June 3, 1952 — A. A. NEESE — 2,598,820

SYNCHRONOUS DRIVE

Filed Nov. 29, 1949 — 4 Sheets-Sheet 1

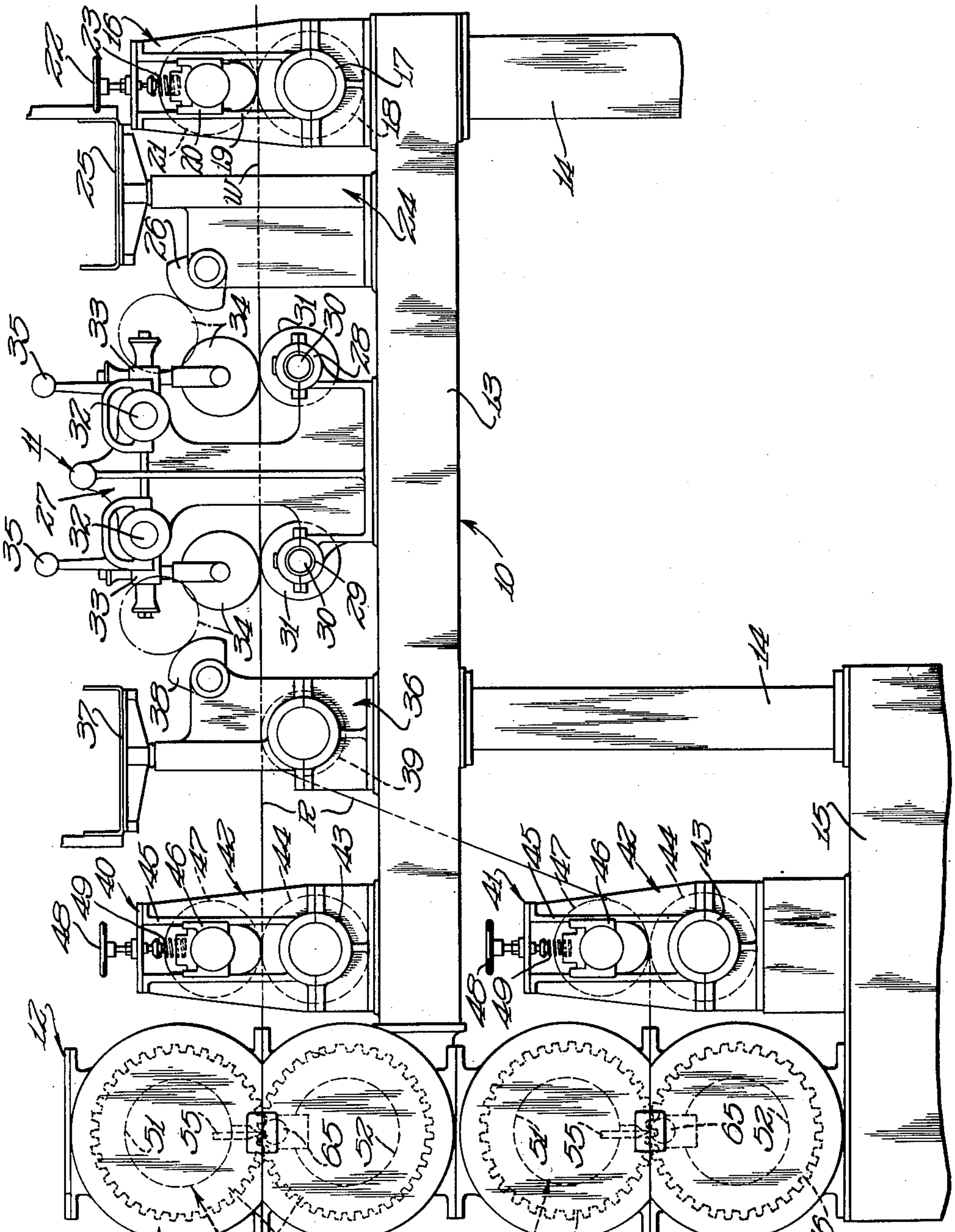

Fig.1

Inventor
Alonzo A. Neese

By The Firm of Charles W. Hills Attys

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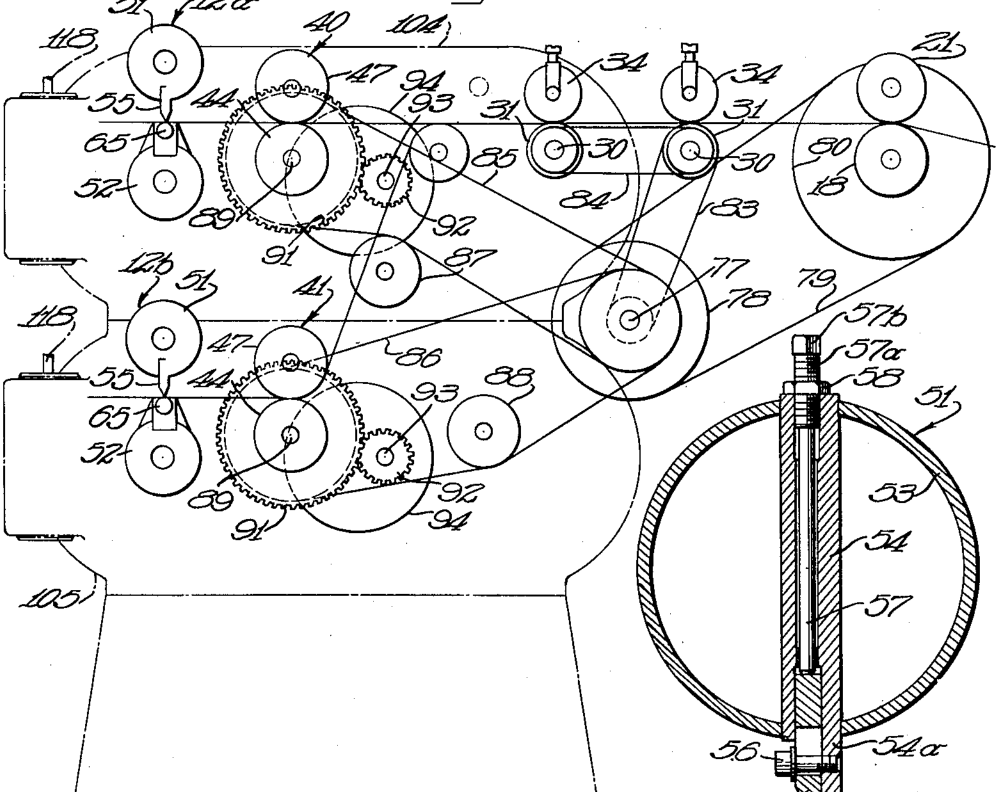
Fig. 2



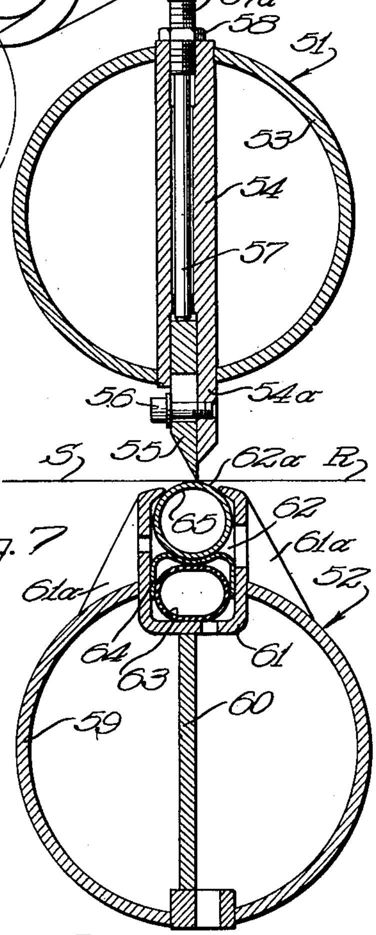


Fig. 7

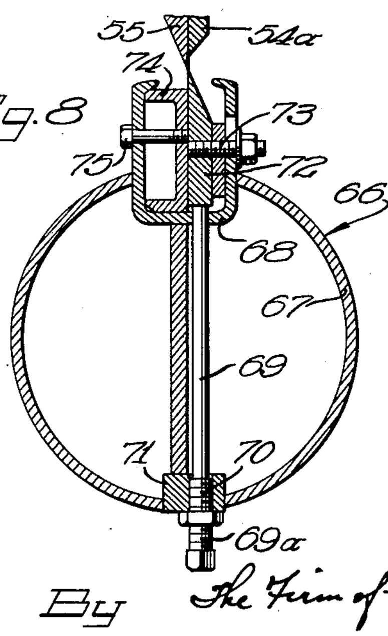


Fig. 8

Inventor
Alonzo A. Neese
By The Firm of Charles W. Hills Attys

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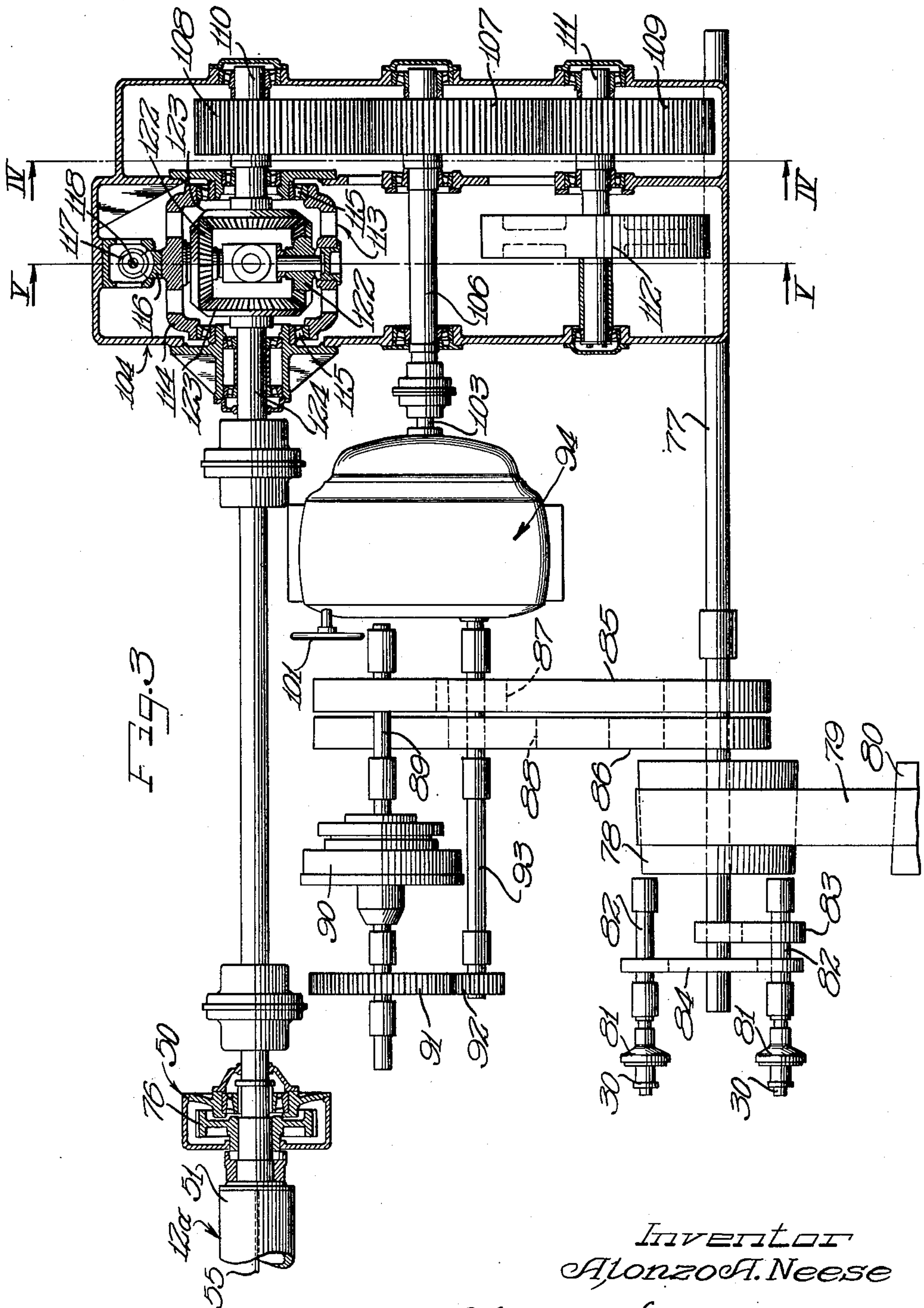

Fig. 3

Inventor
Alonzo A. Neese
By The Firm of Charles W. Hills Attys

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Fig. 4

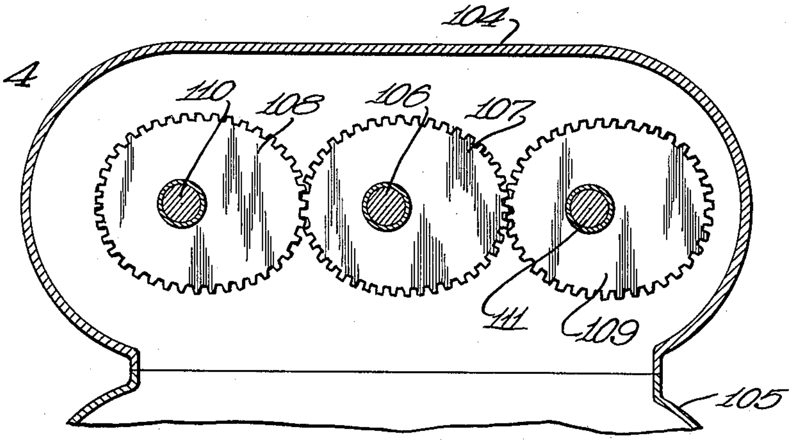


Fig. 5

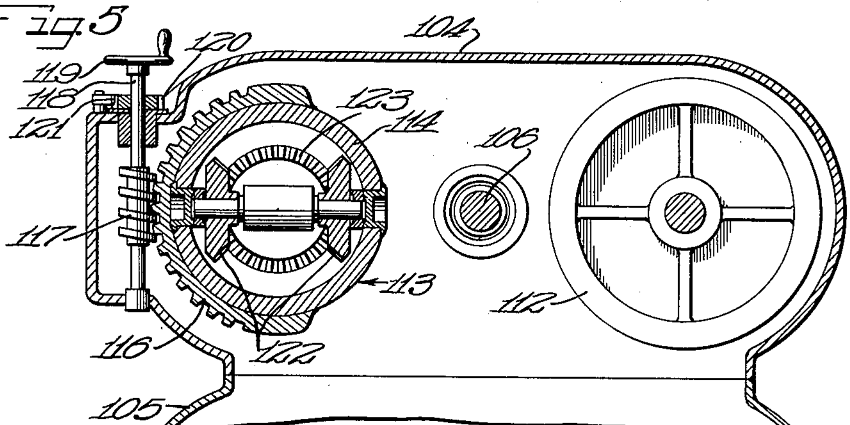
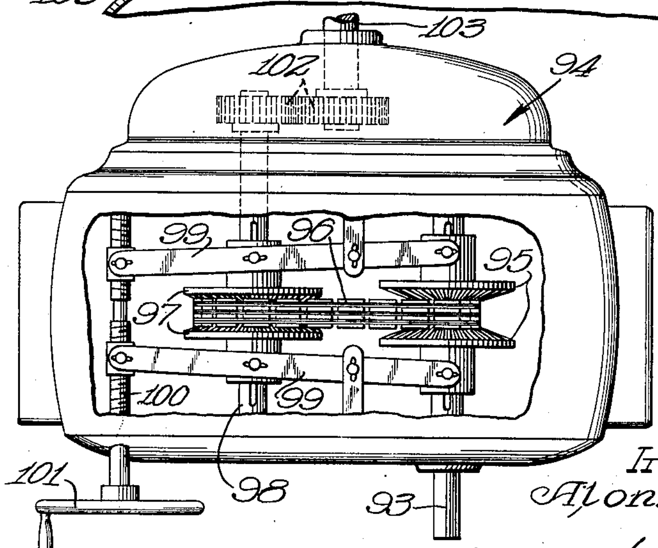


Fig. 6



Inventor
Alonzo A. Neese
By The Firm of Charlesworth Atty's

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2,598,820

UNITED STATES PATENT OFFICE

2,598,820

SYNCHRONOUS DRIVE

Alonzo A. Neese, Beloit, Wis., assignor to Beloit Iron Works, Beloit, Wis., a corporation of Wisconsin

Application November 29, 1949, Serial No. 130,058

1 Claim. (Cl. 164—61)

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This invention relates to a drive capable of alternate acceleration and deceleration even at high rates of speeds without requiring corresponding alternate surges of power input and inertia braking.

Specifically, this invention deals with a sheet cutter which can be easily set to have a desired speed at the instant of cutting and a mean speed which is independent of the instantaneous cutting speed wherein power-absorbing and releasing mechanism will neutralize variations in power requirements due to the variations in mean and instantaneous speeds.

In cutters for traveling web material such as paper, it is desirable to move the cutting knives at the same speed at which the web is traveling, so that, at the instant of cut, the knives will not tear or buckle the traveling web. However, since the knives must be placed in cutting position at the exact instant that a predetermined length of web has passed beyond the knives, in order that the desired sheet length will be severed from the web, the required speed of travel of the knives between cutting operations may bear no relation whatsoever to the desired instantaneous speed at the time of cut. To provide a mechanism which will accommodate different web speeds and will cut different sheet lengths, it is necessary that the instantaneous speed at the time of cut and the speed of travel of the cutters between the cutting operations be independent of each other. It is also highly desirable that easily adjustable control means be provided for these independent speed factors. Further, since the variable mean and instantaneous speeds will require acceleration and deceleration of the cutting knives, it is highly desirable that alternate peak power loads and inertia braking loads be avoided.

The present invention now provides a cutter wherein the cutting knives or blades can be easily set to travel at the speed of the web being cut during the cutting operation and then travel at any desired speed between cutting operations so that they will be in position for the next cutting operation after a predetermined length of the web has passed therebeyond. The cutters of this invention are adapted to be quickly set to accommodate a wide range of web traveling speeds and to cut sheets of any desirable lengths. The cutters of this invention are driven by a synchronous drive mechanism which is so balanced that a constant power input can be used. The neutralization of power surges and inertia braking is accomplished through the use of a non-circular conjugate gear train and a flywheel driven by

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the gears. The arrangement is such that the flywheel will absorb energy during periods of deceleration of the cutter knives and will then release the absorbed energy during periods of acceleration of the cutter knives.

A feature of the invention includes an easily adjusted differential gear drive which will control the position of the cutter knives relative to the position of the non-circular driving gear so that the instantaneous speed of the cutter knives at the time of cut can be accurately set.

A further feature of the invention resides in the provision of a synchronous drive capable of delivering power through repeating accelerating and decelerating cycles without creating a backlash in the driving connections so that a non-slipping type of speed changer can be directly coupled to the drive assembly.

A further feature of the invention resides in the provision of a multiple cutter drive which will actuate a plurality of units through exactly controlled cutting cycles at independent speeds and still be driven from a single source.

It is, then, an object of this invention to provide a synchronous drive especially useful for web cutters which will deliver rotating power in repeated cycles of alternating acceleration and deceleration without requiring correspondingly alternate power surges and inertia braking on the power input side thereof.

Another object of the invention is to provide a synchronous drive wherein a train of elliptical gears has one end gear coupled to a flywheel and another end gear coupled to the pinion gears of a differential unit while an intermediate gear drives the end gears from a constant source of power and causes the alternate acceleration and deceleration of the differential unit and the alternate absorption and release of energy by the flywheel.

A specific object of the invention is to provide a cutter capable of slitting a web of paper into a plurality of ribbons and selectively severing the ribbons into desired sheet lengths while driven from a single source at independent instantaneous and mean speeds.

A still further object of the invention is to provide a device for neutralizing variations in power requirements for delivering alternate accelerating and decelerating rotating power.

A further specific object of the invention is to provide a paper cutter adapted to be driven at desired independent instantaneous and mean speeds without requiring a prime mover which accelerates and decelerates to accommodate the speed variations.

Other and further objects of the invention will be apparent to those skilled in the art from the following detailed description of the annexed sheets of drawings which, by way of a preferred example only, illustrate one embodiment of the invention.

On the drawings:

Figure 1 is a side elevational view of a multiple unit paper cutter and slitter machine of this invention.

Figure 2 is a somewhat diagrammatic elevational view showing the machine of Figure 1 in outline and illustrating the drive for the machine.

Figure 3 is a top plan view, with parts in horizontal cross section, of the drive for the machine of this invention.

Figure 4 is a vertical cross-sectional view taken along the line IV—IV of Figure 3.

Figure 5 is a vertical cross-sectional view taken along the line V—V of Figure 3.

Figure 6 is a top plan view, with parts cut away to show underlying parts, of a speed changer used in the drive.

Figure 7 is a transverse cross-sectional view of one set of cutters for the machine of this invention.

Figure 8 is a view similar to Figure 7, but showing a different type of anvil for the cutter.

As shown on the drawings:

The machine **10** shown in Figure 1 of the drawings is composed of a slitter section **11** and a multiple cutter section **12**. The slitter section **11** is on a level with the top cutter unit and is mounted on suitable elevated framework **13** carried by uprights **14**. The multiple cutter machine **12** is mounted on a bed frame support **15**.

The cutter section **11** includes a feeder or draw roll unit **16** which includes a stationary bearing **17** for a bottom roll **18** and a vertical guide **19** for slidably mounting a bearing **20** for a top roll **21**. A hand wheel manipulated screw **22** acts on each bearing **20** for the top roll **21** to compress a spring **23** for loading the top roll inpressure nip relation with the bottom roll. A web of paper W is fed through the nip.

Suitable framework **24** on the frame **13** supports a crosswalk **25** adjacent the unit **16** and a sector-measuring device **26** for a purpose to be hereinafter described.

Framework **27** for a multiple slitter assembly is mounted on the frame **13** adjacent the frame **24**. This slitter frame **27** includes bottom bearings **28** and **29** each rotatably supporting a shaft **30** on which are mounted the bottom slitter bands **31** in the proper longitudinal relationship. Top shafts **32** are rotatably mounted on the frame **27** above the shafts **30** and these shafts carry slitter frames **33** which rotatably support the top slitters **34** which cooperate with the bottom slitter bands **31** to cut the web W into ribbons of the desired width.

Handles **35** are provided on the frames **33** to swing the frames about the shafts **32** and move the top slitters from the solid line position to the dotted line position.

A sub-frame **36** is mounted in front of the slitter frame **27** and supports a cross walk **37** and a sector member **38** identical with the cross walk **25** and sector **26**. This frame **36** also rotatably carries a guide roll **39**.

Only one set of cooperating slitters **31** and **34** are used at a time, but it should be understood that a plurality of slitters and slitter bands may be mounted along the length of their shafts to cut the web W into any desired number of ribbons. The idle slitter unit has the handle **35** thereof swung to a horizontal position for moving the top slitters **34** to the dotted line positions adjacent their sectors **26** or **38**. These sectors have marking indicia thereon so that the top slitters can be set to cut any desired width when they are lowered. The bottom slitters **31** are adjustable longitudinally of their shafts **30** and these shafts have corresponding marking indicia thereon. Therefore, the idle set of slitters on either the right or left hand sides of the frame **27** can be set to cut ribbons of the desired width while the other set of slitters is cutting a different type of ribbon arrangement. This double slitter unit therefore makes possible a quick change in slicing the web W without stopping the travel of the web. The ribbons R formed from the web W are directed from the slitter unit **27** over the guide roll **39** to separate draw roll units **40** and **41** of the multiple cutter machine **12**. Thus, the top draw unit **40** will receive one ribbon while the bottom draw unit **41** will receive the adjacent ribbon.

Each draw roll unit **40** and **41** includes a frame **42** providing fixed bearings **43** for bottom rolls **44** and guides **45** for slidable bearings **46** which rotatably support top rolls **47**. Hand wheel manipulated screw rods **48** are provided on the top of the frames **42** to compress springs **49** acting on the sliding bearings **46** for urging the top rolls **47** into pressure nip relation with the bottom rolls **44**.

A vertical stack of gear casings **50** is mounted in front of the draw roll assemblies **40** and **41** at both the front and rear sides of the cutter machine. These casings rotatably support the pairs of coacting revolving knives and anvils for each cutting machine.

A top cutting machine **12***a* and a bottom cutting machine **12***b* are thus supported in superimposed relation.

As best shown in Figure 7, each cutting machine has a top rotating knife unit **51** and a coacting bottom rotating anvil unit **52**. The knife unit **51** is composed of a cylinder **53** which is bisected by a blade carrier **54**. This carrier **54** has a projecting lip portion **54***a*, the front face of which receives the cutter blade **55**. The blade is secured in position on the lip by means of tightening screws **56** threaded into the lip as shown.

An adjusting rod **57** extends into the blade support **54** for abutting the inner edge of the blade **55**. This rod **57** has a threaded end **57***a* which is threaded into a sleeve **58**. The sleeve **58**, in turn, is threaded into the end of the support opposite the end receiving the blade **55**. The threaded end **57***a* of the rod has a head **57***b* adapted to be easily engaged by a wrench. Rotation of the rod will therefore raise and lower it so that the blade **55** can be accurately adjusted in the holder **54**. A plurality of rods **57** are provided along the length of the holder **54**.

The anvil **52** of Figure 7 is composed of a cylinder **59** bisected by a support plate **60** which backs up a box-like channel beam **61** extending through one face of the cylinder and having its projecting portion reinforced by ribs **61***a*. The channel **61** defines a chamber **62** having a gap or slot **62***a* along its upper face. An inflated tube **63** of rubber or the like resilient material is mounted in the inner end of the chamber **62** and acts on a slidable retainer 64 in the chamber. An anvil tube 65 is seated in the chamber on the retainer 64 and partially projects through the slot or gap 62*a* to coact with the edge of the blade 55 for severing the leading end of the ribbon R into sheets such as S. The tube 63 provides a cushion for the anvil 65 and the degree of inflation of the tube will determine the degree of resiliency of the cushion.

In place of the rotating anvil 52 of Figure 7, a modified anvil 66 of Figure 8 can be used for coacting with the blade 55. In this modified arrangement, a cylinder 67 carrying the box-like channel beam 68 receives a plurality of adjusting rods such as 69 with threaded ends 69*a* threaded into sleeves 70 which are threaded into a block 71 carried by the cylinder 67. The rods 69 project into the channel beam 68 and act on the inner end of a knife 72 for coacting with the knife 55. Screws such as 73 will tighten the knife in position in the beam 68 while a channel beam 74 held in position by screws 75 backs up the blade 72.

As shown in Figure 1, each pair of cylinders 51 and 52 is geared together by gears 76 in the casings 50. It is preferred to have gears at each end of the cylinders to prevent back lash. The geared together cylinders will thereby rotate in unison to provide the cutter nips for the ribbons R. As best shown in Figures 2 and 3, both the slitter section 11 and the cutter section 12 of the machine 10 are driven from a main line shaft 77. This shaft drives the first feed rolls or draw rolls 18 and 21 through a belt connection including a driving tapered pulley 78 on the shaft 77, a belt 79, and a reversely tapered pulley 80 receiving the belt and coupled with the bottom roll 18. The tapered pulley arrangement provides an adjustment in relative speed of the shaft and feed rollers.

In the belt drives herein described, single flat belts and pulleys have been shown for purposes of simplicity. However, it should be appreciated that V-belts and multiple grooved pulleys might be preferred.

The bottom slitter bands 31 are driven from their shafts 30 which shafts, in turn, are connected through clutches 81 (Figure 3) with drive shafts 82 suitably carried in bearings. The drive shaft 82 for the first shaft 30 is driven through a belt connection 83 from the shaft 77, while the second shaft 82 is driven from the first shaft 82 by a belt connection 84.

The top draw roll unit 40 is driven from the line shaft 77 through a belt connection 85 while the bottom draw roll unit 41 is driven from the shaft 77 through a belt connection 86. Suitable tightener rolls 87 and 88 coact respectively with the belts 85 and 86 to maintain these belts in tight condition. The belt 85 drives a shaft 89 having a clutch 90 therein coupled to the bottom roll 44 of the top draw roll unit 40. The belt 86 drives a similar shaft and clutch coupled to the bottom roll 44 of the bottom draw roll unit 41. Each clutch 90 also drives a gear 91 which is meshed with a gear 92 on a power input shaft 93 to a speed changer unit 94.

As shown in Figure 6, each speed changer unit 94 has slidable toothed gear or pulley segments 95 on the input shaft 93 driving a band 96 which is also trained around a similar pair of toothed segments 97 keyed to a shaft 98. Levers 99 controlled by a screw rod 100 from an adjusting handle 101 regulate the relative spacing of the segments of each pair so that the band 96 will transmit power to shaft 98 at a controlled speed ratio relative to the rate of speed of the input shaft 93. The shaft 98 is geared through a gear train 102 with an output shaft 103. Manipulation of the handle 101 therefore will vary the speed of the output shaft 103 relative to the speed of the input shaft 93.

As shown in Figure 2, superimposed casings 104 and 105 are provided for the gear train and differential units of the synchronous drive of this invention. Each casing houses a train of non-circular conjugate gears driven from the output shaft of the speed changer 94 for each cutter machine. Since the superimposed synchronous drives are identical, the top drive only of Figures 3 to 5 will be described.

As shown in Figure 3, the output shaft 103 of speed changer 94 is coupled to a shaft 106 which is rotatably mounted in the top casing 104 on suitable bearings. An elliptical gear 107 is secured on the shaft 106 and meshes with elliptical gears 108 and 109 respectively mounted on shafts 110 and 111 carried by the casing. The shaft 111 has a fly-wheel 112 mounted thereon in the casing 104. As shown in Figure 4, all three shafts 106, 110, and 111 are in horizontal alignment and the meshing gears 107, 108, and 109 are in horizontal alignment. The end gears 108 and 109 simultaneously mesh with diametrically opposite sides of the center gear 107.

A differential unit 113 is mounted in the casing 104 adjacent the shaft 110 and is driven by this shaft. As best shown in Figure 3, the differential gear unit 113 includes a cage 114 rotatably mounted on bearings 115 in the casing. This cage 114, as best shown in Figure 5, has gear teeth 116 extending partially therearound and meshing with a worm 117 on a vertical shaft 118 projecting through the top of the casing 104 and manipulated by a hand wheel 119. A gear 120 on the shaft 118 coacts with a dog 121 on the casing to lock the rod 118 against rotation.

The cage 113 rotatably carries opposed pinions 122 meshed with mating opposed pinions 123. One of the pinions 123 is coupled to the shaft 110. The opposed pinion 123 is coupled to the input shaft 124 to the top rotary knife unit 51 and to the gears 76 for driving the anvil 52 for this unit.

Since the cage 114 is adapted to be rocked about its axis by manipulation of the hand wheel 119, the relative positions of the gear 108 and knife 55 on the top knife unit 51 can be changed without uncoupling any of the drive assembly. In normal operation, however, the cage 114 is locked against movement and the gear 108 will drive the input shaft 124 through the meshed pinions 122 and 123 while all of these pinions are rotating on fixed axes. Rocking of the carriage 114, in changing the positions for the axes of the pinions 122, will effect rotation of the output shaft 124 relative to the shaft 110.

Since the gears 107, 108, and 109 are non-circular, and are preferably elliptical, their peripheral contour will be variably spaced from their axes and peripheral speeds will vary in proportion to the variation in radial length from the center to the periphery of the gear. As a result, rotation of the driving shaft 106 at a constant preselected angular speed will result in variation in driving speeds of the shafts 110 and 111 from a minimum imparted by the portion of the gear 107 which has the shortest radius to a maximum imparted by the peripheral portion of the gear which has the longest radius. Thus, in the positions shown in Figure 4, the instantaneous speed of the shaft 110 will be less than the speed of the driving shaft 106 because the gear 107 is driving through its shortest radius while the gear 108 is transmitting this drive through its longest radius. However, the shaft 111 will be rotating at a higher speed than the shaft 106 because it is being driven through the long radius portion of the gear 107 and the short radius portion of the driving gear 109. As a result, the shaft 110 will be decelerating while the shaft 111 is accelerating. This cycle of acceleration and deceleration is involved in each revolution of the driving shaft 106 and whenever one driven shaft 110 or 111 is being accelerated, the other shaft is being decelerated an exact amount. Since the shaft 111 is connected to a heavy flywheel 112 it will absorb energy on the acceleration portion of the cycle and this energy is then released as inertia on the deceleration portion of the cycle. In this manner, the input shafts 124 to the cutters will be selectively accelerated and decelerated without requiring peak loads on the drive shaft 106 and without loss of energy by frictional braking.

From the above descriptions, it should therefore be understood that this invention provides a synchronous drive especially adapted for sheet cutters whereby the cutters can be selectively driven at desired mean speed and yet have instantaneous speeds at the time of cut which are totally independent of the selected mean speed. It will also be understood that the synchronous drive of this invention is capable of absorbing and releasing energy so that the alternating accelerating and decelerating cycles of operation brought about by differences in the desired mean and instantaneous speeds will be effected without variation in input speeds and without loss of energy. It will be further understood that the differential units embodied in the synchronous drive afford a very convenient arrangement for varying the relative positions of the driven mechanism with the driving mechanism so that the desired instantaneous speeds will be obtained at the desired points without uncoupling the drives.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

A cutter machine comprising superimposed pairs of rotating cutters each defining a cutting nip, superimposed pairs of draw rolls in advance of the cutters to feed paper ribbons to the cutters, a guide roll for directing the paper ribbons to the draw rolls, slitters in advance of the guide roll for cutting a paper web longitudinally into ribbons of desired width, a pair of web feed rolls in advance of the slitters to feed a web to the slitters, a main drive shaft, belt and pulley connections from the main drive shaft to the web feed rolls, to the draw rolls, and to the slitters, a pair of superimposed speed changer devices each driven from a draw roll drive, superimposed gear trains each including a non-circular center gear driven from a speed changer device and mating first and second conjugate gears on opposite sides of each non-circular center gear, a separate flywheel for each gear train driven by the first conjugate gear of each gear train, a separate differential unit for each gear train driven by the second conjugate gear of each gear train, each differential unit having a first pinion gear driven by the second conjugate gear, rotatable cage-carried gears driven by said first pinion gear and a second pinion gear driven by the cage-carried gears, means coupling each second pinion gear to a pair of said rotating cutters, means for selectively positioning the cage of each differential unit to vary relative positions of the cutters and conjugate gears for obtaining the desired instantaneous speed of the cutters at the point of cut, and means to adjust the speed changers to vary the mean speed of the cutters.

ALONZO A. NEESE.

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