Sept. 2, 1969 M. G. KONING 3,464,610

FAN-FOLDED PAPER STACKER

Filed Nov. 17, 1966 3 Sheets-Sheet 1

Fig. 1

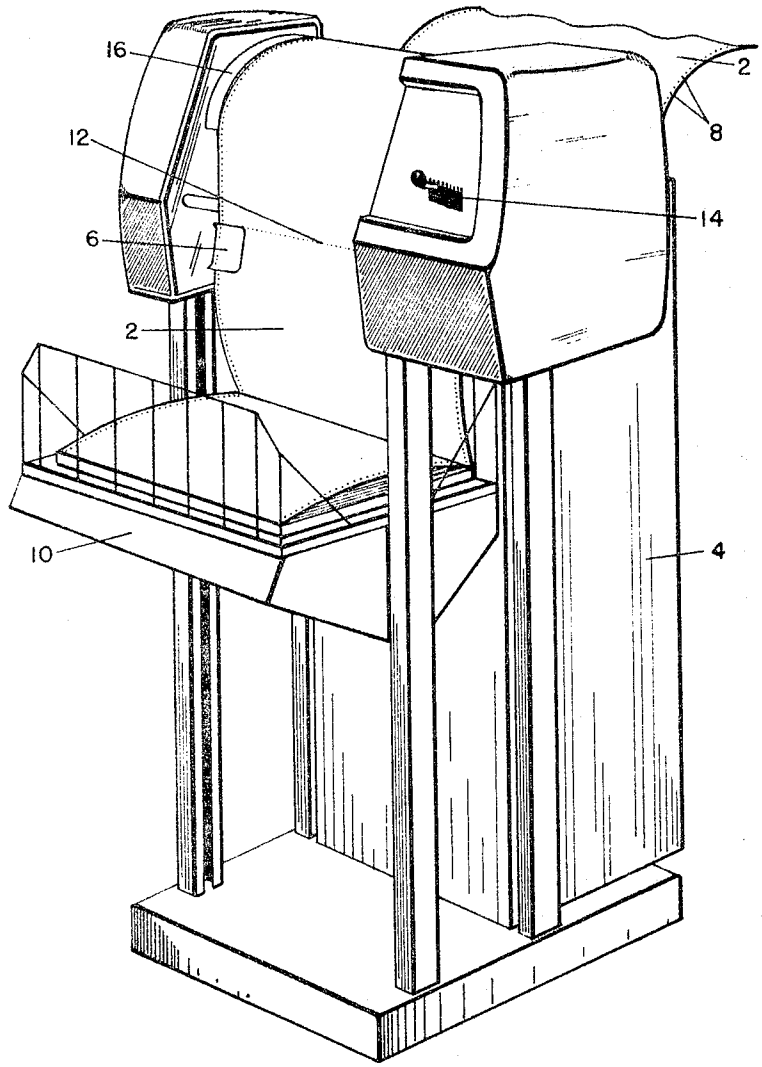

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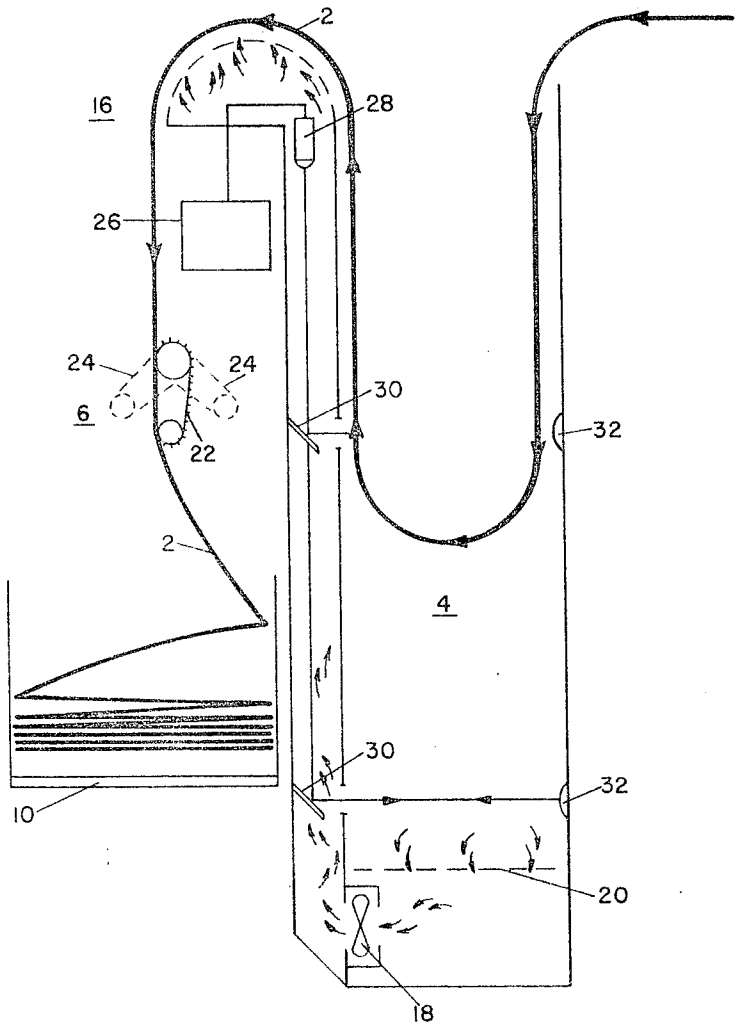
Fig.2



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FAN-FOLDED PAPER STACKER

Filed Nov. 17, 1966 3 Sheets-Sheet 3

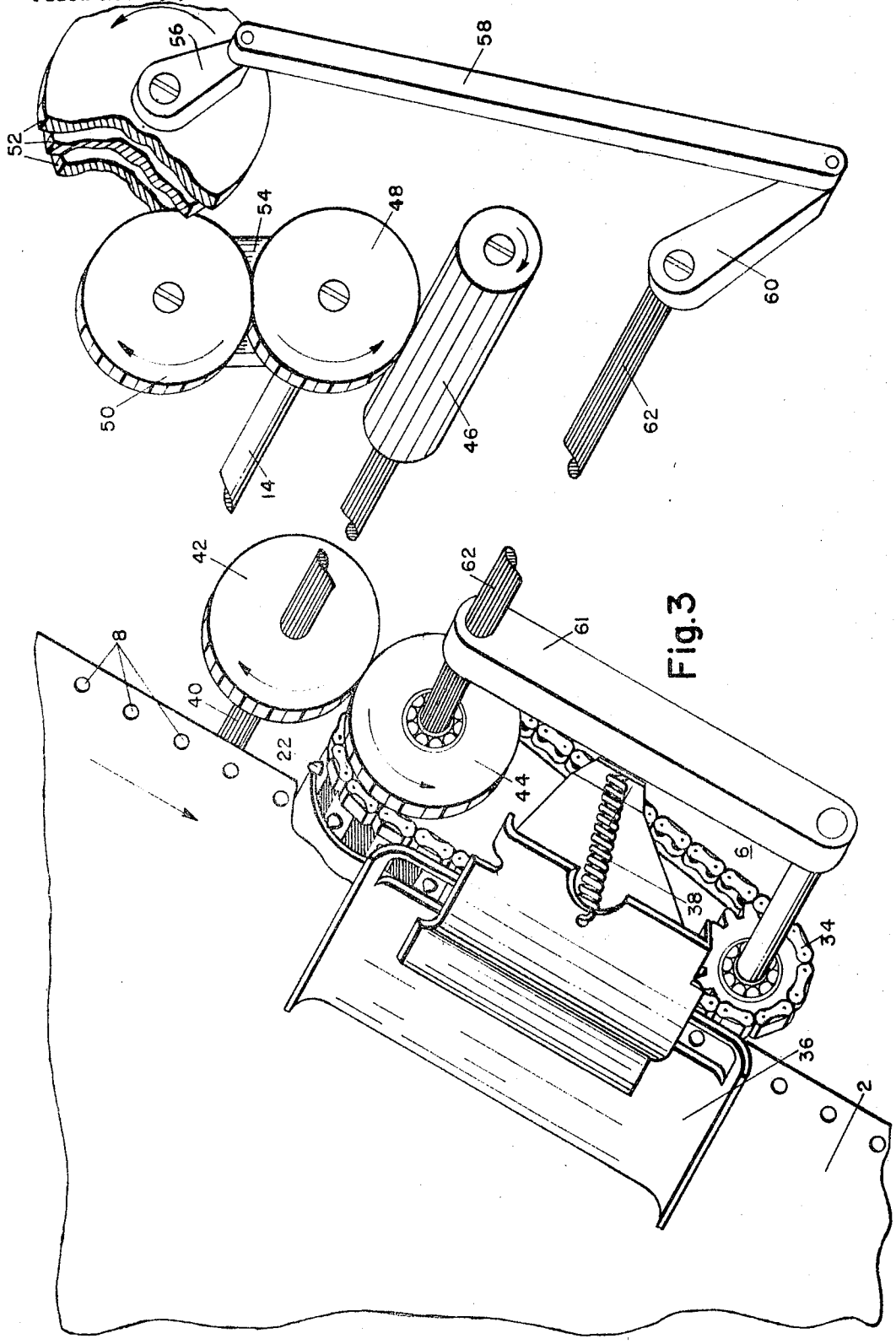

Fig.3

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FAN-FOLDED PAPER STACKER

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ABSTRACT OF THE DISCLOSURE

A high speed stacker for a fan-folded, perforated web includes a pair of oscillating feed tractors having a frequency of oscillations dependent on the speed of stacking and the distance between folds. The tractors pull the web from a vacuum-column buffering chamber which receives the web from a supply source such as a line printer. The web feed path from the buffer to the stacker includes an air bearing which is pressurized with air from the vacuum chamber. When a predetermined maximum amount of web accumulates in the buffer a high speed stacking rate is used to reduce the accumulation to a predetermined minimum amount, whereupon stacking is arrested. When the amount increases beyond the minimum, low speed stacking is switched on.

This invention relates to web folding devices and, in particular, to devices adapted to restack fan-folded paper of the type that is conventionally used with printers in data processing and other systems.

Modern printers for data processing and communications applications often employ fan-folded paper which generally consists of several layers of paper interspersed with carbon paper. After printing, it is convenient to restack the paper by refolding it along the existing fold lines. For slow-speed, continuous operation, the paper can often be refolded solely under the influence of gravity as it drops from the printer onto a stack. However, high-speed or intermittent operation of the printer may result in improper stacking due to air resistance and other effects. Prior attempts to rapidly restack paper at high and intermittent speeds have met with success by the use of oscillating guide bars and other mechanisms, but even with these devices, the paper sometimes wrinkles or crumples behind the guide bars due to friction between the guide bars and the paper. Generally, the slightest wrinkle or any other deviation in the pattern of the stacking paper is immediately compounded, resulting in paper being spewed out of the printer in chaotic fashion and requiring the operator to stop the printer and hand fold the unstacked paper.

In the present invention, precise stacking is achieved by oscillating the paper feed mechanism itself, rather than guide bars or other passive mechanisms. In this manner, the paper does not wrinkle or crumple in or before the oscillating operation, but is forced to alternately fold along the fold lines into a stack. Preferably, the paper feed mechanism contains two sprocketed tractors which engage holes along the edge of the paper, and the oscillating action is accomplished by rocking the output ends of the tractors. The tractors are rocked in synchronism with the advance of paper, each complete oscillation corresponding to two sheets (folds) of paper. Preferably, the rocking cycle is variable to accommodate various sheet lengths. A stacking platform is adjustably located below the oscillating tractors to collect the stacking paper.

When the paper stacker is integrated with the printer, the tractors are synchronously advanced as the lines of printing are completed. When a separate paper stacker is operated independently of the printer mechanism, it is preferable to buffer the paper between the printer and the stacker. In accordance with the present invention, a buffer chamber is adapted to hold a loop of slack paper and photodetector mechanisms are employed to sense the amount of paper in the buffer chamber and appropriately control the advancing of paper from the buffer to the stacker. In the preferred embodiment of the invention, air is removed from the bottom of the buffer chamber to lower the air pressure below the loop of slack paper, thereby drawing paper into the buffer as paper is fed from the printer. The chamber is rectangular in shape with dimensions such that the loop of slack paper substantially blocks the flow of air into the chamber, maintaining reduced pressure below the loop of slack. Another feature is the use of an air bearing between the buffer and the stacker. Pressurized air is forced through holes around a curved surface to maintain the paper at a relatively fixed distance away from contact with surface. In the preferred embodiment of the invention a single air flow mechanism (such as a fan) provides both the reduced pressure for the buffer and the increased pressure for the air bearing.

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.

In the drawings:

FIGURE 1 is an isometric view of the preferred embodiment of the paper stacker, including the buffer and air bearing.

FIGURE 2 is a schematic diagram that illustrates the operation of the mechanism shown in FIGURE 1.

FIGURE 3 is a detailed drawing showing the operation of the paper feed mechanisms, including both the paper advancing and rocking features.

As shown in FIGURE 1, a web of paper **2** to be stacked enters from the rear to form a loop of slack in a buffer chamber **4**. Air is drawn from the bottom of the chamber to cause the supplied paper to enter the chamber. A pair of paper feed tractors **6** (one of which is shown) engage spaced holes **8** along the edges of the paper to advance the paper in the downward direction toward a stacking platform **10**. The platform is adjustable in height and lowered by the operator or by automatic means as the stack of paper rises.

The paper engaging tractors **6** not only advance the paper, but also impart a forward and backward rocking or oscillating motion to coerce folding along fold lines **12**. The distance between fold lines **12** determines the relationship between the speed of advance of the paper and the frequency of oscillation (rocking) of the tractors. This is adjusted with a control **14** by the machine operator.

The paper moves between the buffer **4** and the tractor **6** over an air bearing **16** which is a generally semicircular sheet of material having air holes (not shown) around its surface. The air that is evacuated from the bottom of the buffer **4** is supplied under pressure to the holes in the air bearing to maintain the paper away from the bearing surface, hence reducing friction.

The operation of the mechanism is more clearly demonstrated in FIGURE 2 where dimensions are somewhat exaggerated to facilitate their description.

The web of paper **2** enters the buffer chamber **4** under the influence of reduced air pressure which is present in the lower region of the buffer due to the action of an air flow mechanism **18**, such as a fan or blower. The bottom surface **20** of the buffer contains holes to permit evacuation of air. The end walls of the buffer are not shown in FIGURE 2, but are separated from each other by a distance that is slightly greater than the width of the paper to minimize air flow into the lower region of the buffer. However, it has been found that satisfactory operation is achieved even when there is significant space at the edges of the paper.

The paper **2** is pulled from the buffer **4** and past the air bearing **16** by engaging tractors **6** which advance the paper toward the stacking platform **10**. Pressure to the air bearing is supplied by the same air flow device **18** which develops the reduced pressure in the buffer.

The engaging tractors **6** contain sprockets **22** arranged around an endless belt which is driven to advance the paper. While the tractors are being driven, their lower ends are alternately rocked to either side of the vertical direction to the positions shown by phantom lines **24**. The tractors are advanced and rocked by a tractor control mechanism **26** under the influence of signals from an optical device **28**.

The optical device **28** transmits light against two slanted mirrors **30** toward two reflectors **32**. The lights reflected by reflectors **32** is transmitted via mirrors **30** back toward photodetectors in the optical device **28**. The photodetectors, in turn, supply signals to the tractor control mechanism **26**. When the loop of slack paper in the buffer **4** exceeds a first predetermined amount, the upper light path is blocked, as shown. A further increase in the size of the loop of slack paper causes the lower light path to also be blocked. Thus, the amount of paper in the buffer controls the operation of the tractor control mechanism to advance (and rock) the engaging tractors **6** under appropriate conditions.

In accordance with the invention, a two-speed tractor control mechanism is employed, where the tractors are activated at low speed as the loop of slack paper drops below the upper light path in the buffer and are activated at high speed when the loop falls below the lower light path. As the tractors **6** are activated at high speed the loop decreases in size (because in high speed operation the tractors advance paper faster than the paper can be supplied to the buffer). When the loop of slack paper rises above the lower light path, the tractors can be switched to low speed operation again but, in the preferred embodiment of the invention, high speed operation is continued until the loop is above the upper light path, at which time the tractors are stopped.

The optical device **28** and the tractor control device **26** are not described in greater detail because optically-controlled drive mechanisms of the type illustrated are well known in many applications.

The engaging tractors and their control mechanism are shown in detail in FIGURE 3. The paper **2** contains spaced holes **8** along its edges. The tractors **6** are of well-known design consisting of an endless chain **34**, the links of which support sprockets **22** which engage the holes **8** to cause the paper to advance when the chain is driven. A paper clamp **36** holds the edge of the paper against the sprockets. The clamp is arranged so that it can be swung out of position to insert or remove the paper. A spring **38** provides for positive positioning of clamp **36**.

When paper is to be advanced (as determined by signals from the optical device **28**, FIGURE 2), a motor (not shown) operates at the desired speed, driving a shaft **40** (FIGURE 3). This motion is transmitted by gear wheel **42** to a gear wheel **44** to provide motion to the chain **34**. The gear wheel **44** is supported on a shaft **62** by bearings to permit independent motion of the gear wheel. The motion of shaft **40** is also transmitted through several gear wheels **46**, **48** and **50** to a selected gear wheel **52**. Gear wheels **48** and **50** are mounted on a support **54** which is adjustable to permit gear wheel **50** to coact with the gear wheel **52** corresponding to the distance between paper folds. The selection of gear wheel **52** is determined by the setting of control **14** (FIGURES 1 and 3). The motion of gear wheel **52** is transmitted by a crank **56** to an arm **58** to rock another arm **60**. This rocking motion is transmitted by a shaft **62** to an arm **61** which causes the lower end of the tractor to rock and, hence, effect stacking of the paper along the fold lines. Thus, the tractors are rocked in a cycle which depends upon the speed of advance of the tractors and the selected gear wheel **52** to cause the paper to fold at times corresponding to the fold lines. To insure synchronization with the fold lines, the tractor assembly is initially set to an appropriate position by an operator. This adjustment is only necessary when a web of paper is first entered into the stacker.

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 the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A web feeding device having web advancing means and a web slack buffer, characterized by a buffer comprising a downwardly-recessed, rectangular chamber and airflow means for withdrawing air from the bottom of the chamber, the dimensions of the chamber being arranged so that a loop of slack web in the chamber substantially blocks the path of air flow into the chamber to reduce the air pressure below the loop of slack web, the web advancing means being separated from the buffer by an air bearing, said airflow means including a closed conduit for directing the air withdrawn from the chamber to said bearing to pressurize said bearing.

2. In a web feeding device having web advancing means and a web slack buffer, the latter including a downwardly recessed, rectangular chamber and airflow means for withdrawing air from the bottom of the chamber, the dimensions of the chamber being arranged so that a loop of slack web in the chamber substantially blocks the path of air flow into the chamber to reduce the air pressure below the loop of slack web, the combination comprising:

means for actuating said web advancing means at a high speed and a low speed;

means for detecting the presence of said web at an upper level and at a lower level in said chamber, said levels defining the limits of a normal range of levels; and

control means responsive to said detecting means for controlling said actuating means (1) to advance said web at said high speed when the level of said web changes in a first direction to a level outside said normal range, (2) to disable said advancing means when the level of said web changes in a second direction, opposite said first direction, to a level outside said normal range; and (3) to advance said web at said low speed when the level of said web changes in said first direction to a level within said normal range.

3. The web feeding device set forth in claim **2** wherein:

said web advancing means pulls the web out of the buffer to reduce the amount of web slack therein, thereby raising said web level; and

said control means operates to cause high speed web advance when said web drops to a level below said lower level.

4. The web feeding device set forth in claim 3 wherein said web detecting means comprises:

first and second light beams traversing said chamber at said upper and lower levels; and

photosensitive means for detecting the presence and absence of said beams.

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