Sept. 22, 1964 R. E. WILKINS ETAL 3,149,562

PNEUMATICALLY OPERABLE SLUG MODULE IN HIGH SPEED PRINTERS

Filed Dec. 2, 1960

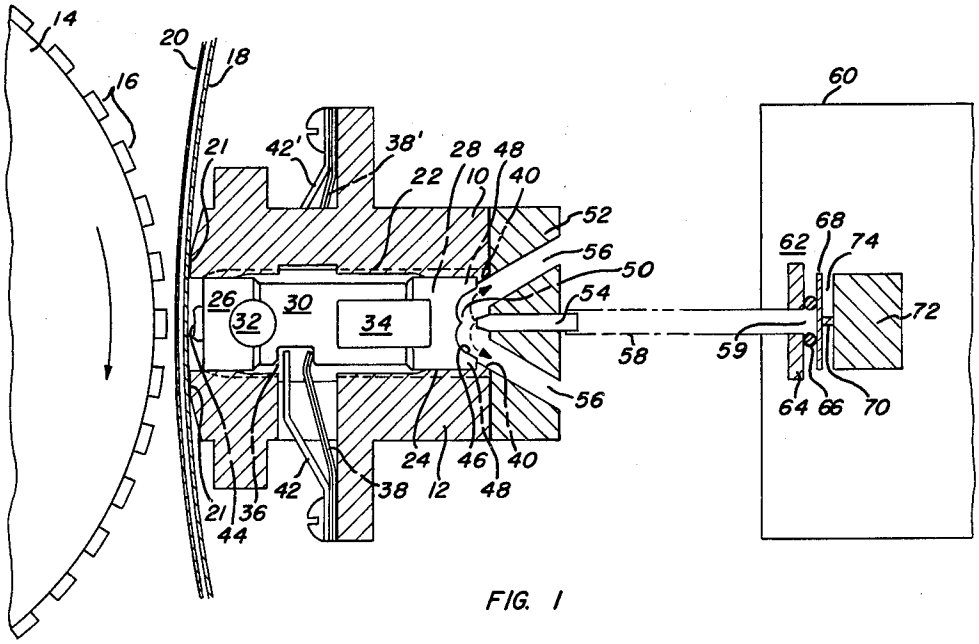


FIG. 1

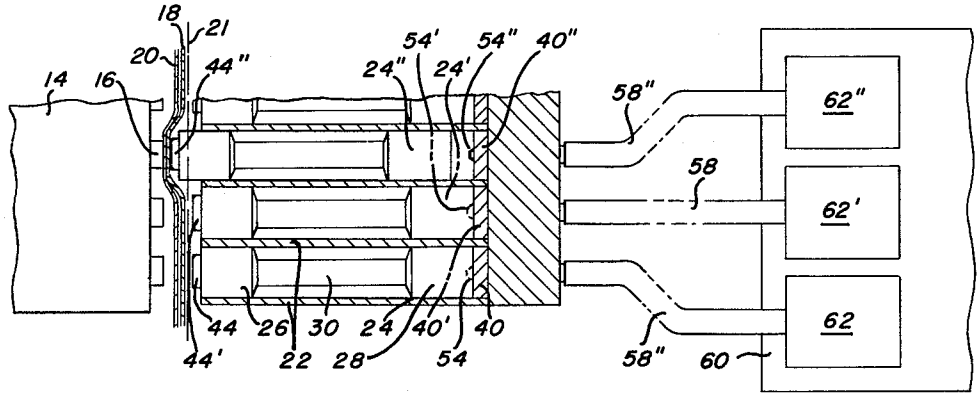


FIG. 2

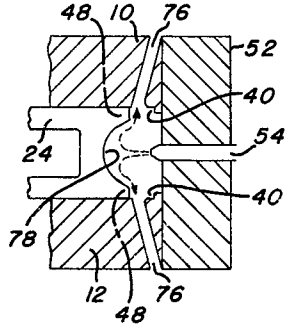


FIG. 3

INVENTORS
ROBERT E. WILKINS
JOHN G. SIMON Jr.

BY Fred Jacob

ATTORNEY

United States Patent Office 3,149,562 Patented Sept. 22, 1964

3,149,562

PNEUMATICALLY OPERABLE SLUG MODULE IN HIGH SPEED PRINTERS

Robert E. Wilkins, Wollaston, and John G. Simon, Jr., Woburn, Mass., assignors to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Filed Dec. 2, 1960, Ser. No. 73,398
17 Claims. (Cl. 101—93)

The present invention relates in general to a new and improved high-speed printer, and in particular to a high-speed printer of the kind wherein movable members are selectively driven forward against a support to effect an imprint on an intermediately stationed paper web.

Present-day high-speed printers, particularly printers which are in use with modern computers, are frequently required to print at speeds upward of 1,000 lines per minute. So-called "on-the-fiy" printers have come into wide use in order to provide a printed output at these speeds. In such a printer the print roll which carries raised type fonts representative of the data characters, rotates at a constant speed. While the paper web is stationary during the printing interval where a carbon ribbon is used, it is positioned between the paper web and the print roll and advances at its own speed, less than that of the print roll, either in the same direction as the latter or opposite thereto. A movable member is selectively impelled forward in each columnar position of the print line to effect an imprint on the remote side of the paper web by driving the latter and the ribbon against the type font which is momentarily passing through the printing position.

It is particularly important, when carbon copies are printed in addition to the ribbon copy, that the movable members, which may be type slugs, strike the paper a blow sufficiently powerful to provide a clear imprint on every copy without damaging the paper and/or the ribbon where the latter is used. The blow must be sufficiently rapid to prevent prolonged contact which may result in smearing due to the relative motion of the above-cited components. Moreover, in order to position the imprint on the print line, the forward movement of the slug must be timed accurately so that the slug arrives precisely at the instant when the selected type font is passing through the printing position.

Linearly movable type slugs have come into frequent use in place of pivoted hammers. Type slugs, in general, afford better timing control and can tolerate a greater amount of eccentricity of the print roll. Heretofore, it has been customary to employ solenoid-operated hammer actuators or the like for impelling the type slugs forward from a reference or home position toward the print roll. In order to obtain better timing control of the slug throughout its travel, printers have been built where the actuating hammers, instead of striking the slugs a blow, start out at rest and in contact with the slugs preparatory to accelerating the latter toward the print roll. The disadvantage of such an arrangement resides in the inability of the hammers to exert sufficient force in the extremely short time interval during which they act, without requiring relatively large actuating solenoids.

In order to enhance the accuracy of the timing control still further, the hammers in many printers do not move through the entire slug travel path. Instead, the forward motion of each hammer is arrested and it is returned to its inactive position while the forwardly impelled slug completes its forward travel under its own momentum. Slug return to the home position occurs after the hammer has resumed its inactive position and is brought about by the rebound of the slug off the print roll, aided by a constantly acting resilient spring force.

A slug actuator arrangement of the type described is

frequently difficult to maintain in proper working order owing to the large number of mechanical parts whose adjustment is critical to the over-all timing. Since the forward slug travel and return to the home position occurs in a time interval of the order of 5 milliseconds or less, very small timing changes may produce imprints of the desired data characters above or below the print line. Since such displaced imprints generally involve a glancing, rather than a direct slug blow on the selected type font, they are usually attended by smearing.

Any change of the time interval during which the hammer is in contact with the slug to impel the latter forward, affects the force of impact with which the slug strikes the print roll and hence it affects the clarity of the printed product on the ribbon copy as well as on any carbon copies. Additionally, the length of the time interval during which the slug maintains the ribbon and paper in contact with the print roll is affected.

From the foregoing explanation it will be clear that a slight change of any one of a number of critical adjustments during the operation of the printer may bring about prolonged slug contact which produces smearing. If the impact force is too small, a faint imprint will result, particularly where the number of carbon copies is large. Where only a ribbon copy is printed, damage to the paper and/or to the ribbon may result if the impact force is excessive. If the hammer has not fully returned to its inactive position upon the return of the slug and a second printing is to follow immediately, radically altered timing conditions will prevail and may bring about any of the above-mentioned effects. Under adverse conditions, the rebound of the returning slug off the forwardly positioned hammer may produce a shadow or ghost imprint.

A further disadvantage of the conventional hammer actuator arrangement described is its lack of flexibility. In order to operate efficiently, the hammer actuators must be positioned in line with their corresponding slugs. Since the solenoids which actuate the hammers are large in size in order to produce the required slug acceleration, a relatively complex and bulky arrangement is generally called for in order to align them with the relatively narrow hammer actuators which are positioned adjacent each other without exceeding the limited available space. Such an arrangement not only increases the cost of the printer, but also tends to lessen its reliability since it requires frequent adjustment in operation.

It is the primary object of this invention to provide a high-speed printer which overcomes the foregoing disadvantages.

It is another object of this invention to provide apparatus for actuating the movable members of an on-the-fly printer whereby the timing of the members may be accurately controlled.

It is a further object of this invention to provide apparatus for actuating the movable members of an on-the-fly printer whereby the force of impact of the members on the print roll may be accurately controlled.

It is an additional object of this invention to provide a slug module and actuating means therefor whereby the timing of the slugs as well as the acceleration applied thereto may be accurately controlled.

It is still another object of this invention to provide actuating means for a printer slug module which is simple in construction, relatively immune to changing operating conditions and flexible as to the manner in which it is positioned in the printer.

The invention which forms the subject matter of this application comprises a slug module which contains a plurality of slug housings wherein the respective print slugs are disposed. Spring means urge each print slug to a rearward home position. Each slug has a forward striking surface and terminates rearwardly in a contoured

impact surface. Means are provided for applying a burst of compressed gas to the impact surfaces of selected slugs during a restricted time interval in order to drive the slugs forward against the print roll. Slug control is achieved by accurately regulating the pressure as well as the duration of the burst.

The various novel features which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its advantages and specific objects thereof, reference should be had to the following detailed description and accompanying drawings in which:

FIGURE 1 illustrates a preferred embodiment of the invention;

FIGURE 2 shows a top view of a portion of the apparatus of FIGURE 1; and

FIGURE 3 illustrates another embodiment of the invention.

With reference now to the drawings, FIGURES 1 and 2 illustrate a preferred embodiment of the invention partly drawn in cross-section for the sake of clarity. It will be understood that FIGURE 2 shows only a portion of a slug module and actuating means therefor. The slug module is seen to consist of two sections, 10 and 12, which are spaced from each other and which are positioned opposite the print roll 14. The latter has raised type fonts 16 and rotates at a constant speed in a chosen direction, e.g. the direction of the arrow. A paper web 18 and a ribbon 20 are positioned between the slug modules and the print roll, the paper web being supported by the module surfaces 21.

The slug module sections 10 and 12 contain facing parallel grooves in which partitions 22 are disposed so as to define a plurality of slug housings with the module. Each housing is open at the front and rear and contains a printing slug 24, 24', 24'', etc. respectively. Each slug has front and rear portions 26 and 28 respectively, which are in sliding contact with the walls of the housing. A central portion 30 of the slug is relieved to avoid contact with the housing walls and to thereby decrease slug friction. Sections of the slug are removed entirely in the areas 32 and 34 in order to keep the slug mass as small as possible for better slug control.

Each slug comprises a slot 36 which is substantially transverse to the direction of linear slug travel. A leaf spring 38 extends into the slot 36 and applies pressure to the rear slot shoulder to urge the slug against its rear stops 40. This position of the slug, which is illustrated in FIGURE 1, is referred to as the home position herein. A limit stop 42 also extends into the slot 36 forwardly of the leaf spring 38, to confine slug travel in both directions.

The forward slug portion 26 terminates in a striking surface 44 whose radius of curvature is substantially identical to that of the print roll 14. The rear slug portion 28 terminates in a contoured impact surface 46 which is seen to consist of a pair of concave sections open to the rear, i.e. to the right in the drawing, which are symmetrically disposed between a pair of rearward slug extensions 48. The two concave sections are connected by a relatively sharp transverse ridge 50 which is positioned forwardly of the aforesaid slug extensions 48. Optimum efficiency of the kinetic energy of the shock wave which drives the slug forward with an impact is obtained with this geometry. The slugs are disposed in their successive housing with the transverse slot facing alternately down, as shown in FIGURE 1, and up. The leaf spring 38' and the limit stop 42' for the adjacent slug, which has an upwardly facing slot, are indicated in FIGURE 1.

A manifold 52 is positioned rearwardly of the module sections 10 and 12 and includes a plurality of nozzles 54, 54', 54'', etc. Each nozzle is positioned symmetrically with respect to the extensions 48 of its corresponding slug opposite the transverse ridge 50 thereof. The manifold further includes a pair of exhaust ports 56 corresponding

to each nozzle and angularly disposed with respect thereto. The ports are positioned to minimize any interference with the forward and rearward slug motion.

A set of conduits 58, 58', 58'', etc. connects the nozzles 54, 54', 54'' respectively to a reservoir 60 in which a gas, e.g. air, is maintained under constant high pressure. The conduits are illustrated in broken lines in the drawings to indicate that they are flexible and may be of any desired length. The conduits terminate in valves 62, 62', 62'', etc. respectively within the reservoir. In FIGURE 1, the conduit 58 is seen to terminate in an opening 59 in a pressure plate 64. The opening 59 is sealed against the entry of air by a gasket 66 which is compressed between a closure lid 68 and the pressure plate 64. The lid 68 is integral with the armature 70 of a solenoid 72 which is positioned inside the reservoir 60. The solenoid is shown in its normal unenergized state when a solenoid spring urges the lid 68 against the gasket 66 and a gap 74 is defined between the lid and the solenoid proper.

Under normal conditions, each leaf spring urges its corresponding slug to the home position of the latter, as shown in FIGURE 1. In FIGURE 2 the slugs 24 and 24' are shown in their respective home positions abutting their respective back stops 40 and 40', while the slug striking surfaces 44 and 44' respectively are recessed within the forward module surfaces 21. The slug 24'' is shown in its forward position with its striking surface 44'' protruding beyond the module surfaces 21. At a predetermined time interval prior to the arrival of the desired type font 16 at the print station, the solenoid 72 is energized and responds by pulling its armature 70 inwardly until the gap 74 is closed. The closure lid 68, which is integral with the solenoid armature 70, consequently moves to the right in the drawing and exposes the opening 59 to admit the pressurized air in the reservoir 60 to the conduit 58.

The function of the nozzle 54 is to provide a burst of air which is directed against the impact surface 46. The transverse ridge 50 deflects the air into the two concave portions of the impact surface as indicated by the pair of broken-line arrows in FIGURE 1. The spent air is exhausted through the ports 56 almost immediately to preclude any interference with a subsequently applied air burst. Provided the ratio of the pressure at the nozzle orifice to that prevailing at the exhaust ports 56 is greater than two, the effect of the air burst on the slug will be equivalent to that of a shock applied by a hammer actuator. As a result of the applied shock, the slug 24'' is accelerated in a forward direction, i.e. to the left in the drawing, the striking surface 44'' driving the paper web 18 and the ribbon 20 against the selected type font 16 at the precise instant when the latter is at the print line.

The impact of the striking surface 44'' on the type font 16 causes the slug 24 to rebound to the rear, i.e. to the right in the drawing. This movement is enhanced by the action of the leaf spring 38 which continuously urges the slug to its home position. The leaf spring 38 further serves to maintain the slug in the home position against the tendency to rebound off the back stops 40 and to produce a second or phantom imprint.

The duration of the air burst, which determines the time interval during which the accelerating force is applied to the slug, may be regulated by adjusting the time period in which the solenoid 72 remains energized. Similarly, the force of the burst may be controlled by regulating the pressure within the reservoir 60. Accordingly, the timing of the slug travel, as well as its force of impact on the print roll, are accurately controllable and a high-speed printer of superior performance is obtained. Moreover, since these two quantities may be readily maintained constant over long periods of time, the reliability of the printer is enhanced.

It is further possible, simply by adjusting the pressure of the air in the reservoir 60, to compensate for an increase in the required number of carbon copies which

necessitates a slug blow of greater force. Similarly, if the number of carbon copies is materially reduced so that the danger exists of damaging the paper and/or the ribbon with a slug blow which is too powerful, a simple adjustment can be made to reduce the pressure in the reservoir.

The shape of the impact surface 46 which deflects the air blast and the ports 56, defines a pair of exhaust paths which afford a rapid removal of the spent air in order to prepare the slug for a subsequent air burst. Thus, the forward slug motion in each case is due entirely to the force of the immediately preceding air burst whose effect on the slug is readily predictable so that accurate slug control is obtained.

From FIGURE 2 it will be clear that the actuating valves 62, 62' and 62'', respectively, need not be aligned with the nozzle, the conduits 58, 58', 58'', etc. being flexible. This presents a distinct advantage over conventional slug actuator assemblies where the size of the solenoid actuators conflicts with the requirement that the slug actuators be aligned with the slug itself and where a complicated arrangement is required, particularly with limited available space. The arrangement of the present invention permits the positioning of the pressure reservoir at any convenient point.

FIGURE 3 illustrates a modification of the embodiment shown in FIGURES 1 and 2, applicable reference numerals having been retained. The module sections 10 and 12 respectively are seen to contain a pair of ports 76 which are located in the module sections 10 and 12 rather than in the manifold 52. The slug 24 is shown in its forward position away from the back stops 40. The impact surface 78 of the slug is seen to consist of a single concave portion symmetrically disposed between the slug extensions 48 and centrally faced by the nozzle 54. The exhaust paths are illustrated by a pair of broken-line arrows. It will be noted that the ports 76 are closed when the slug is in its home position. Accordingly, the exhaust paths are unblocked only when the slug is driven forward. With the exception of the foregoing variations, the operation of the apparatus FIGURE 3 is similar to that discussed in connection with the apparatus FIGURES 1 and 2.

The invention is not confined to the embodiments illustrated and described in connection with the drawings. For example, the impact surface 78 which is shown in FIGURE 2 could operate in conjunction with ports of the type shown in FIGURE 1. Similarly, the slug need not have the precise shape shown in the drawings, it being only necessary to provide slugs of relatively low mass in order to be able to control their travel accurately. They may be returned to their home position by any desirable means provided only that a positive return force is exerted throughout the entire slug travel. The valves need not be located within the reservoir, but could be positioned in the conduits 58, 58', 58'', etc., outside the reservoir. In the latter case, the valves normally block the conduits 58 so that air entering the orifice 59 is barred from reaching the nozzle 54. Neither the precise configuration of the valve 62 nor of the solenoid 72 is necessary to the operation of the invention herein. Similarly, nozzles of the supersonic, sonic or subsonic type may be employed, provided only that they are so positioned as to minimize any interference with the slug motion.

The invention is not limited to the use of linearly movable slugs, but is applicable to any high-speed printer wherein movable members are selectively driven forward against a support to effect an imprint on an intermediately stationed paper web. For example, the air burst could be used to impel pivoted hammers against a support, which may either be a print roll or a platen. In the latter case, the hammers may carry type fonts to the exclusion of the support.

The inking means need not consist of a ribbon interposed between the paper and the slugs. For example, an impregnated inking roll may be used to apply ink directly to the type fonts of the print roll.

From the foregoing explanation, it will be apparent that numerous modifications, changes and equivalents will now occur to those skilled in the art, all of which fall within the true spirit and scope contemplated by the invention.

What is claimed is:

1. A slug module and actuating means therefor for use in a high-speed printer of the kind having a moving platen closely spaced from said module, said module comprising a plurality of slug housings respectively open at the front and rear thereof and aligned side by side, a linearly slideable slug disposed in each of said housings, each of said slugs terminating rearwardly in an impact surface of relatively narrow width contoured to define a pair of rearwardly open concave portions intermediate a pair of spaced rearward extensions, a narrow transverse ridge symmetrically joining said concave portions forwardly of said extensions, a nozzle facing said ridge of each of said slugs and being symmetrically spaced with respect to said extensions, and means for applying a burst of compressed air through selected ones of said nozzles to drive the corresponding slugs forward, the air applied to each impact surface being exhausted by way of a pair of paths defined by the external surface of the corresponding nozzle and the interior surfaces of said extensions.

2. A slug module and actuating means therefor for use in a high-speed printer of the kind having a moving platen closely spaced from said module, said module comprising a plurality of slug housings respectively open at the front and rear thereof and aligned side by side, a linearly movable slug disposed in each of said housings and including a slot substantially transverse to the direction of slug motion, a leaf spring extending into said slot and urging said slug rearwardly to a home position, each of said slugs terminating in a rearwardly facing impact surface, nozzle means spaced to the rear of each of said impact surfaces along the direction of said linear slug motion, and means for applying a burst of pressurized air of short duration through selected ones of said nozzle means to drive the corresponding slugs forward from said home position, each of said impact surfaces being contoured to deflect the applied air into at least one exhaust path angularly disposed to the direction of said burst.

3. In a printer of the kind wherein selected ones of a plurality of linearly movable slugs are driven forward against a closely spaced, rotating print roll to effect an imprint on an intermediately stationed paper web, a slug module comprising a plurality of housings each open at the front and rear thereof, said slugs being slideably disposed in respective ones of said housings and terminating respectively in a rearwardly facing impact surface, and means spaced to the rear of each of said impact surfaces along the direction of said linear slug motion for applying a burst of pressurized gas thereto, said rear impact surface being contoured to define an exhaust path jointly with said last-recited means for said gas angularly disposed to the direction of said burst.

4. In a printer of the kind wherein selected ones of a plurality of movable members are driven forward against a closely spaced, moving support to effect an imprint on an intermediately stationed paper web, each of said members having a rear impact surface, and nozzle means spaced rearwardly from each of said impact surfaces for applying a burst of pressurized gas thereto in the forward direction of motion of said members, each of said impact surfaces being contoured to deflect said gas in cooperation with said nozzle means symmetrically into a pair of exhaust paths angularly disposed to the direction of said burst.

5. In a printer of the kind wherein selected ones of a plurality of movable members are driven forward against a closely spaced, moving support to effect an imprint on an intermediately stationed paper web, each of said mem-

bers having a rear impact surface, and means spaced to the rear of each of said impact surfaces for applying a burst of pressurized gas thereto in the forward direction of motion of said member, said rear impact surface being contoured to define an exhaust path jointly with said last-recited means for said gas angularly disposed to its direction of application.

6. A slug module and actuating means therefor for use in a high-speed printer of the kind having a moving support closely spaced from said module, said module comprising a plurality of slug housings respectively open at the front and rear thereof and aligned side by side, a linearly slideable slug disposed in each of said housings, each of said slugs terminating rearwardly in an impact surface of relatively narrow width contoured to define at least one rearwardly open concave portion intermediate a pair of spaced rearward extension, and a nozzle facing each of said concave portions and symmetrically spaced with respect to said extensions.

7. A slug module for use in a high-speed printer of the kind having a moving support closely spaced from said module, comprising at least one slug housing open at the front and rear thereof, a linearly slideable slug disposed in said housing, said slug terminating rearwardly in an impact surface of relatively narrow width, said impact surface being contoured to define at least one rearwardly open concave portion intermediate a pair of spaced rearward extensions.

8. A slug module and actuating means therefor for use in a high-speed printer of the kind having a moving platen closely spaced from said module, said module comprising a plurality of slug housings respectively open at the front and rear thereof and aligned side by side, a linearly movable slug disposed in each of said housings and including a slot substantially transverse to the direction of slug motion, a leaf spring extending into said slot and urging said slug rearwardly to a home position, each of said slugs terminating rearwardly in an impact surface of relatively narrow width contoured to define at least one rearwardly open concave portion intermediate a pair of spaced rearward extensions, a nozzle facing each of said concave portions and symmetrically spaced with respect to said extensions, and means for applying a burst of compressed air through selected ones of said nozzles to drive the corresponding slugs forward, the air applied to each impact surface being exhausted by way of a pair of paths defined by the external surface of the corresponding nozzle and the interior surfaces of said extensions.

9. A slug module and actuating means therefor for use in a high-speed printer of the kind having a rotating print roll closely spaced from said module, said module comprising a plurality of slug housings respectively open at the front and rear thereof and aligned side by side, a linearly movable slug disposed in each of said housings and including a slot substantially transverse to the direction of slug motion, a leaf spring extending into said slot and urging said slug rearwardly to a home position, each of said slugs terminating in an impact surface of relatively narrow width contoured to define a pair of rearwardly open concave portions intermediate a pair of spaced rearward extensions, a narrow transverse ridge symmetrically joining said concave portions forwardly of said extensions, a nozzle facing said ridge of each of said slugs and being symmetrically spaced with respect to said extensions, and means for applying a burst of compressed air through selected ones of said nozzles to drive the corresponding slugs forward from said home position, the air applied to each impact surface being exhausted by way of a pair of paths defined by the external surface of the corresponding nozzle and the interior surfaces of said extensions.

10. In a printer of the kind wherein slugs drive the paper against a closely spaced, moving support to effect an imprint, a slug module comprising a plurality of housings respectively open at the front and rear thereof and disposed side by side, a slug slideably disposed in each of said housings, each of said slugs terminating in an impact surface contoured to define a pair of rearwardly open concave portions intermediate a pair of spaced rearward slug extensions, a narrow ridge joining said concave portions and being positioned forwardly of said slug extensions, a nozzle positioned opposite said ridge of each of said slugs and spaced from said extensions, a pressure reservoir adapted to store a gas under constant high pressure, a conduit connecting each of said nozzles to said reservoir, and means for selectively controlling the flow of said gas through said conduits.

11. A slug module and actuating means therefor for use in a high-speed printer of the kind having a rotating print roll closely spaced from said module, said module comprising a plurality of slug housings respectively open at the front and rear thereof and aligned side by side, a linearly movable slug disposed in each of said housings and including a slot substantially transverse to the direction of slug motion, a leaf spring extending into said slot and urging said slug rearwardly to a home position, each of said slugs terminating in an impact surface contoured to define a pair of rearwardly open concave portions intermediate a pair of spaced rearward slug extensions, a transverse ridge joining said concave portions, a manifold adjacent the rear openings of said slug housings and including a plurality of protruding nozzles corresponding to respective ones of said housings, each of said nozzles being symmetrically disposed with respect to the extensions of the slug disposed in its corresponding housing and facing said transverse ridge of said impact surface, a reservoir adapted to maintain air under constant high pressure, a separate conduit coupling each of said nozzles to said reservoir, and a normally closed air valve disposed in each of said conduits, said valve being adapted to be electrically operated to selectively apply an air burst to the slug impact surface facing the connected nozzle so as to drive said slug forward from its home position, the applied air being deflected by each of said transverse ridges into a pair of paths defined by the exterior surface of said nozzle and the interior surfaces of said extensions.

12. A slug module and actuating means therefor for use in a high-speed printer of the kind having a rotating print roll closely spaced from said module, said module comprising a pair of module portions spaced from each other and including corresponding pluralities of parallel facing grooves, partitions disposed in said grooves between said spaced module portions to define a plurality of slug housings respectively open at the front and rear thereof, a relatively narrow slug movably disposed in each of said housings, each of said slugs having a forward portion terminating in a striking surface adapted to contact said print roll and a rear portion terminating in an impact surface, each of said forward and rear slug portions making sliding contact with the walls of said housing, each of said slugs being centrally relieved to avoid contact with said housing walls and further including a slot transverse to the direction of slug motion, a limit stop associated with each of said housings to confine slug motion to the rear, a leaf spring extending into each of said slots and urging the corresponding slug against said limit stop to define a home position, a manifold positioned adjacent to the rear openings of said slug housings and including a plurality of protruding nozzles each facing one of said impact surfaces, and means for selectively applying a burst of pressurized air of short duration to each of said impact surfaces to drive said slugs forward from their home positions, the air applied to each of said impact surfaces being exhausted by way of a pair of paths angularly disposed with respect to the direction of said burst.

13. The apparatus of claim 12 wherein each of said impact surfaces comprises at least one rearwardly open concave portion intermediate a pair of spaced rearward slug extensions.

14. The apparatus of claim 13 wherein said exhaust

paths are in part defined by the exterior surface of said nozzle and the interior surfaces of said extensions, and further comprising a pair of ports disposed in said manifold each aligned with the direction of one of said exhaust paths to extend the latter.

15. The apparatus of claim 12 wherein each of said impact surfaces comprises a pair of rearwardly open concave portions symmetrically disposed intermediate a pair of rearward slug extensions, a transverse ridge disposed forwardly of said extensions and connecting said pair of concave portions, each of said nozzles facing one of said ridges.

16. The apparatus of claim 15 wherein said exhaust paths are defined by the exterior surface of said nozzle and the interior surfaces of said extensions.

17. The apparatus of claim 12 and further comprising at least one exhaust port associated with each of said

housings, said exhaust port being located in one of said module portions and being adapted to be uncovered by the forward travel of said slugs.

References Cited in the file of this patent

UNITED STATES PATENTS

1,555,655	Gibson	Sept. 29, 1925
1,926,527	Cornell	Sept. 12, 1933
1,926,528	Cornell	Sept. 12, 1933
2,811,101	De Vol	Oct. 29, 1957
2,874,634	Hense	Feb. 24, 1959
2,883,927	Egbert	Apr. 28, 1959
2,935,018	Lego	May 3, 1960
2,978,978	Lang	Apr. 11, 1961
2,995,082	Sasaki	Aug. 8, 1961
3,045,590	Amada et al.	July 24, 1962