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A. S. ATHENS ETAL
HIGH SPEED PRINT HAMMER

3,175,486

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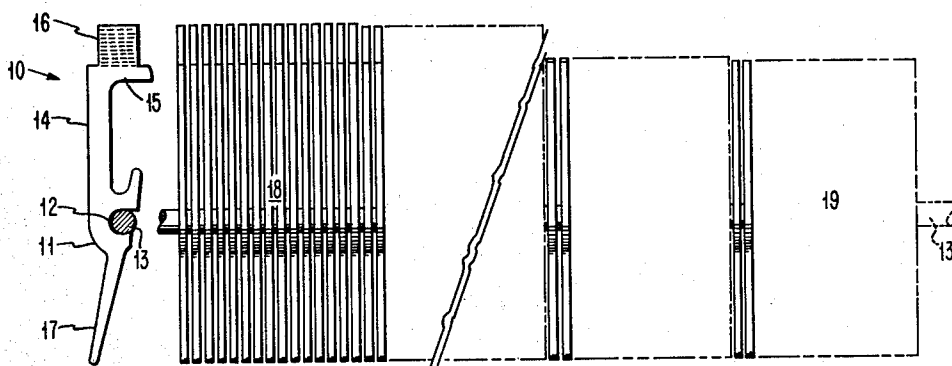


FIG. 1

FIG. 2

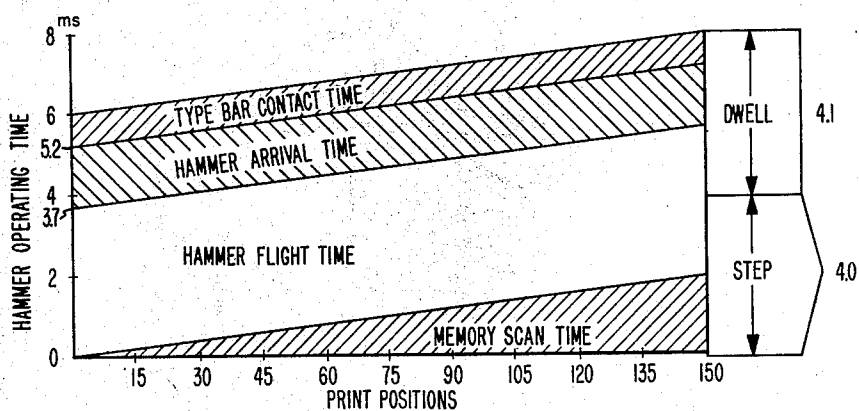


FIG. 3

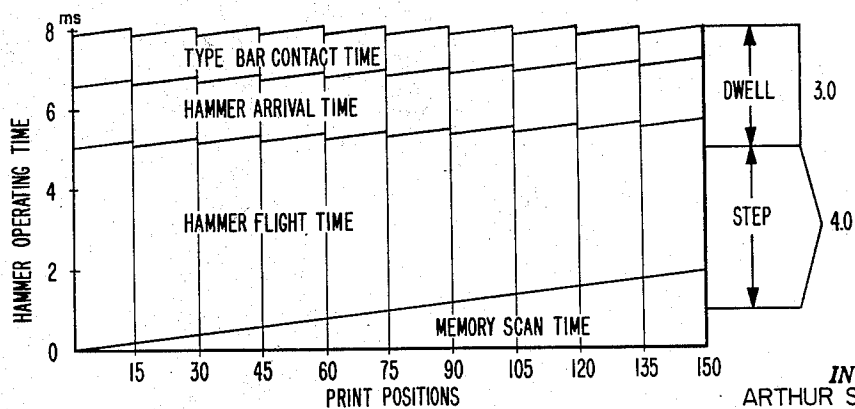


FIG. 4

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HIGH SPEED PRINT HAMMER

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5 Claims. (Cl. 101-93)

The present invention relates to a hammer arrangement for a high speed printing device and more particularly to a hammer arrangement which provides proper timing relationships with a type bar to permit faster printing with increased margin of safety.

In high speed printers it is common to provide a separate hammer for each print position, the hammers being aligned across the width of the printer carriage in front of the platen. In a bar line printer a single horizontal type bar is provided in the form of a flat strip separated into teeth on one side like a comb. An individual type slug character is mounted or fabricated on the end of each tooth. There are as many teeth on the type bar as is necessary to provide a character for each print position, plus one alphabet. The type bar is so arranged that each different type character of the alphabet successively passes each print position as the bar is moved with a stop and start motion in steps between the hammers and the platen. The desired characters to be printed on any one line are stored in a serial memory buffer, one character storage for each print position. The particular print character on the type bar in each particular print position is read and compared with the information stored in the memory. If a compare results, the hammer corresponding to that print position is fired to strike the type bar and print the desired character. Since several hammers may be released while the print bar is in any one dwell position, the entire buffer memory is scanned in a serial fashion during each cycle of movement of the type bar. Accordingly, in determining the amount of time required for each cycle of the type bar, time must be allotted for scanning the memory. In an average size printer, e.g., 150 print positions to a line, the interval of time required to scan the entire memory amounts to a substantial portion, approximately 25 percent, of the total cycle time. The time allotted for scanning the memory must be added to the time intervals required for the mechanical operation of the hammers and type bar to determine the overall cycle time. The result is that the printer must operate at a speed (cycles per second) considerably below the maximum speed of operation of the mechanical elements of the printer.

The object of the present invention is to provide a hammer arrangement for a high speed printer which will compensate for the memory scan time, thus allowing faster printing of uniform quality.

The above object is realized in the present invention by provision of an array of print hammers, one per print position, arranged in a plurality of groups. The mass moments of inertia of the groups are varied in progressively diminishing magnitude from left to right. Accordingly, the group which includes the first hammer has the largest mass moment of inertia and the group which includes the 150th hammer has the smallest mass moment of inertia. This is accomplished by providing each hammer with an inertia tab, the size of which varies from group to group in a diminishing progression from left to right.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

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FIG. 1 is a side view of a typical hammer showing the position of the inertia tab;

FIG. 2 is an elevation view of a hammer array showing the arrangement of the hammers in groups and illustrating the variation in tab size from group to group;

FIG. 3 is a timing chart of a conventional high speed printer; and

FIG. 4 is a timing chart of a high speed printer incorporating the present invention.

Referring more particularly to FIG. 1 of the drawing, a hammer 10 is illustrated as including a central body section 11 which is slotted as at 12 to receive a transverse pivot rod 13. A shank section 14 extends vertically upward from the body section and is provided with a laterally extended arm 15 at its upper extremity. The distal end of the arm 15 forms the striking surface of the hammer. An inertia tab 16 is carried by the shank section and the arm and extends away from the body section. An angularly extending lever 17 protrudes from the lower surface of the body section and is adapted to cooperate with a drive spring to fire the hammer, as shown in co-pending application Serial No. 113,201, filed May 21, 1961. As shown in FIG. 2, the print hammers are mounted in a row on pivot rod 13. One hammer is provided for each print position across the full width of the paper or other print medium. As represented in FIG. 2, the hammers are arranged in groups, e.g., ten groups of 15 hammers each in a typical 150 print position printer. The inertia tabs of the hammers within any one group are similar, but they differ from those of the adjacent groups. As illustrated, the tab height (mass) is diminished progressively, group to group, by uniform increments from left to right. Accordingly, group 18, which includes print hammers 1 through 15, has the largest inertia tabs while group 19, which includes print hammers 136 to 150, has the smallest inertia tabs. The tab heights of the remaining groups vary in a uniform progression between these two extremes.

In FIG. 3, hammer operating time in milliseconds is plotted for each print position in a 150 character printer. The various facets of hammer operation are: hammer flight time; hammer arrival time; and type bar contact time, all of which are nominally identical for each type position; and memory scan time which varies from print position to print position. Hammer flight time covers the minimum time interval required for a hammer to be released and to pivot into position against the type bar. As shown, hammer flight time encompasses a time interval of 3.7 milliseconds. Hammer arrival time is a tolerance of 1.5 milliseconds to allow for variation in the time within which the individual hammers are released, as well as minor variations in flight time. Any individual hammer may hang up or stick occasionally, causing it to release slower than an adjacent hammer. Furthermore, each hammer has its own operating characteristics, so that one hammer may release promptly and require only the minimum flight time; whereas an adjacent hammer may release slower and require a greater flight time. Accordingly, tolerance is provided in the form of the hammer arrival time to accommodate the variations between hammer operating characteristics. The type bar contact time of approximately .8 millisecond denotes the span of time during which the hammer is actually in contact with the type bar. It is during this period of time that the actual printing occurs. The memory scan time is a running total of the time interval required to scan the memory for each particular print position.

The desired characters to be printed on any one line are stored in a 150 character memory buffer, one character for each print position. The particular print character on the type bar in each particular print position is read

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and the memory buffer is scanned in a serial fashion for comparison therewith. If a compare results, the particular hammer for that print position is fired. The time required for comparing with the memory buffer used is 12 microseconds. Since the memory is scanned for each print position, 150 compare cycles are accomplished consecutively from left to right. Accordingly, the total memory scan time for 150 print positions is 1.8 milliseconds. In a conventional high speed printer, the hammers are all identical. Thus, except for variation in individual hammer operating characteristics, the only variation in the hammer operating time for one hammer relative to another, is in the memory scan time.

To permit successful operation of a high speed bar line printer the type bar must remain motionless during the entire time interval of contact between the hammers and the type bar. Otherwise there will be mechanical interference between the type bar and one or more of the hammers, with consequent damage to the machine. This simplifies the type bar construction since no provision need be made in the type slug mounting to accommodate any relative motion between the bar and the print medium. Thus, the stepping motion of the type bar must be completed prior to the initiation of contact of the earliest hammer and cannot commence until after the cessation of contact of the latest hammer. In other words, the type bar stepping motion must be completed by the end of the hammer flight time of hammer number one and cannot be initiated again until the end of the type bar contact time of hammer 150, since the type bar must be motionless during the intervening period. As shown in FIG. 3 this period encompasses 4.1 milliseconds. Since the type bar stepping motion requires only 4.0 milliseconds this necessitates a minimum of 8.1 milliseconds for completion of each type bar cycle.

To compensate for the memory scan time and thus reduce the cycle time of the type bar it is proposed to condense the spread in the print time (hammer arrival time plus type bar contact time) between hammers 1 and 150. This could be accomplished in either of two ways, i.e., by speeding up hammer 150 or by slowing down hammer 1. As shown in FIG. 4, the present invention condenses the spread in print times by slowing down the hammers in a uniform increasing progression from right to left. By means of the inertia tabs the hammer flight times are increased to compensate for the memory scan time. The flight time of hammer 1 is increased to 5 milliseconds while that of hammer 150 remains 3.7 milliseconds. By variation of the inertia tab heights, the flight times of the intermediate hammers are varied progressively to compensate for the progressively increasing memory scan times. The result is that the spread between the beginning of the hammer arrival time of hammer 1 and the end of the type bar contact time of hammer 150 is reduced from 4.1 milliseconds to 2.8 milliseconds. By means of the present invention, a high speed printer of this type can operate on a 7 millisecond cycle (4.0 millisecond step and 3.0 millisecond dwell) with a substantial safety factor. Since the type bar need be motionless for only 2.8 milliseconds of the 3.0 second dwell allowed, .2 millisecond is available as a safety margin to insure that the type bar is motionless prior to inauguration of contact between the hammers and the type bar.

To avoid the necessity of providing a unique size inertia tab and consequent hammer flight time for each hammer, the hammers are arranged in groups of 15. The progressive variation in hammer flight times thus occur from group to group while the flight times for all of the ham-

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mers in each group remain the same (except for variation in hammer operating characteristics).

An advantage of the present invention is that the total energy imparted to each hammer is equal to that imparted to every other hammer. By this means, uniform print quality is provided and there is negligible variation (from light to dark) in quality across the width of the print medium. The variation in the mass of the inertia tabs causes a corresponding variation in the velocity of the hammers, but the energy imparted to the hammer, and the energy with which the hammer strikes the type bar remains the same.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a high speed printer, an array of parallel print hammers mounted for pivotal movement about a common transverse axis and adapted for selective firing sequentially from one end of the array to the other; an inertia tab on each hammer spaced from the pivotal axis, the mass of the various tabs being varied in a uniform diminishing progression from one end of the hammer array to the other.

2. In a high speed printer, an array of parallel print hammers mounted for pivotal movement about a common transverse axis and adapted for selective firing sequentially from one end of the array to the other; an inertia tab on each hammer spaced from the pivotal axis; the hammers being arranged in groups, the hammers of each group having similar inertia tabs, the groups being arranged in a progression of diminishing tab masses from one end of the array to the other.

3. In a high speed printer, an array of parallel print hammers mounted for pivotal movement about a common transverse axis and adapted for selective firing sequentially from one end of the array to the other; and means secured to the hammers for condensing the spread in print times between the first and last hammers in the array while maintaining uniform print quality across the full array.

4. In a high speed printer as set forth in claim 3, in which the means comprises a tab secured to each hammer, the mass of the various tabs varying in a uniform diminishing progression from one end of the array to the other.

5. In a high speed printer as set forth in claim 4, in which the hammers are arranged in groups of similar tab masses, the masses of the tabs varying from group to group.

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