United States Patent

Konkel et al.

[15] **3,636,865**

[45] **Jan. 25, 1972**

[54] PRINT HEAD FOR HIGH-SPEED PRINTERS

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[22] Filed: **May 8, 1969**

[21] Appl. No.: **822,929**

[52] **U.S. Cl.** ..... **101/93 C**

[51] **Int. Cl.** **B41j 9/02**

[58] **Field of Search** ..... 101/93 C; 197/1; 307/89, 91; 336/84; 179/174

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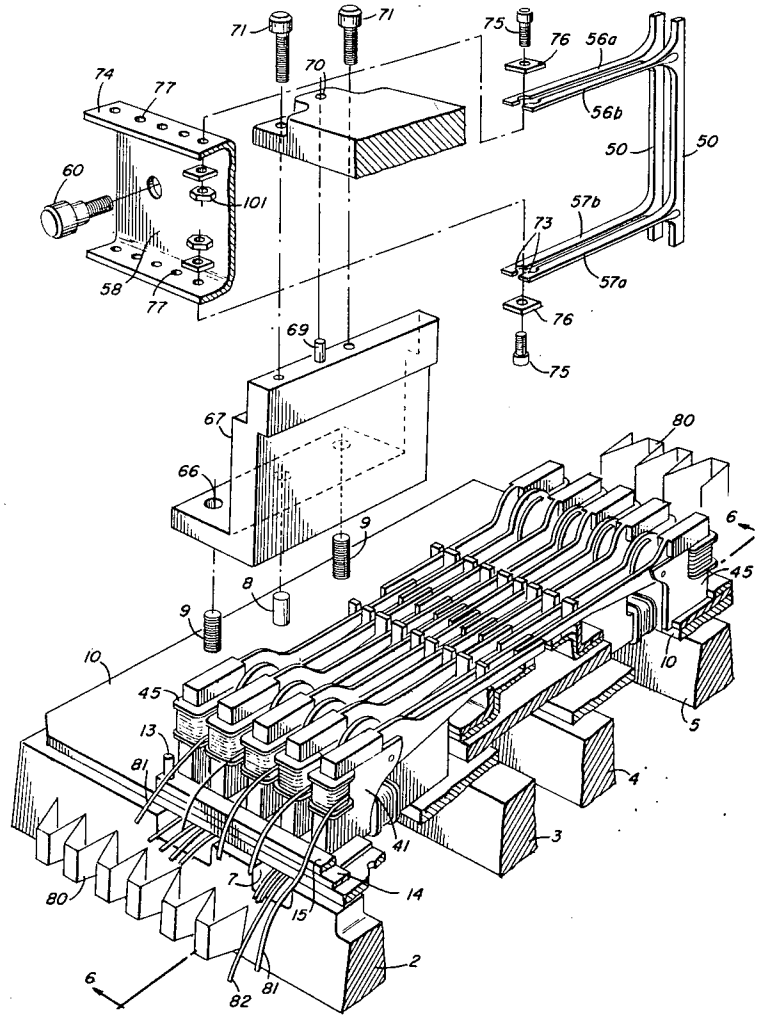
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[57] **ABSTRACT**

A print head in which a bank of hammers is disposed over a bank of actuators, comprising inner and outer actuator elements of complementary construction. The apparatus is constructed by successively pinning stamped plates to a base frame, one on top of the next. Alignment of the parts is accomplished by a series of dowels so that in general only one positioning step is required to align each part that is secured to the frame.

8 Claims, 6 Drawing Figures



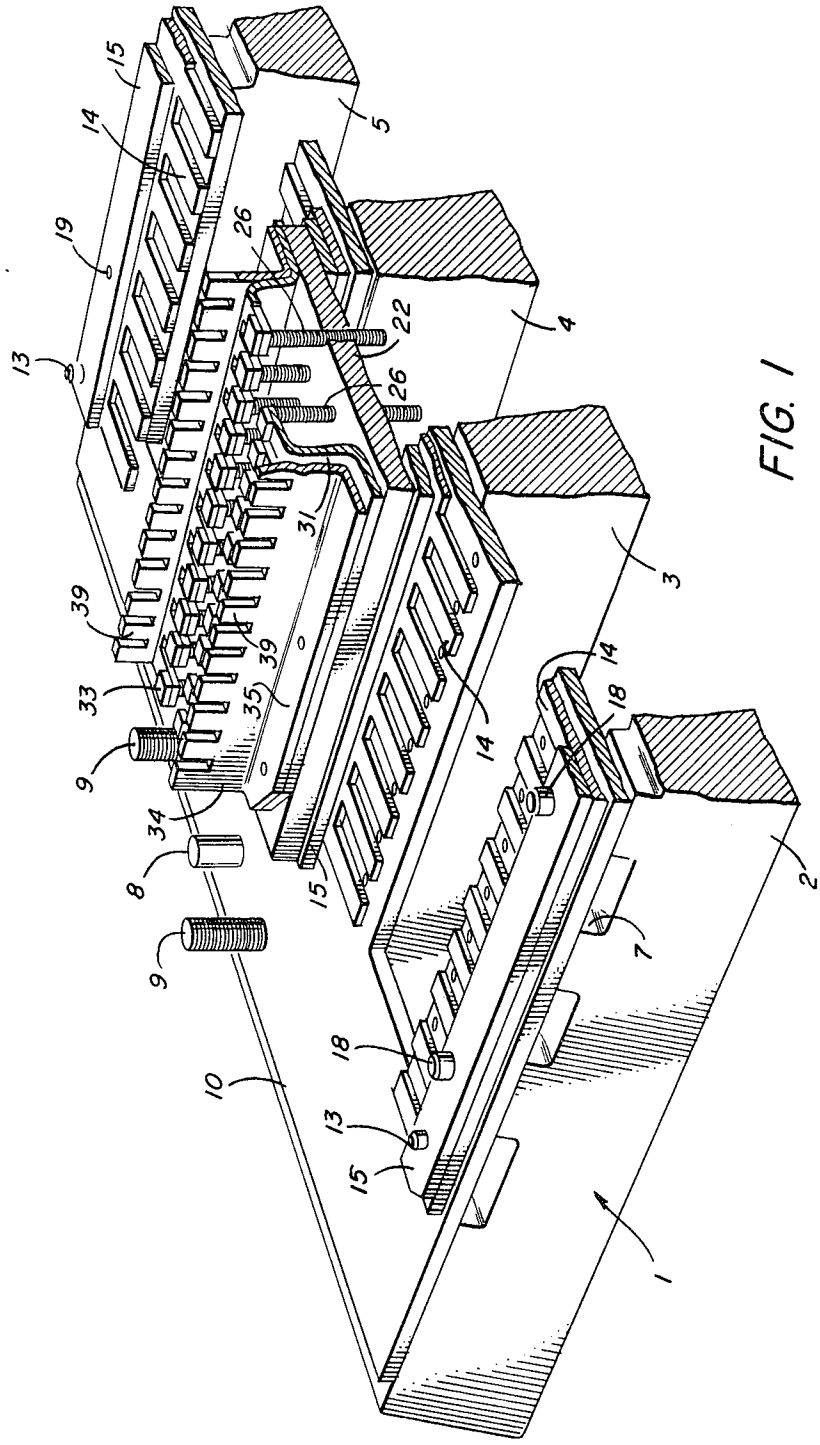


FIG. 1

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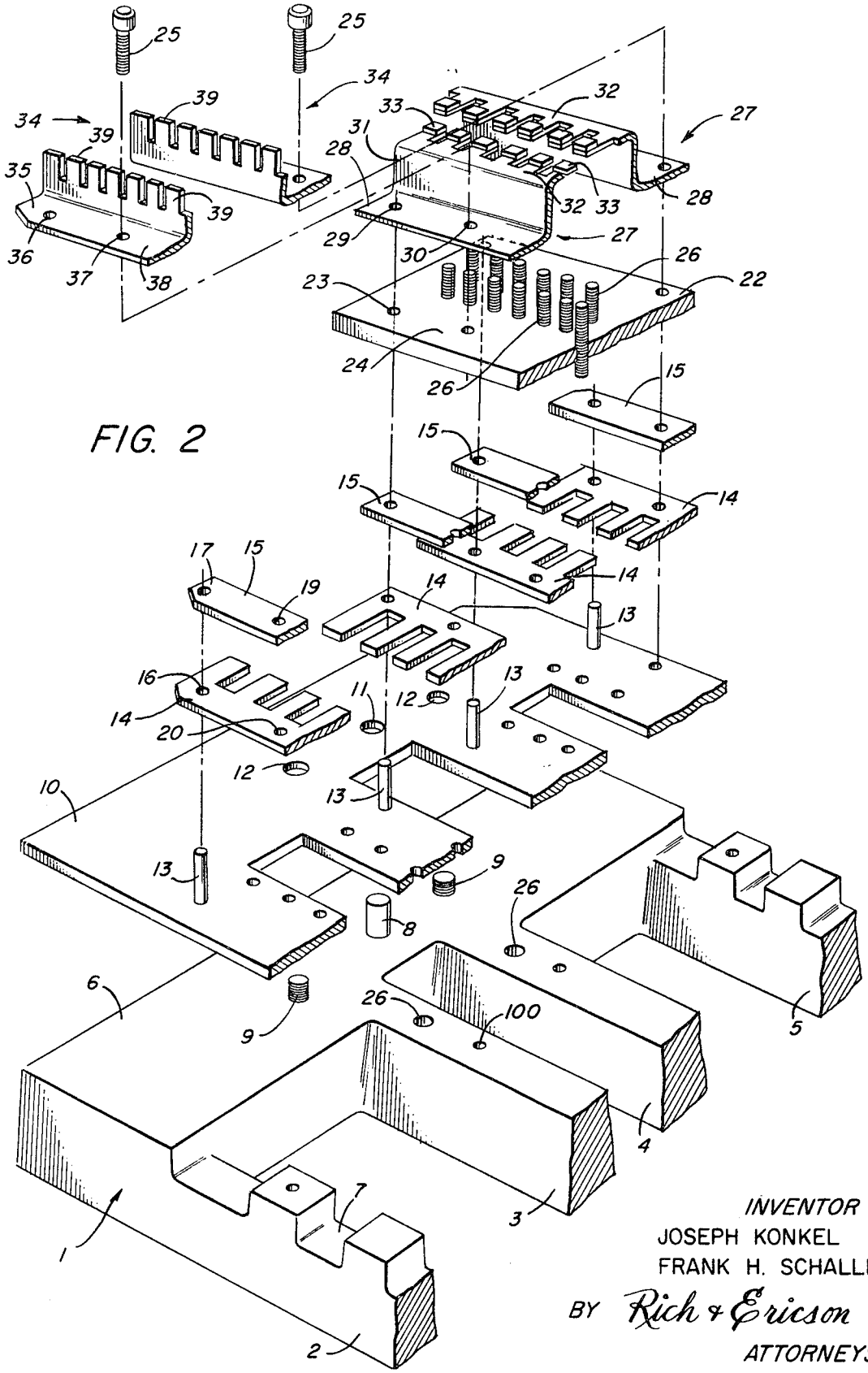


FIG. 2

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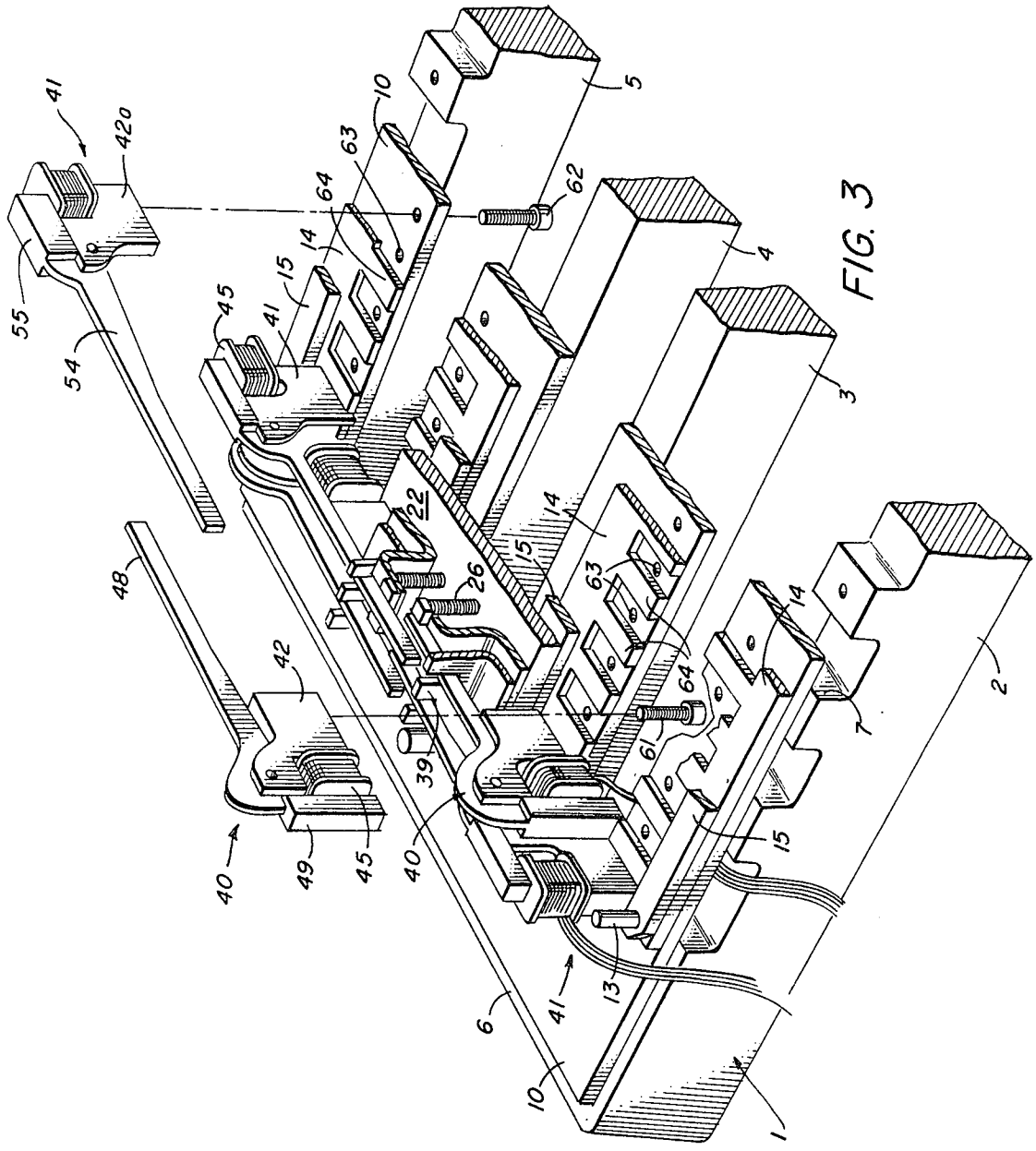


FIG. 3

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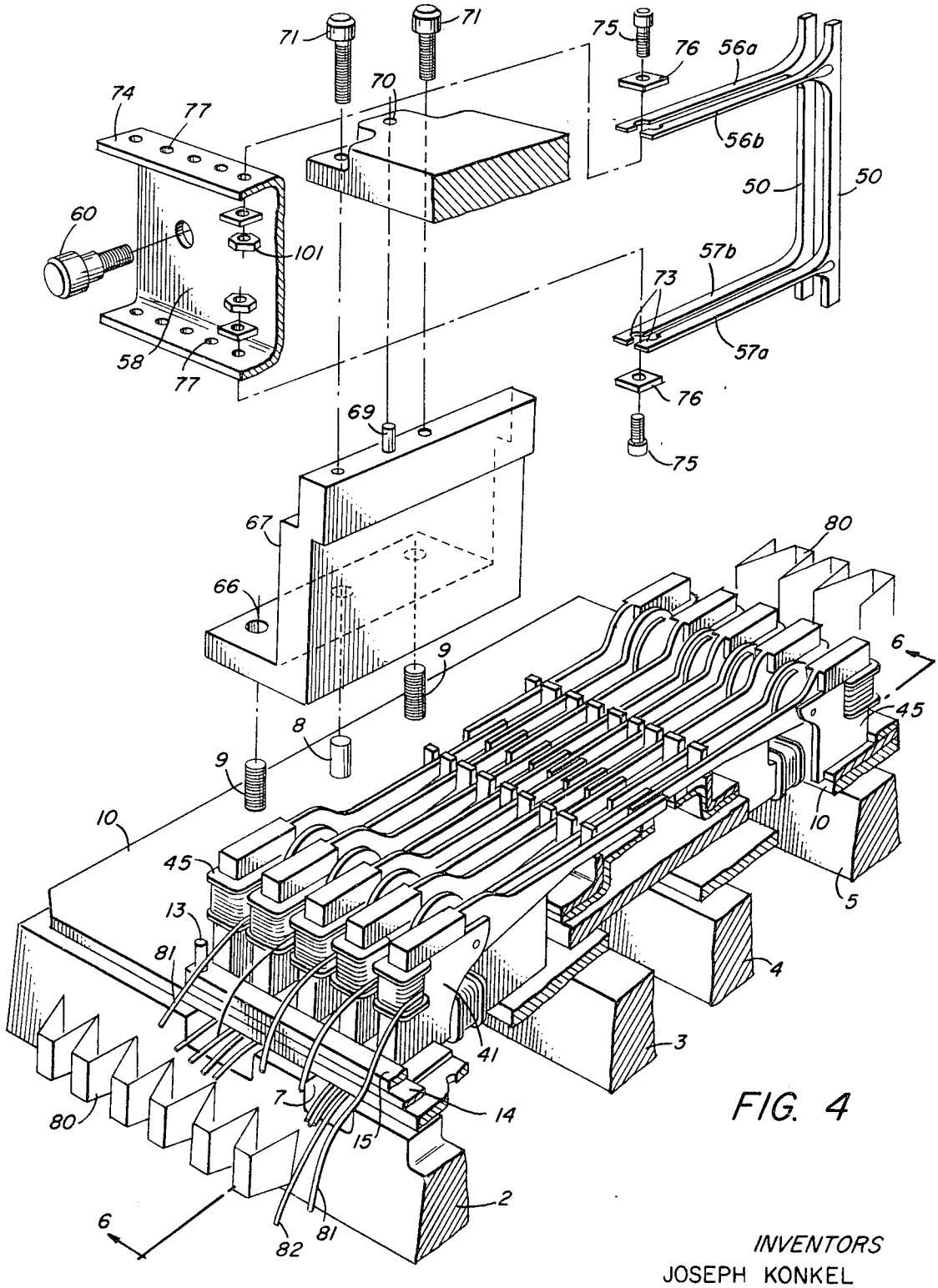


FIG. 4

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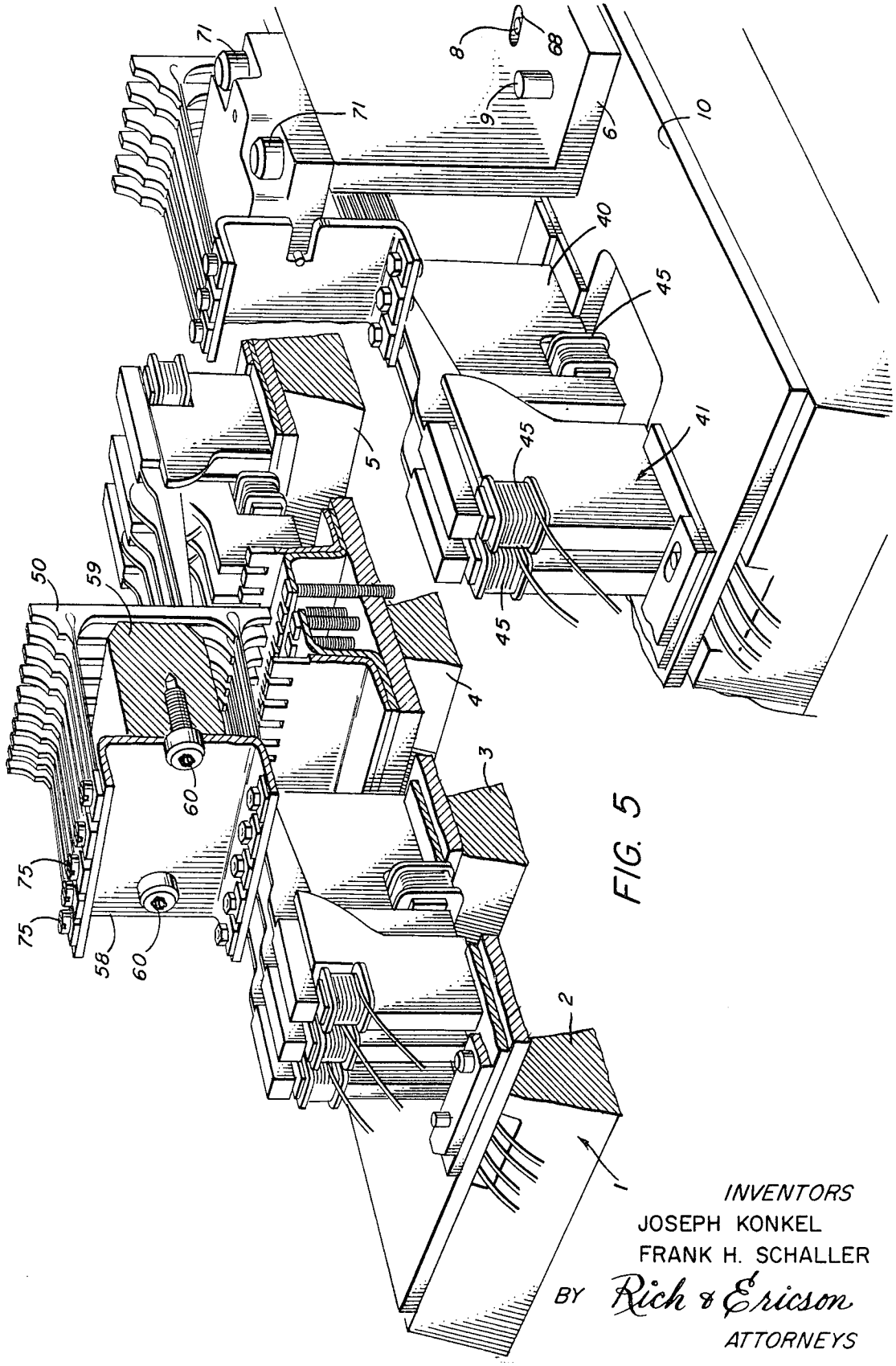


FIG. 5

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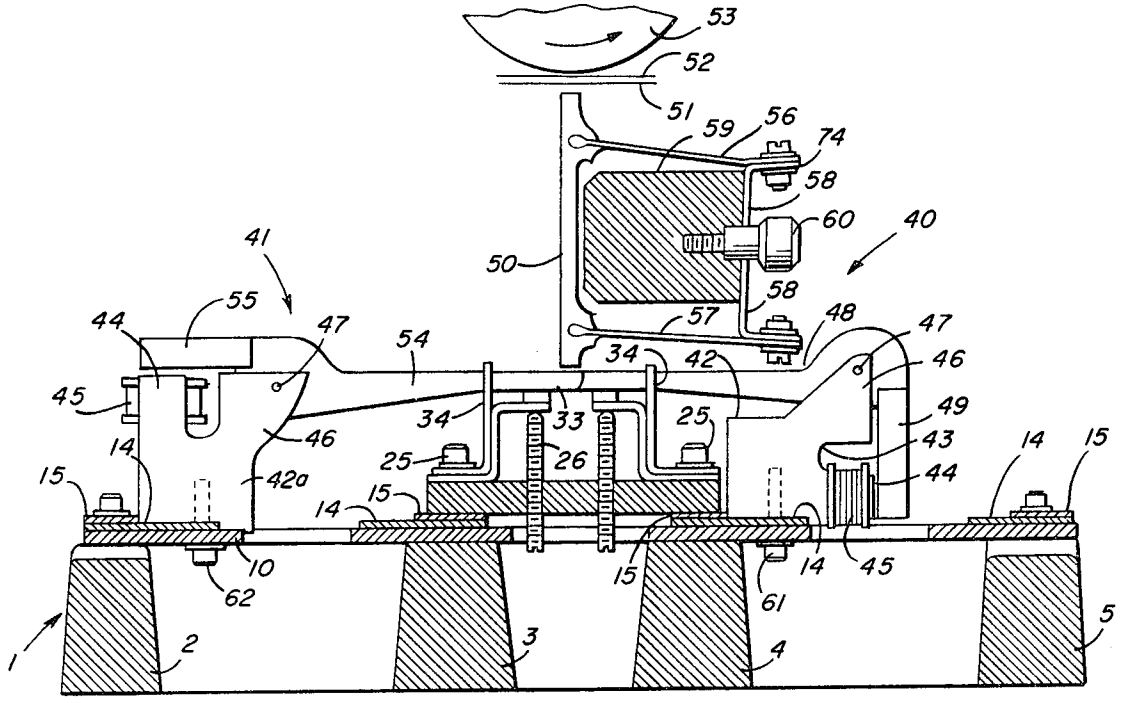


FIG. 6

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PRINT HEAD FOR HIGH-SPEED PRINTERS

Our invention relates to high-speed printers, and particularly to a novel print head construction.

High-speed printers of the line-at-a-time type for printing at rates of 200 to 1,200 lines per minute have long been in common use. Such printers basically comprise a moving-type carrier, such as a drum or chain, carrying engraved characters past a bank of print hammers, one for each column along the line to be printed. The record sheet, and usually a transfer sheet, are carried between the type carrier and the hammers to receive character images when the hammers are actuated.

Since the hammers are relatively small and close together (commonly, they are on 1/10-inch centers) supplying the necessary mechanical energy to actuate the hammers is a difficult problem. The solutions which have been devised have in general involved complex hammer-actuator mechanisms of compound shape that are difficult to manufacture and assemble. The objects of our invention are to simplify the construction and to facilitate the manufacture, maintenance and repair of print heads for such printers.

Briefly, the above and other objects of our invention are attained by a method of construction in which a relatively heavy base frame of cast iron or the like serves as the support for the print hammers and their actuating assembly. A baseplate is provided that is located by a pair of cardinal pins, in the form of dowels, that are rather precisely located on the base frame. The baseplate is secured to the frame by bolts extending through clearance holes, so that only the dowel pins need to be accurately located. The baseplate is preferably made of relatively thin material that is preferably stamped to provide the necessary apertures and external configuration.

The actuator baseplate is assembled on the base frame with the aid of the cardinal pins, and then fastened to the base frame. Next, a series of alignment combs are mounted on dowel pins secured to the actuator mounting plate, whereupon a series of actuator stop plates are mounted on the alignment combs, with the aid of the same dowels, and the parts so far assembled are then fastened together. A pair of supports are secured to the base frame through the actuator mounting plate by registration with the cardinal pins, and serve to mount a hammer support on which the print hammers are carried.

Below the print hammers are located the arms of actuators which are secured to the mounting plate and are registered by the stop plates and stop alignment combs. Each actuator arm extends from an electromagnetic armature, to its position beneath an associated hammer, over an alignment comb and a stop comb secured together to an intermediate plate mounted on the actuator mounting plate. The intermediate plate carries a set of individual screws for adjusting bottom stops provided for each hammer actuator. By that arrangement, the alignment and mounting of the actuator and of their guides, strips and flight-timing adjustments are made quite simple, while providing ready access to each part for service, maintenance or replacement.

The print head of our invention, together with the method of making the same, will best be understood in the light of the following detailed description, together with the accompanying drawings, of a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a schematic perspective sketch of a portion of a print head constructed in accordance with our invention, with parts shown in cross section and parts broken away;

FIG. 2 illustrates further steps in the construction of a print head in accordance with our invention; and comprises an exploded view of a portion of the print head;

FIG. 3 is a schematic fragmentary exploded perspective sketch illustrating further details of a print head in accordance with our invention;

FIG. 4 is a schematic fragmentary exploded perspective sketch of another portion of the print head of our invention;

FIG. 5 is a schematic fragmentary perspective sketch, with parts shown in cross section and parts broken away, of a completed print head in accordance with our invention; and

FIG. 6 is a cross-sectional view taken essentially along the lines 6—6 in FIG. 4, and including an additional fragmentary showing of the type carrier, transfer sheet and record sheet associated with the print head.

FIG. 1 shows one-half of a subassembly comprising a portion of the print head of our invention. The other half may be identical, and extends symmetrically to the right of the crosshatched portions. As shown, the apparatus comprises a relatively massive base frame having ribs 2, 3, 4 and 5 extending from end arms 6. The frame 1 may be made of cast iron or the like, and serves to minimize vibration and absorb energy dissipated in the operation of the printer.

At each end of the base frame 1 is secured a cardinal pin 8 comprising a dowel made of hardened steel or the like and located in a precisely drilled hole in the frame 1. The cardinal pins serve to locate all of the other apparatus of the print head relative to the frame. A set of bolts 9 extend through the frame on each side of the cardinal pins, and adapted to extend through clearance holes in the other elements to be described. The bolts 9 serve the purpose of securing other parts to the base frame 1.

Ports 7 are provided in the outer ribs 2 and 4 to permit the passage of wires that connect the actuator coils, to be described, to electronic drive circuits.

As best shown in FIG. 2, the next element in the subassembly is an actuator mounting plate 10 secured to the base frame 1. The mounting plate 10 is provided with precisely located holes 11 to register it with the cardinal pins 8, and with clearance holes 12 to accept the bolts 9.

Secured to the mounting plate 10, and inserted in precisely located holes in the mounting plate, are a set of eight dowel pins 13, four at each end of the mounting plate, as shown in FIG. 2. These dowel pins serve to locate a set of actuator-locating combs 14 and a set of actuator stop bars 15.

There are four such combs 14, and four such stop bars 15.

Each comb 14 is provided with a locating hole 16 at each end to accept the locating dowels 13 on the mounting plate 10. Each actuator stop bar 15 is similarly provided with holes such as 17 at each end to accept the locating dowels 13. While the stop bars are shown slightly behind the ends of the teeth in some of the views, for clarity, in practice the bars project over the teeth to control the position of the actuators in a manner to be described.

While not shown, it is preferred that one hole 16 in each of the combs 14, and one hole 17 in each of the strips 15, is elongated in the direction of the length of the comb or strip so that while no rotational movement of the strip or comb is possible, some lengthwise tolerance can be accepted.

As shown in FIGS. 1 and 2, the stop combs 14 and stop bars 15 are secured in place by screws 18 extending through clearance holes 19 in the stop bars, and corresponding clearance holes 20 in the stop comb, and corresponding clearance holes in the actuator-mounting plate 10, and thence into threaded holes in the base frame 4.

Referring to FIG. 2, a screw plate 22 is provided with locating holes 23 at two corners thereof to receive and be registered with the dowel pins 13, with corresponding clearance holes to admit the other dowel pins 13. It is further provided with clearance holes 24 to receive bolts 25 that extend down into threaded holes 100 on the base frame 4. Threaded into a screw plate 22 are a series of individual bottom-stop-adjusting screws 26, one for each print hammer actuator.

On the screw plate 22 are mounted a pair of confronting stop combs generally designated 27. Each stop comb has a base flange portion 28 provided with a locating hole 29 at each end thereof to receive the locating dowels 13. The comb 27 is further provided with clearance holes such as 30 to receive the bolts 25. The stop comb further comprises an upstanding flange portion 31, and, projecting laterally therefrom, a series of teeth 32 on each of which there is mounted a resilient bottom stop pad 33. The stop pads 33, under the control of the corresponding adjusting screws 26, determine the bottom positions of the actuating arms in a manner to be made apparent below.

Mounted adjacent to and upon each stop comb **27** is mounted an alignment comb **34**. Each comb **34** comprises a base portion **35** having a locating hole **36** at each end to receive the corresponding dowels **13**, and a series of clearance holes **27** to receive the bolts such as **25**. The alignment comb is formed with an upstanding portion **38** terminating in upwardly projecting teeth **39** that serve to separate and guide the individual actuator arms in a manner to appear.

Referring next to FIGS. **3** and **6**, when in place and secured, the combs **14** and stop bars **15** define the positions of the print hammer actuators. These actuators are each of one of two forms, either the form shown at **40** at the right in FIG. **6**, and at the left in FIG. **3**, or the form shown at **41** at the left in FIG. **6**, and at the right in FIG. **3**. These actuators **40** and **41** are mechanically equivalent but have complementary shapes to facilitate their close positioning together.

Referring first to the actuator **40** in FIG. **6**, each such actuator comprises a ferromagnetic core member **42** formed with a slot as shown at **43** to provide a core leg **44** on which an electromagnetic coil **45** is wound. The core member **42** is formed with a pair of outstanding ears **46** that receive a pivot pin **47** on which an actuator arm is pivotally mounted.

The actuator of the kind shown at **40** are provided with arms **48** that are pivotally supported on the pin **47** and are connected at right angles to a ferromagnetic armature block **49**. The armature block **49** is attracted to the core leg **44** when the coil **45** is energized. That will drive the associated hammer such as **50** up into engagement with a sheet of paper **51**, a transfer sheet **52** and a type carrier such as the drum **53** or the like.

The actuators **41** are essentially of the same construction, except that the actuating arm **54** extends essentially straight from its connection to the corresponding armature **55**. The cores **42***a* are the same as the cores **42**, except that the core **42** is secured to the plate **1** by means of a bolt indicated at **61** that extends generally normal to the core arm **44**, whereas the bolt **62** that secures the core **42***a* to the mounting plate **10** extends parallel to the corresponding core arm **44**.

Comparing FIGS. **3** and **6**, it will be seen that the bolts **61** which secure the inner actuators such as **40** to the mounting plate **10** extend up through clearance holes **63** between the teeth **64** of the combs **14**, and the bolts **62** which fasten the outer actuators **41** extend through similar clearance holes **63** through the corresponding recesses between the teeth of the comb **14**.

Referring again to FIG. **6**, it will be seen that the core pieces **42** and **42***a* of the actuators **40** and **41** are located transversely by engagement with the edge of the stop plates **15**, and that they are located in directions parallel with the line of print by the edges of the teeth **64** of the combs **14**.

Referring now to FIGS. **4** and **5**, the bolts **9** extend up through suitable threaded recesses such as **66** in a pair of upstanding brackets **67** at each end of the baseplate **10**. The cardinal pin **8** passes through a locating hole, shown in dotted lines, centered in the base flange of the bracket **67** in FIG. **4**, and through an elongated locating recess **68** as shown in FIG. **5**, in the bracket **67** at the other end. The object of the elongation is to permit slight tolerances in the spacing between brackets while keeping them in alignment parallel to the line of print.

In the rest position of the apparatus, the actuator arms such as **48** and **54** are held down against the bottom stops **33** by the hammers **50**. The hammers **50** are supported by leaf springs **56** and **57** that are in turn bolted to a channel **58** that is secured to a crossbeam **59** by suitable means, preferably including two shoulder screws such as **60** that also serve as dowels to locate the channel **58** relative to the bar **59**.

The hammer support bar **59** is located with respect to the brackets **67** by dowels such as **69**, FIG. **4**, seated in suitable locating holes **70** in the bar **59**. The bar **59** is secured to the bracket **67** by means such as the bolts **71**.

The supporting springs for the hammers **50** are divided into complementary pairs, such as **56***a* and **56***b* for the upper springs in FIG. **4**, and **57***a* and **57***b* for the lower springs. The springs such as **56***a* and **56***b* have complementary recesses such as **73** such that when placed side-by-side they can be clamped down in pairs on the upper flange **74** of a channel **58** that is bolted to the bar **59**.

The springs are secured by means such as the screws **75** and gibs **76**. The screws **75** pass through holes such as **77** in the upper and lower flanges of the channel **58**, and are there secured by nuts such as **101**. It will be apparent that the hammers are readily accessible and can be removed in pairs and replaced individually without disturbing other hammers in the bank.

An important feature of the print head construction of our invention is that the coils **45** of the hammer actuators are readily accessible. Referring to FIGS. **4** and **5**, it can be seen that the coils **45** of the outer banks of actuators form rows, aligned along the outer sides of the assembly, to which direct access can be had. As shown in FIG. **5**, and as will be apparent from a comparison with FIG. **6**, the coils **45** of the inner banks of actuators are similarly accessible through the recesses in the mounting plate **10**. In accordance with our invention, the advantage of that result is taken by employing shielding materials, of the form shown at **80** in FIG. **4**, of suitable low-reluctance magnetic-shielding material. The shielding material is cut in strips and folded as shown and inserted around and between the coils for the purpose of minimizing magnetic linking of adjacent coils and cores.

The advantages of this construction will be appreciated when it is realized that, in conventional interlocked module construction, it is necessary to individually install shielding on each coil as the module is assembled, because the interlocked modular construction does not lend itself to ready access to the coils.

The operation of our apparatus will be generally apparent from the above description. Briefly, it will be seen that the apparatus may be assembled in a simple sequential manner, beginning with the installation of the mounting plate **10** on the base frame **1**, proceeding by the successive location of the parts serving to align the actuators on the mounting plate and securing them thereto, and followed by installing the actuators and bolting them down. The hammer module, comprising the support bar **59**, channel **60**, the hammers **50** and the brackets **67**, may be completely assembled prior to mounting on the frame **10**, or the parts can be installed in place on the frame.

After the apparatus is assembled, the frame **1** may be located between the side frames of a conventional high-speed printer construction, by means of suitable dowels between the frame **1** and the side frames, and there bolted down. Referring to FIG. **4**, the leads such as **81** on the coils **45** of the outer actuators may be led out directly over the frame, and the leads such as **82** from the inner banks of actuators may be led out through the ports **7** in the frame. It will be apparent that that construction makes possible clean and simple dressing of the leads to cables going to the electronic hammer drive circuits.

Referring to FIG. **1**, it will be seen that the bottom stop adjustment screws **26** are readily accessible through the recess between the ribs **3** and **4** of the frame **1**, so that when the assembly is installed in the printer, it is a simple matter to make the final adjustment of the flight times of the hammers so that uniform print quality is achieved. Once the print head is assembled, no other adjustment is necessary because all alignment steps have been completed during the assembly of the apparatus.

A significant advantage of the print head assembly of our invention is that the parts, other than the coils **45**, base frame **1**, and the screw plate **22**, can all be produced by stamping operations from relatively thin sheet material. Even the actuator cores can be produced in this manner, if some machining is done following the stamping operation. While the screw plate **22** could also be produced by stamping, it is preferred to make it by conventional precision jig drilling or tape-controlled techniques, because of the large number of threaded holes that must be accurately located on the plate.

While we have described the apparatus of our invention with respect to the details of the preferred embodiment thereof, many changes and variations will occur to those skilled in the art upon reading our description, and such can obviously be made without departing from the scope of our invention.

Having thus described our invention, what we claim is:

1. In a print head for high-speed printers,
a relatively massive base frame adapted to be secured to the side frames of a printer adjacent the type carrier thereof,
an actuator-mounting plate secured to said base frame, said plate and said frame being provided with a set of three confronting apertures each extending along a central axis parallel to a line that will coincide with the line of print where said frame is installed between the side frames of a printer, said set of apertures comprising two outer apertures and an inner aperture located between said outer apertures,
a set of four alignment combs mounted in pairs on said mounting plate on either side of said outer apertures, each pair having confronting teeth projecting normal to said line,
a stop bar mounted on said plate adjacent each alignment comb and having an edge parallel to said line,
a set of print hammer actuators mounted on said plate and each located between and engaging a different pair of teeth of one of said combs and engaging said edge of one of said stop bars, said actuators being thereby located in directions parallel to said line by said combs and in directions normal to said line by said stop bars,
said actuators having movable arms projecting over said central aperture beyond a normal from said plate to said line in position to drive hammers toward said line,
a screw plate mounted on said actuator mounting plate over said central aperture, a pair of guide combs, one mounted on each side of said screw plate and each having teeth projecting up between the actuator arms extending from actuators on that side of the mounting plate,
a pair of stop combs, one mounted on each side of said screw plate and each having teeth each projecting under a different one of the actuator arms on that side of the mounting plate,
a resilient stop pad mounted on each tooth of each stop comb in position to engage one of said actuator arms,
a set of screws threaded in said screw plate and each extending into contact with a different one of said stop comb teeth to adjust the position of the stop pad thereon relative to the associated actuator arm,
a pair of supports mounted on said actuator mounting plate,
a hammer support bar having ends connected to said supports and extending therebetween over said actuators along a longitudinal axis parallel to said line,
a channel beam having a central web connected to said bar and extending above and below it in directions normal to said line, said beam having parallel flanges extending away from said hammer support bar,
upper and lower hammer support springs mounted on said flanges and extending over and projecting from said hammer support bar, and
print hammers each connected between a different pair of superposed upper and lower springs and adapted to be engaged by a different one of said actuator arms.

2. In a print head for high-speed printers of the line at a time type having a type carrier adapted to move past a line of print,
a print hammer assembly comprising:
an integral support member extending parallel to and at least coextensive with the line of print,
a first set of independent hammer support springs having first ends connected to a first side of said member and having second ends projecting over it with clearance,
a second set of independent hammer support springs having first ends connected to a second side of said member opposite said first side and having second ends projecting over it with clearance, the projecting end of each spring of said first set being opposite the projecting end of a different spring of said second set, directly adjacent print hammers each connected between a different opposed pair of springs of said first and second sets and adapted to produce a continuous line of image forming impacts, in which said springs comprise adjacent pairs formed on confronting sides adjacent their first ends with confronting openings adapted to receive a fastener, and fastening means for each adjacent pair of springs, said fastening means comprising gib means overlying said first ends of said springs and formed with a recess to receive a portion of a fastener protruding through the recess formed by the confronting openings of said springs, a fastener having a portion protruding through the openings formed in said gib means and by said confronting openings, said fastener having an enlarged portion overlying said gib means, and means for securing said fastener to said support to clamp said springs to said support by pressure on said gib means.

3. In a print hammer assembly for high-speed printers, the combination comprising:
a support having spaced parallel elongated flanges and means connecting said flanges together,
a first set of adjacent pairs of independent elongated parallel leaf springs having first ends projecting from a first of said flanges and second ends connected to said first flange, said springs extending normal to the direction of elongation of said flanges and equally spaced each from the next,
a second set of pairs of adjacent elongated parallel leaf springs having first ends projecting from the second of said flanges and second ends connected to said second flange, the springs of said second set extending normal to the direction of elongation of said flanges parallel to the springs of said first set, the springs connected to each of said parallel flanges comprising adjacent pairs each formed with confronting recesses forming an opening, a corresponding aperture formed in said support and underlying said opening, gib means overlying said second ends of each of said adjacent pairs and formed with an aperture overlying said aperture and said opening,
a fastener for each of said adjacent pairs having a portion protruding through said aperture in said gib means and said support and through said opening, said fastener clamping said gib means, said springs and said support together, and juxtaposed print hammers each connected to said first ends of different pairs of springs each comprising one from each set.

4. A print hammer assembly for a high-speed printer, comprising:
a bank of adjacent print hammers arranged in a parallel array,
an elongated support extending along said array, and
a pair of independent springs for each hammer, each pair comprising one spring having a first end overlying one side of said support and one spring having a first end overlying the other side of said support, both extending normal to said support to second ends, and both connected to the associated hammer at said second ends, in which the springs of said pairs on each side of said support are arranged in adjacent pairs, each pair being formed at their first ends with confronting recesses to receive a single fastener, gib means overlying said first ends and formed with an aperture, a single fastening means for each pair comprising a screw having a head engaging said gib means and a shank protruding through said aperture and said recesses, and means for detachably securing said shank to said support to cause said gib means to clamp said springs to said support in independently detachable pairs.

5. A print hammer assembly, comprising:
a support extending along a predetermined axis,

a first parallel array of leaf springs each having a first end overlying a first side of said support and a second end projecting from said support normal to said axis,

a second parallel array of leaf springs each having a first end overlying a second side of said support spaced from said first side and a second end projecting from said support normal to said axis, the springs of said second array being parallel to the springs of said first array, and each aligned with a different spring of said first array in a different line normal both to said axis and to the direction of extension of said springs, each of said arrays of leaf springs comprising adjacent pairs formed with confronting recesses adjacent said first ends thereof and overlying said support,

gib means overlying said first ends of each of said adjacent pairs and formed with an opening aligned with the region between said recesses, and

fastening means for each of said adjacent pairs comprising means for clamping said springs to said support by way of said gib means and comprising a portion protruding through said opening, between said recesses, and through a corresponding opening in said support, and

a print hammer connected between each aligned pair of springs for restrained movement generally normal to said axis, said hammers being spaced on centers equal to the centers on a complete line to be printed.

6. In combination, a support plate, a pair of uprights mounted on said support plate in spaced relation,

a support bar connected between said uprights and extending parallel to said plate along a first axis,

a channel member having a central web wider than said support bar and connected to said bar and having a parallel flanges extending normal to said web and away from said bar,

a first set of independent parallel leaf springs extending normal to said bar and having first ends overlying one of said flanges and projecting over and beyond said bar to second ends,

a second set of independent parallel leaf springs extending normal to said bar and having first ends overlying the other of said flanges and projecting over and beyond said bar to second ends, each spring of said first set overlying and opposite a different spring of said second set, in which said springs of each set comprise adjacent pairs, each pair being formed at their first ends with confronting recesses to receive a single fastener, gib means for each pair overlying said first ends of said pair and said flange and formed with an aperture, and detachable fastening means for clamping said gib means to said support and comprising means engaging said gib means and means extending through said aperture and said recesses to fix said springs to said support, whereby each of said pairs is independently and detachably mounted to the corresponding flange, and

elongated print hammers closely spaced to comprise the complete hammer bank of a line to be printed each connected to the second ends of a different pair of opposite springs, one from said first set and one from said second set, for restrained movement in directions generally normal to said bar and to said springs.

7. A print head for a high-speed printer of the kind having a type carrier movable past a line of print, comprising:

a base frame adapted to be mounted between the side frames of a printer,

an integral elongated support means extending parallel to and at least coextensive with said line of print,

means mounting said support means on said base frame in spaced parallel relation thereto,

a bank of adjacent parallel print hammers closely spaced on centers corresponding to a complete line of print, said support means comprising an elongated channel beam having parallel flanges extending parallel to said frame, each of said hammers being resiliently mounted on said channel by a different pair of leaf springs, each of said pairs of leaf springs being mounted at a first end on said hammer and at a second end on a different one of said flanges, said springs extending normal to the direction of elongation of said channel, the springs on each of said flanges comprising adjacent pairs formed with confronting complementary recesses adapted to receive a single fastener, a fastener securing each such pair to the corresponding flange, and gib means between said fastener and said pairs, said gib means being engaged by said fastener to clamp each pair of springs to said support means.

8. The apparatus of claim 7 further comprising:

a group of print-hammer-actuating means, one for each hammer, mounted on said frame adjacent said hammers and each operable to drive its associated hammer away from said frame.

* * * * *