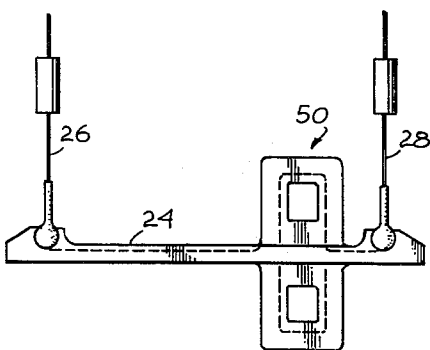
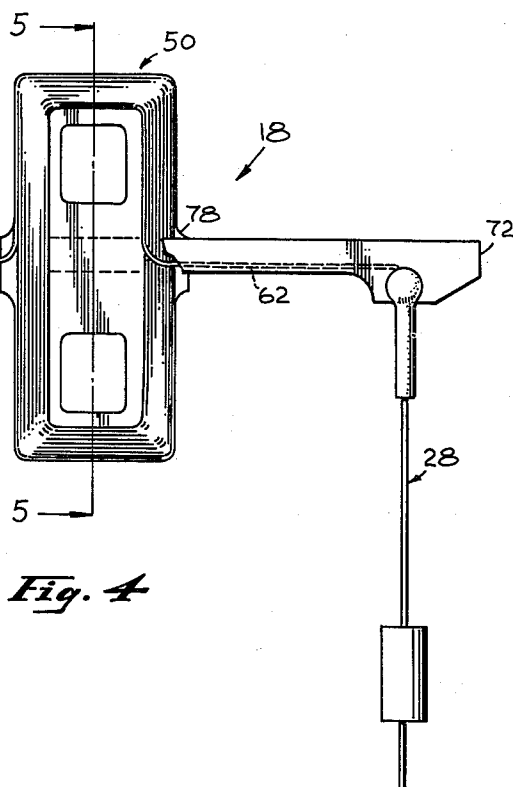
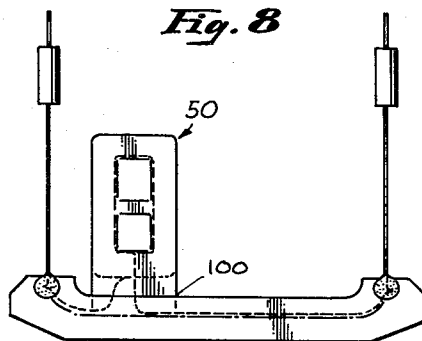


Fig. 7

Fig. 8



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1

3,172,352

PRINTING HAMMER ASSEMBLY

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13 Claims. (Cl. 101-93)

This invention relates generally to electrically controlled high speed printing apparatus, and more particularly to an improved electromagnetically operated hammer assembly for use in such apparatus.

High speed printing devices utilizing rotating type drums are well known in the prior art. Typically, such drums are provided with alphabetic and/or numeric printing characters which are provided in columnar fashion around the periphery of the drum. More particularly, the drum is provided with a plurality of circumferential tracks equal to the maximum number of characters to be printed on any one line and each such track includes one full set of characters which the particular printing device is adapted to print.

In such printing devices, a printing hammer is associated with each circumferential track and mounted such that it can be caused to strike a selected character during the rotation of the drum in response to appropriate control signals. An inked ribbon and a paper strip upon which data is to be printed are positioned between the drum and hammers. Each hammer, when actuated, strikes the back of the paper strip thereby forcing the paper strip against the ribbon, and the ribbon in turn against the character on the drum to consequently print the selected character on the front of the paper strip.

In high speed printing devices of this type, a control system is provided which functions to appropriately actuate the various hammers at the proper line during each rotation of the drum so that one line of type can be printed on the paper strip during each rotation. In this manner, such printing devices can be caused to print at rates in excess of 1,000 lines per minute.

Typical prior art hammer assemblies consisted of a movable impact device (hammer) which was associated with a solenoid such that upon energization of the solenoid coil, a solenoid armature would be driven against the impact device to thereby cause the impact device to strike the paper. In attempting to significantly increase the speed of printing devices, problems arose involving the coupling between the solenoid armature and the impact device and consequently, an improved hammer assembly was introduced, as disclosed in U.S. Patent No. 3,087,421. The hammer assembly disclosed therein avoided coupling problems between a solenoid armature and an impact device by mounting a magnetic coil directly on the impact device and associating the coil with an external magnetic field in such a manner that energization of the coil caused the coil to be moved thereby propelling the impact device against the paper strip. This hammer assembly represents a significant advance over previously known hammer assemblies inasmuch as it affords much greater positive control over the hammer operation. Nevertheless, because of its construction and the manner in which this hammer assembly is mounted, its reliability is still somewhat less than optimum. More particularly, after an extended period of use, the relative travel times of the several impact devices vary so as to cause the misalignment of printed characters.

That is, if the travel time of a hammer increases, the hammer will strike the paper strip when the selected character on the drum has moved slightly past the position of the line to be printed so that the printed character will appear slightly below the other charac-

2

ters on the line. Many prior art hammer assemblies frequently suffer from variations in travel time which are generally due to variations in propelling and retarding forces such as friction and also to the distance over which the hammer is required to travel. Travel distance variations generally result from wear caused by the use of the hammer over an extended period (an extended period frequently can be as short as 2 hours of continuous operation).

In view of the above, it is an object of this invention to provide an improved hammer assembly which is less subject to variations in travel time than heretofore known hammer assemblies.

In addition to requiring that the hammer travel time remain substantially constant over a period of extended use, it is desirable to provide hammer assemblies which are capable of rapidly recovering after each actuation. That is, since the line per minute rate at which printing devices can be operated is determined to a great extent by the frequency at which the hammer assemblies can be actuated, it is desirable to minimize the time which must be allowed between successive actuations.

In addition to travel and recovery time considerations involved in the design of hammer assemblies, many prior art hammer assemblies have proved to be unsatisfactory because their utilization involved complex packaging considerations. That is, certain prior art hammer assemblies are exceedingly cumbersome and as a result, it has been extremely difficult to package the hammer assemblies such that they can be spaced as closely as desired.

In view of this, it is an object of this invention to provide an improved and less expensive hammer assembly which can be more compactly and accurately arranged in a stack of such assemblies, for use in a printing device, than heretofore known hammer assemblies.

Briefly, the invention herein is based on the recognition that improved hammer performance can be achieved by employing a single movable element comprising an impact or hammer portion of a hammer assembly which is mounted on support members that function as conductors for a magnetic coil carried by the movable element.

More particularly, in a preferred embodiment of the invention, an elongated shank is provided which carries a coiled electrical conductor arranged so as to define an axis extending perpendicularly to the elongation of the shank. The coil is disposed in a magnetic field established by opposed permanent magnets, such that when the coil is energized, it generates a magnetic field which interacts with the magnetic field of the permanent magnets to propel the shank against a paper strip and into contact with the ribbon positioned adjacent a rotating type drum.

The shank is supported in spaced relation to a support base by a pair of conductive spring members which permit the shank to be moved in a substantially parallel path with respect to the support base. In addition, the spring members are connected to the terminals of the coil carried by the shank. Consequently, the application of an electrical potential across the spring members energizes the coil to thereby propel the shank in the manner indicated.

As a result of relying solely on the spring members to support the shank, drag due to friction encountered in prior art devices is substantially eliminated. Moreover, the unique shank mounting permits the shanks to be supported above a lower support base or in a depending manner from an upper support base. Consequently, the hammer assemblies can be more closely and conveniently

3

spaced than in prior art devices by interleaving hammer assemblies supported from both bases.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view, partially broken away, illustrating a stack of hammer assemblies and showing the relationship between the assemblies and a rotating type drum;

FIGURE 2 is a schematic illustration indicating the manner in which hammer assemblies are arranged in a stack;

FIGURE 3 is a plan view illustrating the manner in which the permanent magnets can be arranged and related to hammer assemblies in a stack;

FIGURE 4 is a front view, partially broken away, of a preferred hammer assembly embodiment;

FIGURE 5 is a vertical sectional view taken substantially along the plane 5-5 of FIGURE 4;

FIGURE 6 is a vertical sectional view taken substantially along the plane 6-6 of FIGURE 4;

FIGURE 7 is a front view of a variation of the hammer assembly embodiment shown in FIGURE 4; and

FIGURE 8 is a front view of a second hammer assembly embodiment.

Attention is now called to FIGURE 1 of the drawings which illustrates a perspective view of a portion of a high speed printing device including a rotatable type drum 10 on which are distributed a plurality of printing characters 12, and a hammer assembly stack 14 positioned adjacent the drum 10. A paper strip 16 which is to be printed upon, is positioned between an inked ribbon (not shown) disposed adjacent the drum surface, and the hammer assembly stack.

As previously indicated, the drum 10 is provided with a number of circumferential tracks equal to the maximum number of characters which are to be printed on any one line on the paper strip. Each of these tracks has distributed thereon one set of all of the printing characters which the printing device is able to print. The hammer assembly stack 14 includes a number of hammers equal to the number of circumferential tracks on the drum and of course also equal to the maximum number of characters to be printed on any one line.

In the conventional operation of the printing device of FIGURE 1, the drum 10 rotates continuously. Means (not shown) are provided for incrementally moving the paper strip 16 one line at a time through the gap between the hammer assembly stack 14 and the drum 10. The hammers are selectively actuated to cause them to strike the paper strip 16 the instant the character desired to be printed is in alignment with the hammer. Consequently, one full line can be printed on the paper strip 16, for every rotation of the drum 10. If desired of course, a plurality of sets of characters can be provided in each track on the drum and as a consequence thereof, a plurality of lines could be printed for each drum rotation.

The hammer assembly stack 14 includes a plurality of hammer assemblies 18. In the preferred embodiment of the invention, a first group of the hammer assemblies 18 are supported on a lower support base 20 while a second group of hammer assemblies 18 are dependently supported from an upper support base 22.

Each of the hammer assemblies 18 includes a shank portion 24 carried by a pair of support members 26 and 28. The support members 26 and 28 can comprise flat electrically conductive spring members and each is provided with a circular cylindrical sleeve 30. The sleeves 30 are adapted to be received in open V-shaped receptacles 32 defined in the support bases 20 and 22.

A holding screw block 34 is fixedly mounted adjacent

4

the open V-shaped receptacles 32 in the support bases. The block 34 defines a plurality of openings 36 therein which are respectively in alignment with the V-shaped receptacles in the support bases. The holes 36 are adapted to receive holding screws adapted to urge the sleeves 30 toward the vertex of the V-shaped receptacles and consequently very accurately position the support members 26 and 28.

The conductive support members 26 and 28 extend through the sleeves 30 and terminate adjacent a terminal block 38 which includes a plurality of conductive sections 40 separated by insulative spacers 42. Conductors 44 are respectively connected to the conductive sections 40. A connector screw block 46 is fixedly mounted adjacent the terminal block 38 and is provided with openings 48 in alignment with the terminal portions of the support members 26 and 28. The holding screw block openings 48 are adapted to receive holding screws therein for the purpose of forcing the terminal portions of the support members 26 and 28 into electrical contact with the terminal block conductive sections 40.

Each of the printing hammer assemblies 18 has an electrically energizable magnetic field producing element, preferably in the form of an electrical coil assembly 50, carried on the shank 24 thereof. The coil assembly 50 is of flat configuration and adapted to pass between a gap 52 defined between opposed permanent magnets 54 and 56.

Upper and lower pairs of permanent magnets including magnets 54 and 56 are provided for each hammer assembly 18 in the stack 14. The pairs of opposed permanent magnets are mounted in a staggered fashion as illustrated in FIGURES 2 and 3, on mounting strips 58. That is, the permanent magnets supported on the upper and lower mounting strips closest to the drum 10 define gaps every unit length (L), the magnets on the center upper and lower mounting strips define gaps at points in alignment with $\frac{2}{3}$ L and the magnets on the mounting strips furthest from the drum define gaps at points in alignment with $\frac{1}{3}$ L. The hammer assemblies are alternately supported from the upper and lower support bases 22 and 20. The shanks 24 of assemblies supported from the upper base 22 are represented by dotted lines in FIGURE 2 and the shanks 24 of assemblies supported from the lower base 20 are represented by solid lines.

The mounting strips 58 and support bases 20 and 22 are respectively provided with aligned holes 59 for permitting air to flow through the hammer assembly stack in order to alleviate any heating problems which might otherwise occur. The holes also permit the use of air pressure means (not shown) to assure that dust, which might introduce frictional effects, is excluded from the hammer assembly stack.

Conductor ends 60 and 62 (FIGURE 4) of a coiled electrical conductor disposed in the coil assembly 50 pass through the shank 24 and are respectively connected to the support members 26 and 28. Consequently, when an electrical potential is applied across the support members 26 and 28, as by selectively applying a potential to the conductors 44, a current is initiated in the coil which establishes a magnetic field in a direction perpendicular to the elongation of the shank 24. In accordance with well known magnetic principles, the interaction between the magnetic field so generated by the coil and the magnetic field established by the opposed permanent magnets 54 and 56 will cause the coil assembly 50 to be moved either between the opposed north and south poles on the magnets 54 and 56 respectively or the opposed south and north poles on the magnets 54 and 56 respectively depending upon the direction of current in the coil. Inasmuch as the coil assembly 50 is carried by the shank 24, such movement will impart movement to the shank 24, causing the spring support members 26 and 28 to bend about the anchored sleeves 30 secured thereto. The shanks 24 are positioned adjacent the paper strip 16 such that the mo-

5

tion imparted to the shanks 24 by virtue of the interaction between the magnetic fields causes the shanks 24 to strike the back face of the paper strip 16 which in turn engages the ink ribbon (not shown) which causes the character on the drum 10 beneath the striking shank to be printed on the front face of the paper strip 16.

As noted, a first end of each shank 24 is positioned adjacent the paper strip 16. A backstop block 64 is positioned adjacent the second end of each of the shanks 24. The backstop block 64 defines a plurality of openings 66 which are respectively aligned with the second ends of the shanks 24. The openings 66 are adapted to receive locating screws 68 which engage the second ends of the shanks 24 when the shank is at rest. It should be appreciated that the position at which the shanks 24 reside when in their rest state is critical inasmuch as it determines the distance which the shank must travel in order to strike the paper strip 16 and consequently, the travel time of the shank. As previously noted, if the travel time varies, the characters printed on each line of the paper strip 16 will not be in alignment.

Attention is now called to FIGURES 4 through 6 which illustrate in detail a preferred embodiment of the hammer assembly 18. The hammer assembly 18 includes a shank portion 24 which is symmetric about perpendicular vertical center planes drawn therethrough. As a consequence, either a first end 70 or a second end 72 of the shank 24 can act as an impact tip for striking the paper strip 16. Each of the ends 70 and 72 is flat and is backed by solid shank material, the shank being formed of a low mass material such as aluminum. The upper surface of the shank 24 is flat while the lower surface defines channels therein extending between rounded receptacles 74 and a central opening 76 extending from the upper to the lower shank surface.

The coil assembly 50 is received in the opening 76 and is secured therein, as by solder means 78. The coil assembly 50 is caused to extend beyond the upper and lower surfaces of the shank 24 by equal amounts so as to balance the shank about a horizontal center plane drawn therethrough to thereby avoid any tendency of the shank to pivot as it is propelled into engagement with the paper 16 against the drum 10. It is desirable to avoid any imbalance in the shank because resulting pivoting would tend to stress the support members 26 and 28 after a certain period of use.

The coil assembly includes a coil 80 formed of flat insulated wire. It is preferable to utilize flat wire because in a coil so formed, it is not possible for any of the coil turns to be buried. The presence of buried coil turns raises the likelihood that hot spots will be developed in the coil which would cause the coil resistances to be varied and as a consequence result in variations in the currents driven therethrough by constant voltages. Of course, current variations are undesirable inasmuch as the strength of the magnetic field generated by a current driven through the coil depends upon the magnitude of the current. Variations in magnetic field strength will in turn vary the shank travel time inasmuch as the force on the coil assembly 50 and consequently the shank 24, depends upon the interaction and strength of the magnetic field generated by the coil assembly and the magnetic field produced by the permanent magnets. The coil 80 is fitted around a spacer 82 which serves to space a pair of coil skins 84 and 86.

The support members 26 and 28 comprise flat conductive spring members which are preferably coated with a rubber or epoxy film 88 which serves as a damping agent functioning to quickly damp out any vibrations which develop as a result of the shank 24 being bounced back against the locating screw 68 after striking the paper strip 16. As previously pointed out, it is desirable that the shank 24 come to rest as quickly as possible in order to rapidly permit the hammer assembly 18 to be actuated again. The upper terminal portion of the support mem-

6

bers 26 and 28 is potted in a material (e.g. epoxy) which secures the members in the receptacles 74 provided on the lower surface of the shank 24. The conductors 60 and 62 are connected to the coil 80 and extend through the channels defined on the underside of the shank 24 and are soldered in the area of the receptacles 74 to the conductive spring members 26 and 28 respectively.

The sleeves 30 are secured to the support members 26 and 28 by an epoxy substance 92 disposed therebetween.

In order to compactly package the hammer assemblies 18 in the stack 14, it has been indicated that a first group of hammer assemblies 18 can be dependently supported from a support base 22 while a second group of the hammer assemblies can be supported on a support base 20 such that the first and second groups are interleaved. In addition, it has been indicated, in FIGURE 3, that the permanent magnet pairs can be mounted in three rows to permit adjacent hammer assemblies to be spaced very closely. In order to utilize a permanent magnet mounting arrangement as shown in FIGURE 3, it is necessary to provide hammer assemblies 18 in which the coil assemblies 50 are positioned at different points along the shank. Although it initially appears that three different hammer assembly arrangements are necessary, that is one hammer assembly in which the coil assembly 50 is located at a point midway between the ends, and two other hammer assemblies in which the coil assemblies are respectively located closer to the first and second ends, it becomes apparent that due to the symmetry of the proposed hammer assemblies only two different hammer assemblies are required. More particularly, in addition to the hammer assembly shown in FIGURE 4 in which the receptacle 76 is provided midway between the first and second ends 70 and 72 of the shank 24, a hammer assembly is provided, as shown in FIGURE 7 which is adapted to receive the coil assembly 50 closer toward one end thereof. By appropriate manipulation of the hammer assemblies of FIGURES 4 and 7, the hammer assembly stack 14 of FIGURE 1 can be formed with half of the hammer assemblies in a first group supported from base 20, and half of the hammer assemblies in a second group supported from base 22. In each of the hammer assembly groups, one-third of the hammer assemblies would have their coil assembly 50 positioned midway between the first and second ends of the hammer assemblies while one-third of the hammer assemblies will have their coil assemblies positioned adjacent the first or impact end 70 of the shank 24 and another one-third of the assemblies will have their coil assemblies 50 positioned adjacent the second or rear end 72 of the shank 24.

Attention is now called to a second embodiment of the invention illustrated in FIGURE 8. The second embodiment of the invention is similar to the embodiment already discussed, except however that in lieu of providing an opening 76 extending through the shank 24, a receptacle 100 is provided in the lower surface of the shank for partially receiving the coil assembly 50. Where such an arrangement is utilized, it is convenient to provide only two pairs of permanent magnets for each hammer assembly. That is, whereas permanent magnet pairs are preferably positioned above and below the shank 24 of the embodiment of FIGURE 4, a permanent magnet pair need only be provided on one side of the shank of the embodiment of FIGURE 8. However, in the hammer assembly embodiment of FIGURE 8, an undesirable unbalanced condition will exist with respect to the shank unless the shank is weighted adjacent the surface thereof opposite to the surface carrying the coil assembly, for compensating for the weight of the coil assembly. As should be apparent, the upper surface of the shank illustrated in FIGURE 8 has been built up for this purpose.

It is pointed out that in both of the embodiments illustrated, the structural joint between the support members 26 and 28 and the shank 24 is out of the direct line of impact of the shank. More particularly, it is to be noted

that when the shank 24 is propelled substantially linearly against the paper strip 16, the flat end 70 will strike the paper against the drum thereby stressing the shank. However, the stressing force will be transmitted substantially linearly through the shank and by positioning the joints below the flat or impact tip of the shank 24, any detrimental effects on the joints will be minimized.

From the foregoing, it should be apparent that an improved printing hammer assembly apparatus has been disclosed herein in which all factors normally causing travel time variations have been minimized. More particularly, the hammer assembly is characterized by the utilization of only one movable element, the element being able to move free of any rubbing friction. This ability is achieved by utilizing conductive spring members to support a movable shank or impact device carrying a coil thereon in association with a magnetic field. In this manner, deleterious friction forces typically present in previously known hammer assemblies have been eliminated. In addition, by supporting the shank in the manner indicated, a compact hammer assembly stack can be provided utilizing only two different types of hammer assemblies.

What is claimed is:

1. A hammer assembly comprising a shank; electrically energizable means secured to said shank for generating a first magnetic field; a support base; a pair of electrically conductive support members secured between said support base and said shank; conductive means connecting said support members to said electrically energizable means; and means for establishing a second magnetic field adapted to interact with said first magnetic field generating means.

2. A printing hammer for use in a high speed printing apparatus comprising a shank; electrically energizable means secured to said shank for generating a first magnetic field; a support base; support means attached between said base and said shank for supporting said shank at a distance spaced from said base and for permitting said shank to be moved relative to said base; said support means comprising a pair of electrically conductive support members; conductive means connecting said support members to said electrically energizable means; and means for establishing a second magnetic field adapted to interact with said first magnetic field for propelling said first magnetic field generating means.

3. A printing hammer for use in a high speed printing apparatus comprising a shank; electrically energizable means secured to said shank for generating a first magnetic field; a support base; a pair of spaced electrically conductive spring support members secured between said base and said shank for spacing said shank from said base and for permitting relative substantially parallel movement therebetween; conductive means connecting said support members to said electrically energizable means; and means for establishing a second magnetic field adapted to interact with said first magnetic field for propelling said first magnetic field generating means.

4. A printing hammer for use in a high speed printing apparatus comprising an elongated shank; electrically energizable means secured to said shank for generating a first magnetic field in a direction perpendicular to the elongation of said shank; a support base; a pair of electrically conductive support members secured to said base and said shank for supporting said shank in spaced relation to said base; conductive means connecting said support members to said electrically energizable means; and means for establishing a second magnetic field in a direction perpendicular to the elongation of said shank and adapted to interact with said first magnetic field for propelling said first magnetic field generating means.

5. A printing hammer for use in a high speed printing apparatus comprising an elongated shank having first and second ends and an impact tip on at least one of said ends; an electrical coil assembly secured to said shank

between said ends and having an axis extending perpendicularly to the elongation of said shank; said electrical coil assembly including a coiled conductor having first and second ends; a support base; a pair of spaced electrically conductive spring members secured between said base and said shank for spacing said shank from said base and for permitting relative substantially parallel movement therebetween; conductive means respectively connecting said spring members to said first and second coil ends; and means for establishing a magnetic field adapted to move said shank in response to the application of an electrical potential between said spring members.

6. The hammer of claim 5 wherein said shank is provided with an opening extending therethrough and said electrical coil assembly is secured in said opening and extends by equal amounts in opposite directions from said shank to thereby balance said shank.

7. The hammer of claim 6 wherein said shank is provided with channels extending between said opening and said spring members for receiving said conductive means.

8. The hammer of claim 5 wherein said shank is provided with a receptacle extending into one surface thereof and a portion of said electrical coil assembly is secured in said receptacle.

9. The hammer of claim 8 wherein said shank is weighted adjacent the surface thereof opposite to that provided with said receptacle to thereby compensate for the weight of said coil assembly.

10. The hammer of claim 9 wherein said shank is provided with channels extending between said receptacle and said spring members for receiving said conductive means.

11. A high speed printing apparatus comprising a movable surface having a plurality of printing characters distributed thereon; a plurality of printing hammer assemblies positioned in operative association with said movable surface; each of said printing hammer assemblies including an elongated shank having first and second ends; electrically energizable means secured to each of said shanks for generating first magnetic fields; spaced first and second support bases; a pair of electrically conductive support members attached to each of said shanks; means for securing the support members attached to a first group of said shanks to said first support base extending toward said second support base; means for securing the support members attached to a second group of said shanks to said second support base extending toward said first support base; said first and second groups of shanks being aligned and interleaved; conductive means in each of said shanks for connecting the electrically energizable means secured thereto between the conductive support members attached thereto; and means associated with each of said shanks for establishing a second magnetic field adapted to interact with the first magnetic field generated by the means secured to the shank for propelling the shank against said movable surface.

12. The apparatus of claim 11 wherein a cylindrical sleeve is secured on said support members and said support bases are provided with V-shaped receptacles; said sleeves being disposed in said V-shaped receptacles; and means for urging said sleeves toward the vertex of said receptacles.

13. The apparatus of claim 11 wherein said first and second groups of shanks each include shanks having said electrically energizable means secured intermediate said first and second ends and shanks having said electrically energizable means secured proximate to said first end.

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