SHEET DRIVING AND ALIGNING MECHANISM

Filed Feb. 12, 1962 2 Sheets-Sheet 1

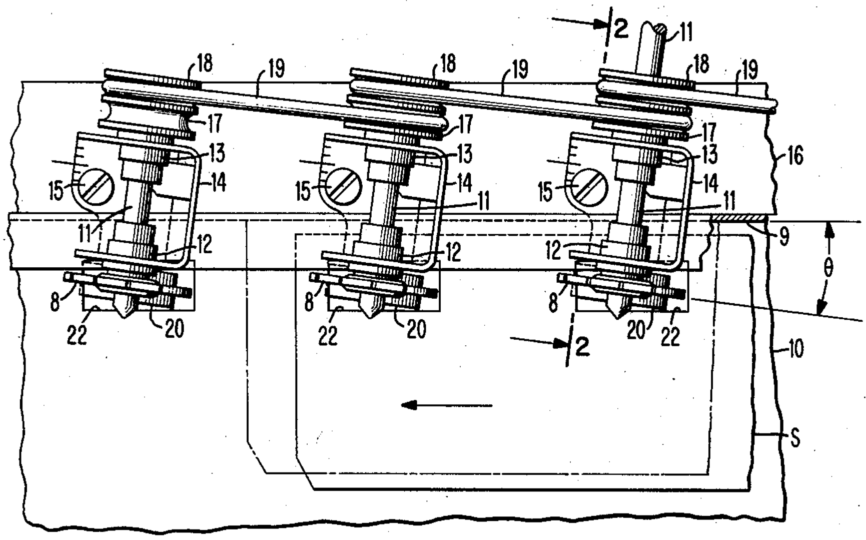

FIG. 1

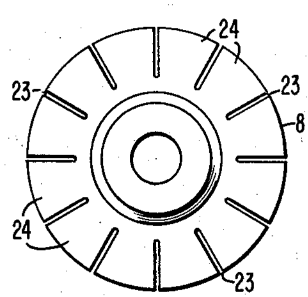

FIG. 3

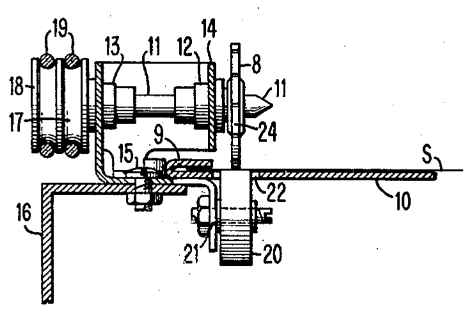

FIG. 2

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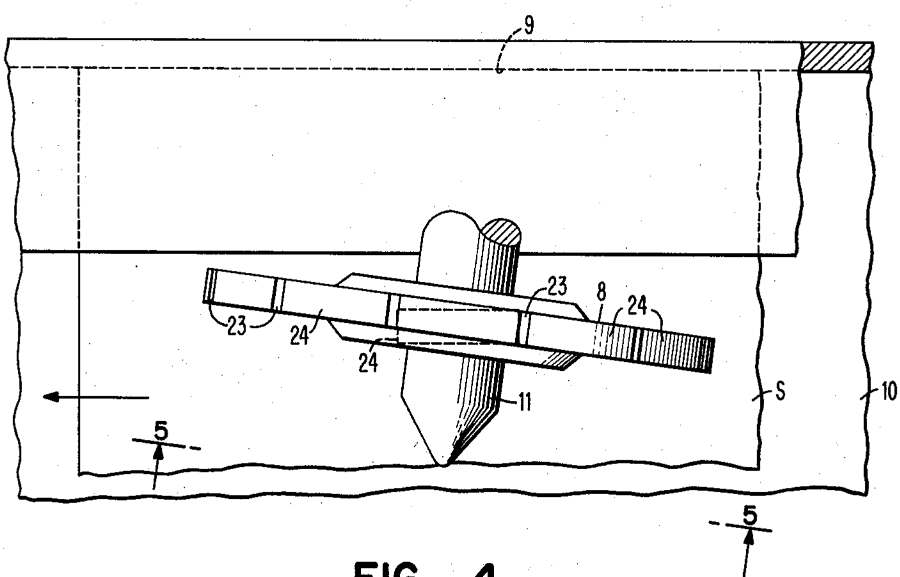

FIG. 4

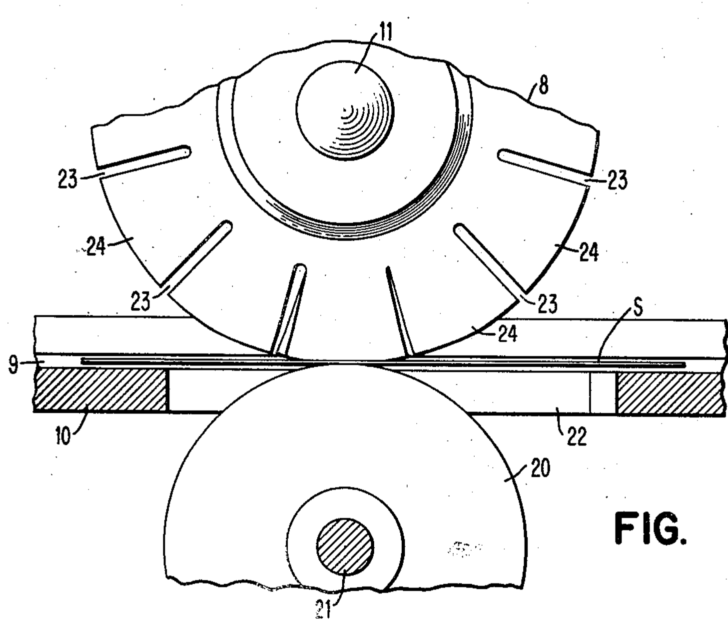

FIG. 5

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SHEET DRIVING AND ALIGNING MECHANISM

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This invention relates to sheet driving and aligning mechanisms, and more particularly to those embodying at least one combination sheet-driving and aligning member capable of aligning thin sheets against a registration edge without damage and driving them relative to said edge with a high ratio of driving force to aligning force.

It is known to provide driven aligning belts or rolls which are disposed askew the path of longitudinal travel of a sheet and cooperate with a primary drive means, such as a belt or rolls, to drive a sheet obliquely into contact with a registration edge. However, after such contact is established, the aligning belts or rolls continue to drive the sheet obliquely. With such arrangements, the sheet must have sufficient rigidity to be guided by the registration edge; and as the sheet is driven along said edge, the sheet will be scuffed as slippage occurs between the sheet and the aligning means. Obviously, such arrangements cannot be used to drive and align thin or flimsy sheets because the edge of the sheet would be damaged or the sheet would buckle or wrinkle.

It is also known to use castered idler rolls which hold a sheet in contact with a moving sheet-driving surface. These castered rolls are spring-biased normally to assume an angle oblique to the direction of motion of said surface and of a moving registration edge. After a sheet strikes the registration edge, it turns into registration with the edge and thus swivels the castered rolls against resistance of the spring bias. This spring bias increases progressively to a maximum value as the sheet becomes aligned with the registration edge; and thereafter the spring bias remains at said maximum value and acts continuously via the castered rolls to impart a large lateral or aligning component of force to the sheet, which tends to damage the edge of the sheet.

With these previously proposed arrangements, the driven aligning belt or roll or the castered idler rolls or other aligning members merely supplement, but do not take the place of, the primary sheet-driving means that must be used to drive the sheets generally parallel to and along the registration edge. Since the aligning member must drive the sheet laterally on the primary sheet-driving means to register the sheet with the registration edge, the coefficient of friction of the aligning member and the aligning force must exceed the coefficient of friction of the driving means and the driving force. Thus, the ratio of driving force to aligning force must always be less than one; and, conversely, the ratio of aligning force to driving force must be greater than one. The components of force in an aligning direction (i.e., perpendicular to the registration edge) must therefore be high, and this results in damage to the edges of the sheets. To reduce the degree of edge damage caused by these high aligning forces, it has been necessary to employ a moving registration edge and/or used curved transport or feed paths to increase the lateral rigidity of the sheets sufficiently to withstand the reactive force exerted by the registration edge on the side edge of the sheet.

It is therefore one object of this invention to provide an improved sheet driving and aligning mechanism embodying at least one low-inertia combination sheet driving and aligning member which is capable of driving a sheet at a desired oblique angle into contact with a registration edge, and is thereafter capable of altering its

driving direction progressively to enable the driving components to advance the sheet parallel with said edge without damage to or buckling of the sheet.

Another object is to provide a low-cost, compact sheet driving and aligning mechanism wherein no skidding or scrubbing of the sheets on a primary driving member occurs, and wherein a high ratio of driving force to aligning force is possible.

Another object is to provide a mechanism of the above general type wherein the aligning component of force after registration with the edge is essentially independent of the normal force and coefficient of friction of the sheet driving member.

Still another object is to provide a combination sheet driving and aligning member which limits the aligning component of force to that necessary to effect lateral deflection of the sheet-engaging portion of said member.

A further object is to provide a mechanism of the above general type which is capable of driving and aligning sheets of random varying sizes and thicknesses without requiring the use of moving registration edges or curved transport or feed paths.

According to these objects, the combined sheet driving and aligning mechanism comprises at least one endless member which is formed of material having a higher coefficient of friction than that between the sheets and a stationary guide surface. Each member is movable in a plane which is disposed at an angle oblique to the desired path of advancement of a sheet along a fixed registration edge. Each member preferably is circular and provided with a plurality of radial slots or slits extending inwardly from its outer periphery to provide a corresponding plurality of flexible sector-like fingers or sections. The composition and configuration of these sections is such that the member will have considerable rigidity or stiffness in a tangential direction but be yieldable or deflectable laterally by a relatively light force. Hence, as the sections successively come into contact with a sheet, they will drive the sheet at said oblique angle over the guide surface and toward the registration edge. However, after the sheet strikes the registration edge, the lateral resistance of said edge to the sheet will cause each section to yield laterally as it comes into contact with the sheet, thereby limiting the aligning component of force substantially to a degree corresponding to the lateral deflection strength of a single section.

Thus, no scuffing will occur prior to alignment; and after alignment, the aligning component of force will be substantially independent of the normal force and coefficient of friction. Moreover, the aligning force may be preselected to be a low value, appreciably less than the driving force. This, in turn, permits a thin sheet to be driven and aligned without buckling or damage.

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, wherein:

FIG. 1 is a plan view of a sheet driving and aligning mechanism embodying the invention;

FIG. 2 is a section view taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged elevation view of a radially slotted combination driving and aligning disc, shown in its free state;

FIG. 4 is an enlarged fragmentary plan view showing the manner in which the flexible section in contact with a sheet deflects laterally after the sheet is aligned with a registration edge; and

FIG. 5 is a fragmentary elevation view taken in the direction of the arrow 5 in FIG. 4.

Description

As shown in FIGS. 1 and 2, the sheet driving and aligning mechanism embodying the invention comprises a plurality of thin wafer-like rolls or discs 8 spaced along a desired feed path for successive sheets, such as S. These discs rotate in parallel planes, each making the same slight oblique angle θ with a common fixed registration edge 9 at one side of a stationary guide 10 defining one side of the feed path.

Each disc 8 preferably is formed of a deformable or flexible material, such as polyurethane synthetic material, having a coefficient of friction substantially higher than that between the sheets S and guide 10. As illustrated, each disc has an integral hub that is press fit over the inboard end of a shaft 11 journaled in bearings 12, 13 carried by a U-shaped upper portion of a bracket 14. This bracket has a central horizontal section that is adjustably secured, such as by screws 15, to a fixed element 16. A scale is provided on this horizontal portion of each bracket 14 to permit accurate adjustment of the angularity of each disc relative to the registration edge 9. This scale also helps assure that each disc 8 will be adjusted to the same angle θ.

Suitable means is provided to drive all discs 8 at, as nearly as possible, the same peripheral speeds. In the embodiment illustrated, the disc-driving means is modularized. Each module includes a power take-off pulley 17 and a driven pulley 18 which are keyed or otherwise secured to the outboard end of each shaft 11 so as to rotate therewith; and the pulley 17 of one module drives the pulley 18 of the next module through a corresponding belt 19.

As illustrated, a freely rotatable idler roll 20 (see FIG. 2) is mounted below and in vertical alignment with each disc 8 to provide a sheet-gripping bite into which successive sheets are advanceable. Each roll 20 is rotatably supported on a stub shaft 21 and has a peripheral surface formed of material having a low coefficient of friction. Each shaft 21 is carried by a down-turned lower portion of the adjustable bracket 14; and each roll 20 projects upwardly through a cut-out or slot 22 in the guide 10. Since the shafts 11, 21 are both carried by the bracket 14, they will always remain in vertical alignment with each other irrespective of the adjusted position of the bracket.

As best shown in FIG. 3, each disc 8 has a plurality of narrow slots 23 which extend inwardly from the outer periphery of the disc and divide it into a plurality of equally sized flexible sectors or sections 24. While the rotating discs 8 are driving a sheet at the aforementioned slight oblique angle θ toward registration edge 9, each section 24 upon being rotated into contact with the sheet may be driven rearward a slight distance toward the succeeding section, correspondingly reducing the width of the intervening slot 23. Whether or not this occurs, however, depends upon the selected stiffness of the material of which disc 8 is made and the minimum width and overall length of the sections. In any event, the discs are constructed to have a strength and rigidity sufficient to provide a desired driving force when driving a sheet at said angle. However, each flexible section 24 has a lateral deflection strength which is intentionally limited to an amount governed by the stiffness of the sheets, so that after a sheet strikes the registration edge 9, the aligning or lateral component of force will cause lateral deflection of such section rather than damage to the sheet. Such deflection will be in a direction generally away from the registration edge, as best shown in FIGS. 4 and 5. Due to the spacing between sections provided by the slots 23, this lateral deflection of one section can be readily accomplished without frictional scraping contact of that section with the adjacent section.

Summary of Operation

Assume that the discs 8 are being rotated by the drive belts 19, but that no sheet is between the discs and corresponding idler rolls 20. As a sheet S enters between successive discs 8 and their corresponding mating idler rolls 20, the discs will drive the sheet at said angle until it contacts the registration edge 9. As the discs continue to rotate in contact with the sheet, they will drive the sheet longitudinally, i.e., parallel to edge 9 in the embodiment illustrated; however, the lateral resistance offered to the sheet by the registration edge will cause each flexible section 24 to yield laterally as it comes into contact with the sheet. Thus, the aligning component of force exerted by each sheet-contacting disc 8 is limited to that corresponding to the lateral deflection strength of each successive single section of that disc, plus the very slight force exerted by each corresponding sheet-contacting idler roll 20. The latter force equals the product of the normal force and low coefficient of friction of the idler roll 20.

This aligning component of force varies according to the stiffness of the material of which the discs are composed, being greater as the stiffness increases. Thus, if exceptionally thin and light-weight sheets (like tissue paper) are to be driven and aligned, the discs should be formed of material which is quite flexible in order to keep the aligning component of force at an absolute minimum and prevent edge damage to the sheets. However, if thicker and heavier sheets are to be processed, the discs preferably should be of stiffer material to provide a high enough aligning component of force to maintain these sheets aligned despite the increased weight and inertia of the sheets.

Assuming that the discs 8 are made of a given material, the aligning component of force can also be modified by changing the thickness of the discs, and/or the widths of the sections at their narrowest points (i.e., near the disc axis), and/or the depth of the slots 23 and/or the oblique angle θ. For example, the aligning force can be reduced by reducing the thickness of the discs and/or the widths of the sectors and/or the angle θ and/or increasing the depths of the slots 23.

The driving force of each disc 8 is, of course, determined by the coefficient friction of the disc and normal force exerted by the disc on the sheet. As already stated, the entire driving force acts to drive the sheet at the oblique angle θ toward the registration edge 9 until the sheet contacts said edge; and there is no scuffing of the sheet prior to its striking said edge. The component of driving force in a longitudinal direction (i.e., parallel to the registration edge) does not change significantly after the sheet contacts said edge. It remains the same as prior to such contact except for the substantially negligible frictional drag imposed on the side of the moving shreet by the stationary registration edge 9.

Although, for a given sheet, the component of driving force and sheet velocity in the longitudinal direction remain substantially constant, the magnitude of the longitudinal component of driving force will vary according to the thickness of the sheet. Thus, as sheets increase in thickness, the normal force and hence the longitudinal component of driving force will increase accordingly. However, this is desirable because the greater thickness of the sheet means greater sheet mass, thus requiring greater driving forces to maintain the sheet speed. Thus, despite variations in actual driving force caused by variations in sheet thickness and hence in normal force, the sheet velocity will tend to remain substantially constant.

It should here be noted that the discs 8 may, if preferred, be thin unslotted wafer-like discs which are sufficiently flexible to be able to deflect laterally after alignment of a sheet with the registration edge 9. In such case, the aligning component of force would, of course, correspond to the force necessary to effect lateral deflection of the sheet-contacting portion of the continuous disc, plus the product of the normal force and coefficient of friction of the idler roll 20.

However, use of the slotted discs 8, as herein illustrated, is deemed preferable for several reasons: They provide aligning force control factors (like the slot width and depth and sector width) which can be varied independently of other common factors (like the thickness and stiffness of the disc material) which influence both aligning force and driving force. Thus, controlled slotting of the discs provides a means for facilitating achievement of a desired ratio between driving force and aligning force, or in other words, between stiffness in the tangential driving direction and deflection in the lateral direction. Also, where a plurality of slotted discs **8** are used to align each sheet, the slots provide a built-in speed compensation feature between the respective discs. For example, if one disc tends to rotate at a peripheral speed somewhat higher than another, each section of the faster disc upon coming into contact with a sheet will be somewhat overloaded in relation to those of the slower disc. This will cause that overloaded section to be shifted rearward toward the following section, partially closing the intervening slot **23**, until the shifted section leaves the sheet; whereupon said section will snap back to its normal position. The extent of such closure will depend upon the degree by which the speed of the faster disc exceeds that of the slower or slowest disc. This tangential movement of one section **24** relative to the adjacent section results in all discs tending to impart equal driving forces to a sheet and drive it at the same speed despite minor variations in peripheral speeds of the discs.

In the embodiment illustrated, each disc **8** is associated with an idler roll **20**. This desirably permits a sheet to be driven with lower normal forces than would otherwise be required. Also, it reduces wear of the discs substantially below that which would be encountered if the discs were permitted to rotate in contact with a stationary surface while no sheets were being driven. Of course, if preferred, each disc could be spaced with slight radial clearance from the idler roll **20** or stationary low friction surface of guide **10** to prevent wear and abrasion of the discs when no sheets are in contact therewith. However, such spacing is not deemed preferable because the radial clearance must, of course, be critically adjusted to a value somewhat less than the minimum thickness of the thinnest sheet, and this is very difficult to achieve, especially where thin sheets are to be handled.

In the embodiment illustrated, each idler roll **20** is shown as continuously rotatable in the same oblique plane as that in which the corresponding disc **8** rotates before a sheet contacts registration edge **9**. Since both the disc **8** and roll **20** move in closed paths lying at the selected oblique angle θ to the registration edge, they cooperate to drive a sheet into contact with said edge without scuffing. Because roll **20** is disposed at angle θ, the aligning component of force after registration of a sheet with edge **9** corresponds to the lateral deflection strength of a single section **24**, plus the product of the normal force and low coefficient of friction of the idler roll, as already noted. If preferred, though, this aligning component of force could be reduced merely to the lateral deflection strength of a single sector and said product eliminated by having the idler roll **20** always rotate in a plane parallel to the registration edge **9**. However, this would require the use of stiffer material in the disc to assure sufficient driving force to carry the sheet into alignment with the registration edge because the idler roll would tend to resist such alignment as it is driven parallel to said edge by the sheet.

It will thus be seen that with a sheet driving and aligning mechanism constructed according to the invention, sheets of random varying sizes and thicknesses can be aligned without requiring curved feed paths or moving aligning or registration edges. The mechanism is of low inertia and can provide high normal and hence high driving force and yet provide low aligning forces; and this makes it highly desirable for use in apparatus wherein sheets are to be started and stopped rapidly, such as in intermittent or incremental clutched feed applications. Moreover, the aligning force is controllable through selection of the stiffness of the material used in the discs **8**, as well as by selection of the slot depth and section width and adjustment of the oblique angle θ. Furthermore, the discs may be made of a high friction material which permits a small normal force, to provide any desired pull-out force. In addition, the discs may be readily molded or stamped out and are readily replaceable, thereby reducing costs material. No skidding or scrubbing of a sheet occurs prior to alignment, and a minimum of scrubbing occurs after alignment because of the crab-like twisting of the individual sections **24**. A high ratio of driving force to aligning force is possible, enabling the feeding of thin sheets without damage or buckling.

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. Sheet driving and aligning mechanism comprising:
means providing a registration edge, and
an endless member having a hub portion rotating in a predetermined constant plane at an angle oblique to said edge and a sheet-contacting portion for initially driving a sheet into contact with said edge and thereafter laterally deflectable relative to the hub portion by the resistance offered to the sheet by said edge,
whereby the lateral aligning component of force after such contact will vary according to the preselected lateral deflection strength of such sheet-contacting portion of said endless member.

2. Sheet driving and aligning mechanism comprising:
means providing a registration edge, and
means for driving sheets obliquely into contact with said edge and then driving them longitudinally in the direction of said edge, the driving means including at least one rotating disc, each having a non-varying axis of rotation so as to rotate in a respective preselected non-varying plane oblique to said edge and having a sheet-contacting portion which is substantially unyieldable when driving a sheet obliquely but after such contact is laterally deflectable by the resistance offered to the sheet by said edge,
thereby after such contact to limit the lateral aligning component of force on the sheet to that corresponding generally to the preselected lateral deflection strength of the sheet-contacting portion of each disc.

3. Sheet driving and aligning mechanism comprising:
means providing a sheet-supporting guide surface,
means providing a registration edge joining said surface,
at least one roll, each having a respective preselected substantially constant axis of rotation oblique to said edge and exposed through an aperture in said surface, and
a driven disc cooperating with each roll and having a constant axis of rotation contained in the same plane as the axis of rotation of the corresponding roll to provide a sheet-receiving bite, each disc being substantially unyieldable when driving a sheet within the bite at substantially right angles to the corresponding plane but having at least one portion which after such contact is laterally deflectable relative to the remainder of the disc by the resistance offered to the sheet by said edge,
whereby the lateral aligning component of force on the sheet after such contact will correspond substantially to the lateral deflection strength of that portion of each disc contacting the sheet, plus the product of the normal force and coefficient of friction of each such roll contacting the sheet.

4. Mechanism according to claim 3, wherein:
each roll is an idler roll, and

the guide surface and the registration edge are stationary.

5. Sheet driving and aligning mechanism comprising:
means providing a stationary registration edge, and
at least one endless member for driving a sheet at an oblique angle into contact with said edge and then driving the sheet along said edge in alignment therewith, each endless member comprising a plurality of contiguous sheet-engageable portions formed of flexible material, said portions upon contacting a sheet being substantially unyielding while driving the sheet at said angle but each being independently laterally deflectable relative to the remaining portions after contact of the sheet with said edge,
whereby the aligning component of force acting on the sheet after it contacts said edge will vary according to the lateral deflection strength of each portion which successively contacts and drives the sheet.

6. Mechanism according to claim 5, wherein:
each endless member is substantially circular, and
the sheet-engageable portions of each endless member are sectors defined by slots extending inwardly from the sheet-engaging outer periphery of such member,
the width of these slots between adjacent sectors being sufficient to permit each sector, upon its successively contacting a sheet, to deflect laterally without scrubbing against the adjacent sector.

7. Mechanism according to claim 6, wherein:
the depth of the slots and the minimum width of each sector and the material of which the sheet-engageable portions is composed are so selected as to provide a predetermined ratio of driving force to aligning force.

8. Sheet driving and aligning mechanism comprising:
means providing a stationary sheet-supporting guide surface,
means providing a registration edge joining said surface, and
an endless member movable in a predetermined constant plane oblique to said edge and divided into a plurality of contiguous sheet-engageable sections formed of flexible material that is substantially rigid for driving a sheet generally in the direction of said plane and toward said edge,
each section, upon contacting the sheet after the sheet has contacted said edge, being deflectable laterally to provide an aligning component of force on the sheet which is essentially independent of the normal force and coefficient of friction of the endless member.

9. Mechanism for driving a sheet relative to a sheet-engageable surface and into alignment with a registration edge, said mechanism including:
at least one deformable disc divided into a plurality of contiguous laterally yieldable sheet-engageable sections, and
means for rotating each deformable disc in a respective constant plane oblique to said edge to cause each sheet to be driven obliquely by successive sections toward said edge until such sheet contacts and aligns against said edge, and then cause each section upon coming into contact with the sheet to yield laterally substantially independently of the others and twist a degree necessary to provide a relatively low aligning component of force sufficient to maintain the sheet aligned with said edge as it is driven therealong but insufficient to damage the edge of the sheet.

10. Mechanism according to claim 9, wherein:
the sections are separated by slots extending generally radially inward from the outer periphery of each deformable disc,
the slots being of sufficient width to permit lateral yielding of each section without significant scrubbing contact with the adjacent section.

11. Mechanism according to claim 9, including:
means for adjusting the position of each deformable disc to preselect the oblique angle its plane of rotation makes with the registration edge.

12. Sheet driving and aligning mechanism comprising:
means providing a registration edge, and
means for driving sheets obliquely and into contact with said edge and then driving them longitudinally in the direction of said edge,
the driving means including a plurality of discs each rotating in parallel planes which are at substantially the same oblique angle to said edge and each divided into a plurality of sections separated by generally radial slots,
the configuration and composition of the sections being such that each disc has considerable rigidity in its said plane for driving a sheet at said angle into contact with said edge but each section upon striking the sheet after such contact being deflectable laterally independently of the others by the resistance offered by said edge to the sheet,
each section when overloaded being movable arcuately rearward relative to the forwardly advancing next following section as permitted by partial closure of the intervening slot,
whereby if the peripheral speeds of each disc differ, each sheet-contacting section of the fastest moving disc can yield arcuately rearward and thus tend to reduce the effective speed of that disc for providing a speed-compensating feature that will tend to cause each disc to impart equal driving forces to a sheet.

13. A sheet driving member movable in a closed path and comprising:
a plurality of contiguous sheet-engageable sections formed of flexible material and substantially unyielding when driving a sheet in the plane of said path,
each section being individually laterally deflectable such that if the sheet encounters an obliquely arranged obstruction, each section upon striking the sheet can yield laterally relative to the remaining sections and thus limit the component of driving force in a lateral direction to a degree governed essentially by the lateral deflection strength of a single section.

References Cited in the file of this patent

UNITED STATES PATENTS

2,165,161	Spiess	July 4, 1939
2,300,625	Martin	Nov. 3, 1942
2,767,982	Noon	Oct. 23, 1956
2,888,261	Barnes	May 26, 1959
2,995,364	Frederick et al.	Aug. 8, 1961