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Huelsman

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[54] **ROTATING LOCK FOR SLITTER APPARATUS**

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[52] U.S. Cl. **83/503,** 83/169, 83/504, 83/699

[51] **Int. Cl.** **B23d 19/06**

[58] **Field of Search** 83/498, 499, 501–504, 83/169, 698–700

[56] **References Cited**

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[57] **ABSTRACT**

Web slitting apparatus, particularly for metal webs, is provided with a rotating lock mechanism for maintaining the proper working relationship between the slitter knives on a pair of parallel rotating arbors. The lock mechanism comprises a pair of parallel spaced disks on one of the arbors and a single disk on the other arbor, which disks interfit radially to interlock the arbors against relative axial movement.

8 Claims, 7 Drawing Figures

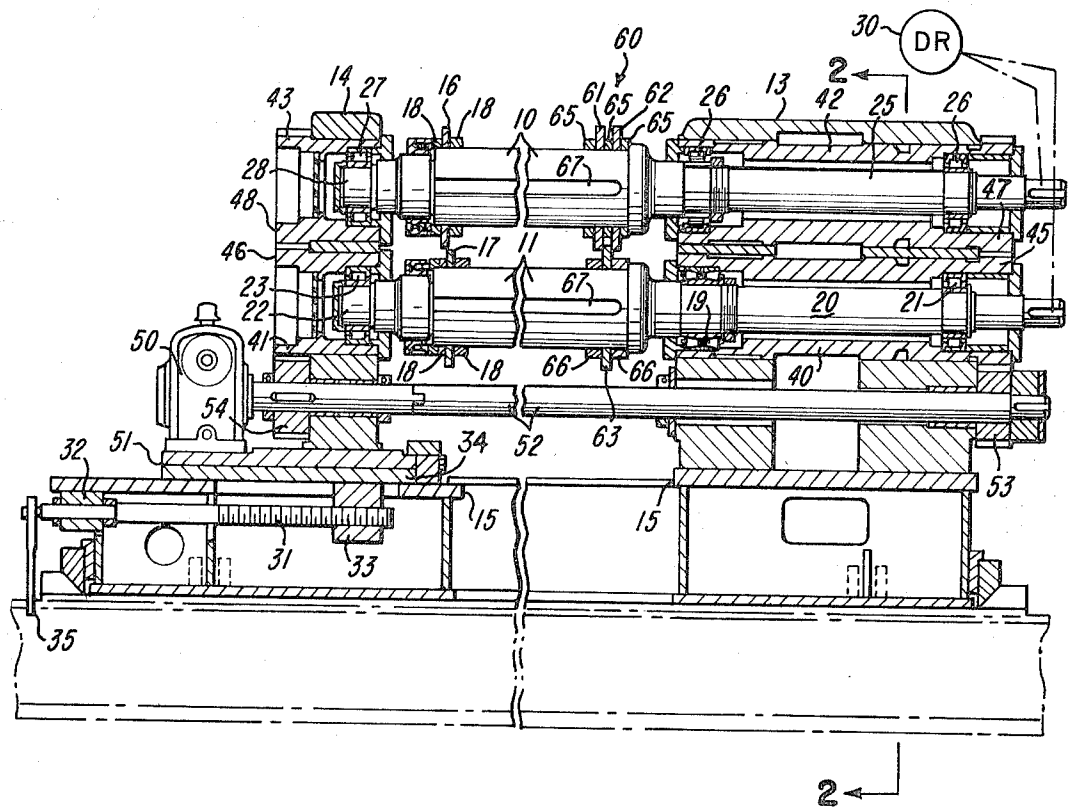


FIG-1

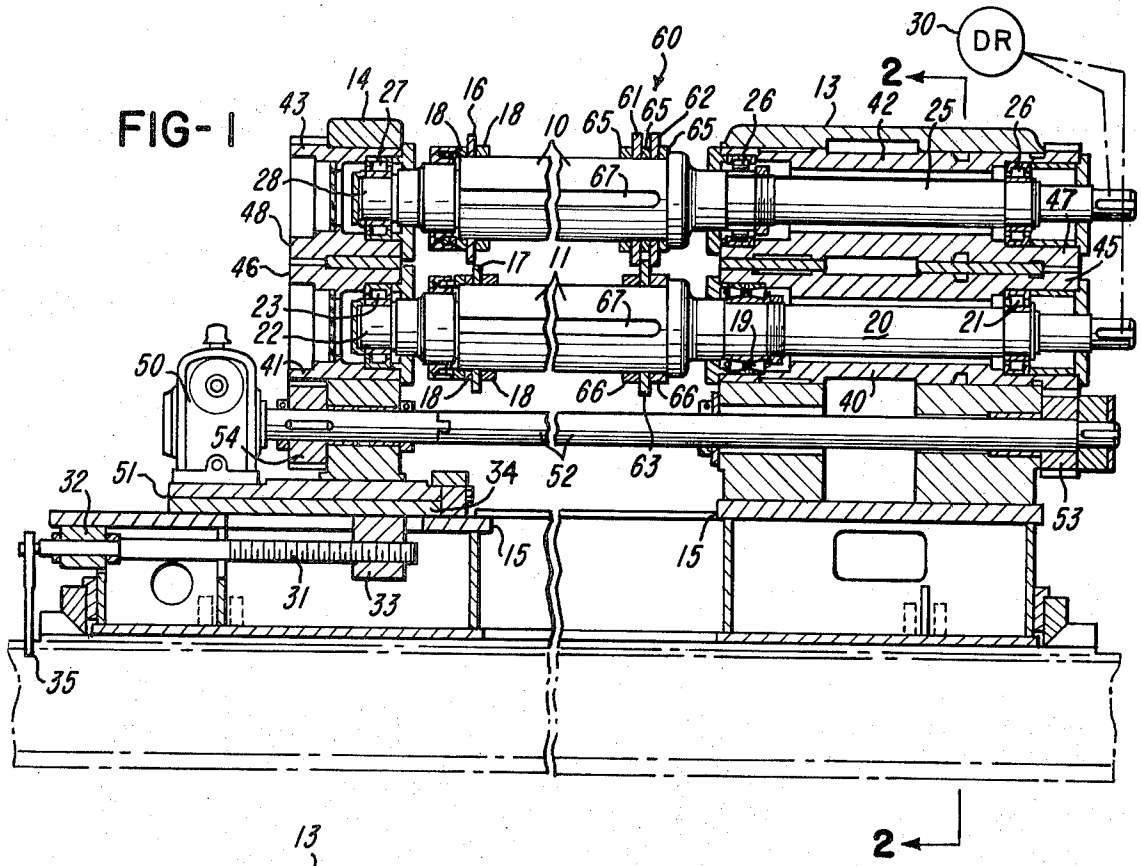


FIG-2

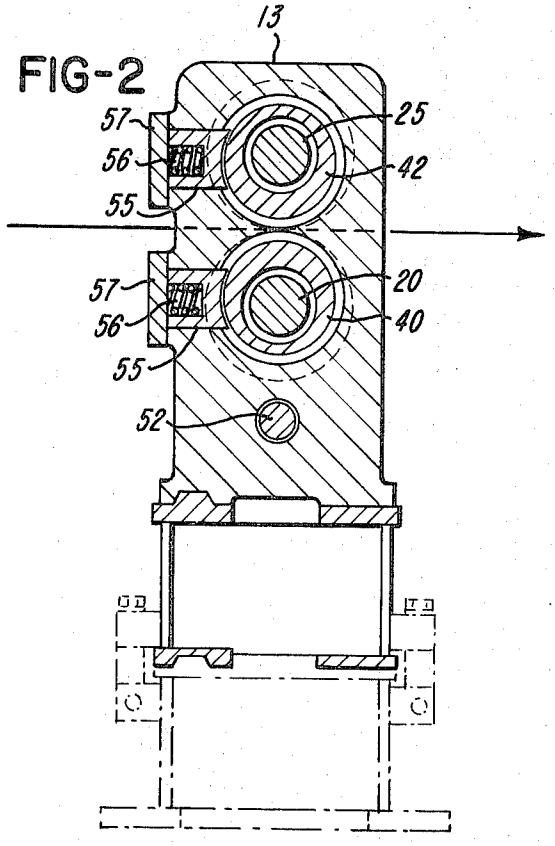


FIG-3

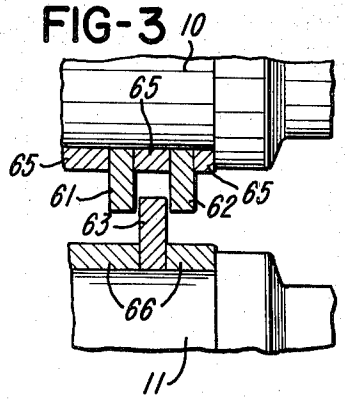


FIG-4

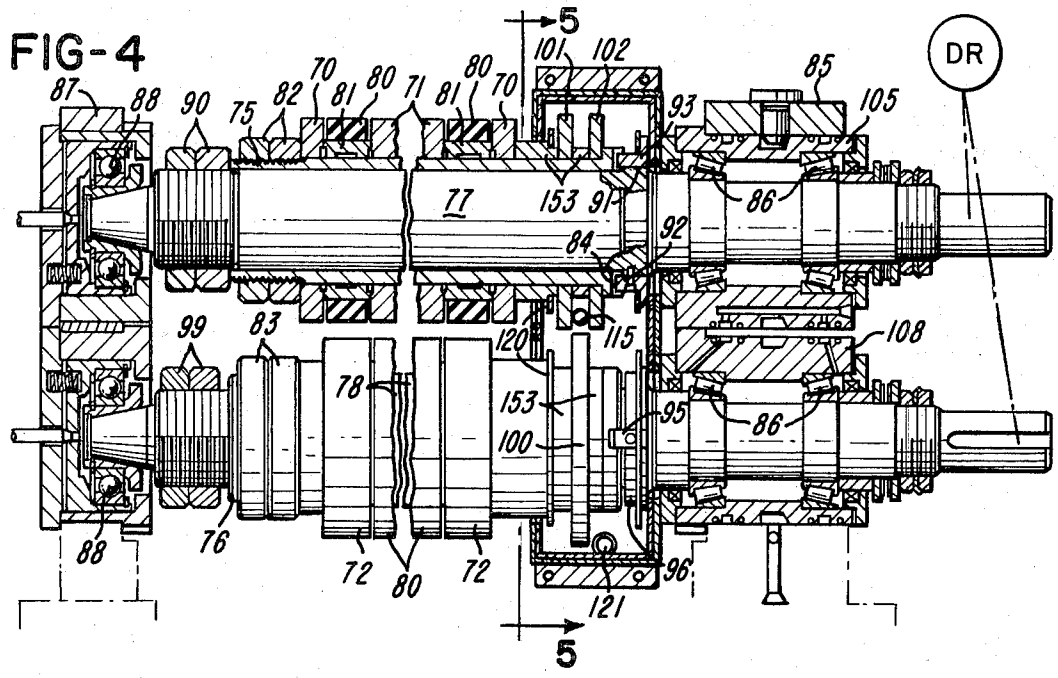


FIG-5

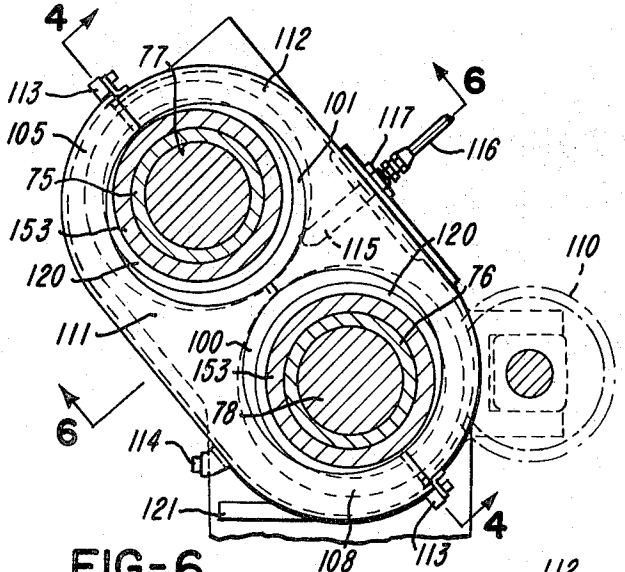


FIG-7

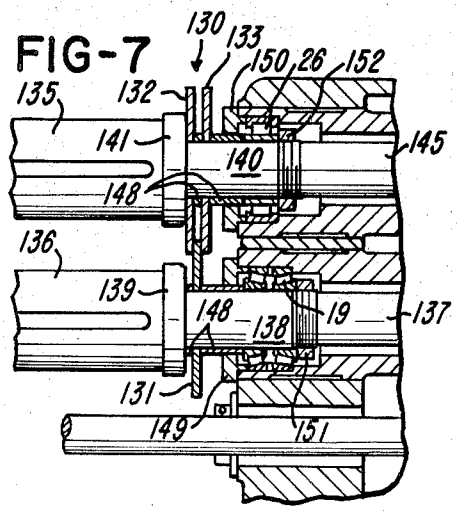
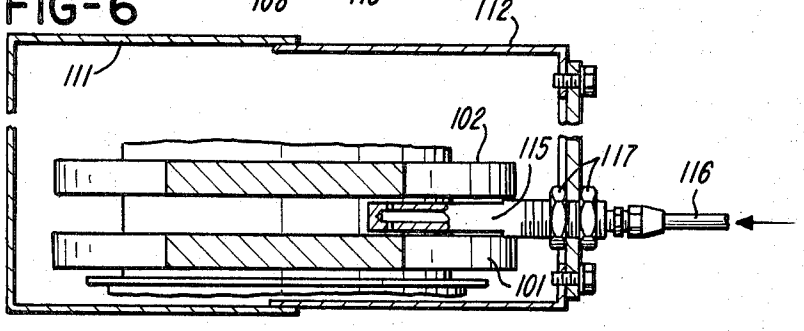


FIG-6



ROTATING LOCK FOR SLITTER APPARATUS

BACKGROUND OF THE INVENTION

This invention is directed to a moving guide or rotating lock which will maintain the alignment of the cutting knives in a rotary web shearing or slitting apparatus.

In the past, maintaining the spatial relationship between the cutting edges or knives on the two arbors of a rotary slitter has been a problem. This has been especially true when dealing with thin sheet materials such as plastics and thin gauge metals. When the blades or knives are too close together, they abrade one another. This will either reduce the cutting life of the knives or at least damage them such that a clean, burr-free line cut is no longer possible. Further, if the blades or knives drift too far apart, they will no longer continue to shear the material within desired burr tolerances and may completely cease cutting. These changes in the spatial relationship between slitter knives can be caused by a variety of factors, including thermal expansion, vibration, and conditions of imbalanced strains, and imperfect bearing alignment and set up.

In a sheet metal slitter for shearing thin gauge metals, it is a general rule of thumb that the clearance between the slitter knives should be approximately 10 percent of the metal thickness, which means a clearance of 0.0005 inch for a 0.005 inch thick sheet. Thus in shearing thin gauge sheet metal, the margin of error is very small. This is especially important with carbide knives, which are frequently used in slitters, despite their high cost, for increased life. However, contact between carbide knives will cause these knives to chip, and therefore no longer be usable without regrinding.

One attempt to overcome this problem has been to rely upon spring biasing of dished knives, to control the axial relationship between the slitter knives, but this means that the cutting edges are constantly urged into contact and cutting engagement. But spring biasing only prevents the edges from drifting too far apart. It does not solve the problem of maintaining a clearance between the edges which will prevent the edges of the knives from abrading one another while still making a clean, burr-free cut.

A need thus exists for a means which will maintain the proper spatial relationship or working clearance between the slitter knives in a slitter apparatus. This need is for a reliable guide means for use on continuous rotary slitters, which will maintain the knives or edges in their originally designed clearances, and which will not interfere with the cutting operations. There is also a need in rotary slitters to be able to make vertical (radial) adjustments of the knife-carrying arbors, while maintaining the axial relationship of the knives.

SUMMARY OF THE INVENTION

This invention is directed to novel means for maintaining the proper spatial relationship between the slitter knives in a continuous sheet slitter apparatus. The spatial relationship, i.e., the proper working clearance, between the slitter knives is maintained by a moving guide or rotating lock which comes into engagement before the slitting knives reach their positions of working relation.

The rotating guide or lock of the invention may be employed on any conventional slitter apparatus. For example, U.S. Pat. No. 2,792,060 discloses a slitter apparatus wherein the rotating lock of the invention can be employed.

Generally, conventional slitter apparatus consists of a pair of parallel, spaced, and commonly horizontal rotatable shafts or arbors. Disk-like slitter knives or blades are mounted on the arbors or shafts. The knives can be either directly on the arbor, or on a sleeve which is subsequently mounted on the arbor. The advantage of the latter is that down-time can be minimized, because the knives can be premounted over the sleeve so that the entire subassembly can be mounted as a unit on the arbor.

The radial relation of cooperating slitter knives is important for proper slitting action, and varies in accordance with the thickness of the web to be slit. Thus cooperating knives are usually operated in overlapping relation for slitting thin webs, but for thicknesses of ⅛ inch and more, the knives may operate in radially spaced relation. It is therefore important to be able to effect radial adjustment of the arbors while holding all knives in predetermined axial relation.

Commonly, the arbors are driven for cutting thin stock, but for thick stock, the web may be pulled between knives on free-running arbors. When the web is to be cut into a plurality of thin width strips, e.g., one-half inch strips, it is common to have the knives out of cutting or shearing engagement until a small part of web, e.g., a leader, has passed. After the leader has passed, the knives are engaged. This is called plunge cutting and can be done whether the arbors are driven or free wheeling.

One of the arbors is permitted to float axially at both ends while the other is restricted at one end against axial movement but permitted to float at the other. That is, one of the arbors will be able to move along its length, to a limited extent. The other arbor is restrained, at one end, commonly with respect to the base, and thus is able to move along its length only at one end to compensate for thermal expansion and contraction while the other end is held in desired relation with the adjacent edge or the centerline of the web.

The rotating lock of the invention generally comprises a pair of spaced parallel disks on one arbor and a single disk on another arbor. The single disk is aligned between the parallel disks. Thus when the guides, i.e., the guide disks, are engaged, the single disk will rotate between the parallel disks, which also, generally, will rotate. Their rotation will generally be the same as the slitter knives, i.e., driven or free wheeling.

Once the rotating locks are engaged, they will generally remain in their engaged relationship. This will prevent loss of axial alignment even when vertical (radial) adjustments are made between the knives or when knives are replaced. Continual radial engagement of the rotating locks is also important in performing plunge cutting. The interlocking of the arbors insures proper axial alignment of the knives before they engage the web material already passing between the arbors. Thus, the vibrations of operation, and other causes, which could cause misalignment, will not because of the rotating lock.

The disks can be made of any conventional material capable of withstanding their operating loads. For example, steels of the type used in slitter knives, have proved satisfactory. Also, it may be desirable to lubricate the contacting surfaces of the rotating lock. Any

conventional lubricant can be employed, such as, e.g., light machine oil. Polymeric lubricants, graphite, and other materials can be used. There is no criticality in how the rotating lock is to be lubricated, if lubrication is desired. Examples of lubricating techniques include spray coating the lubricant onto the contacting surfaces, using a wick, or using a metal which is impregnated with lubricant.

Three embodiments of the rotating guide or lock of the invention are disclosed. In the first embodiment, the guides are mounted directly on the arbors, in a manner similar to the cutting knives. In the second embodiment, the slitter knives and the guides are mounted on sleeves which in turn are mounted on shafts to form composite arbors. In the third embodiment, the guides are mounted on the arbors but separately from the slitter knives and/or spacers.

Is is therefore a primary object of this invention to provide continuous rotary slitter apparatus having guide means which will maintain the proper working clearance between the slitter knives in operation, and especially during relative radial adjustment of the knives.

It is a further object of this invention to provide continuous rotary slitter apparatus having a moving guide or rotating lock which will maintain the proper working clearance between the slitter knives when the slitter knives are mounted directly on the arbor.

It is yet a further object of this invention to provide slitter apparatus having a moving guide or rotary lock which can be used when the slitter knives are mounted on sleeves which in turn are mounted on shafts.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an axial section of one embodiment of the slitter apparatus of the invention, taken on the line 1—1 of FIG. 2;

FIG. **2** is a vertical section on the line 2—2 of FIG. 1;

FIG. **3** is an enlarged fragment of FIG. 1;

FIG. **4** is a partial view, similar to FIG. 1, of another embodiment of the slitter apparatus of the invention;

FIG. **5** is a vertical section on the line 5—5 of FIG. 4;

FIG. **6** is an axial section taken along the line 6—6 of FIG. 5; and

FIG. **7** is a fragmentary axial section showing a third embodiment of the slitter apparatus of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. **1** and **2** show a general arrangement of a slitter apparatus employing one embodiment of the rotating lock of the invention. While only the slitter is shown, it is to be understood that it is only one element in a slitting line for slitting webs of metal. Arbors **10** and **11** in FIG. 1 are rotatably supported in parallel relationship in housings **13** and **14** mounted on machine base **15** and they have slitter knives **16** and **17** mounted thereon in axially fixed positions by any conventional means represented by spacers **18**. FIG. 1 shows only one knife on each arbor for simplicity of illustration, but any number of paired slitter knives may be employed depending upon the number and width of strips to be cut, as is conventional.

The arbor **11** is shown as fixed at one end against axial movement with respect to base **15**, by means of the tapered roller bearing **19** which supports its journal portion **20** in housing **13**. The outboard bearing **21** for journal portion **20** is shown as a radial bearing but could also be a tapered bearing. The other journal **22** of arbor **11** is supported for both rotational and floating axial movement in housing **14** by bearing **23**.

The arbor **10** is supported for floating axial movement at both ends, its journal portion **25** being provided with radial bearings **26** in housing **13**, and a similar radial bearing **27** supporting its other journal **28** in housing **14**.

There is no criticality in the selection of the bearings for arbors **10** and **11**, and other equivalent bearings could be used. It is important only that one end of one arbor be restricted against axial movement with respect to a reference point, e.g., the machine base, which has a fixed relation to one edge of the web to be slit, and the other arbor may be free to float axially within reasonable limits, e.g., ¼ inch. In operation, both arbors may be driven, as indicated diagrammatically by the drive symbol **30**, although the web could be driven (by means not shown) and the arbors allowed to free wheel.

Housing **14** is mounted for movement on base **15** axially of the arbors **10** and **11** in order to disengage it from arbor journals **22** and **28** for removal and replacement of knives or the arbors. A screw jack **31** journalled in a block **32** on base **15** is threaded in a lug **33** on a plate **34** secured to housing **14** and has a handle **35** to provide for such movement of the housing.

Slitters of this type are commonly provided with means by which the slitter knives **16** and **17** on arbors **10** and **11** are brought into and out of engagement, and while this is not a part of the invention, in the interests of completeness, FIGS. 1 and 2 show eccentric means for this purpose. The bearings **19** and **21** for journal **20** are mounted in the eccentric bore of a sleeve **40** rotatably supported in housing **13**, and the bearing **23** for journal **22** is mounted in the eccentric bore of a sleeve **41** rotatably supported in housing **14**. The bearings **26** and **27** for arbor journals **25** and **28** are similarly mounted in eccentric bores in sleeves **42** and **43** supported in housing **13** and **14**.

Controlled rotational movement of sleeves **40-43** is effected through the meshing gears formed thereon or secured thereto and designated as **45–48** respectively. A motor **50** is mounted on a common subbase **51** for housing **14** and drives shaft **52** journalled in both of housings **13** and **14** and carrying pinions **53** and **54** which mesh with gears **45** and **46** respectively on sleeves **40** and **41**. Friction brake members **55**, which are mounted in housing **13** with biasing springs **56** and cover plates **57**, tend to hold the sleeves **40** and **42** in adjusted position, as shown in FIG. **2**.

In conventional practice with a slitter of the general construction shown in FIG. 1, both of arbors **10** and **11** would be fixed axially in housing **13** by means such as tapered bearings **19**, while the other end of each arbor would be allowed to float axially in housing **14**. The difficulty resulting from this arrangement has been that whenever either arbor tends to move axially more than the other, by reason of any one or more of the causes already noted, the relative positions of the paired slitter

knives could change axially sufficiently to destroy the effectiveness of the slitting action or to damage the knives by reason of frictional engagement.

The present invention has overcome this difficulty by the provision of the rotating lock mechanism indicated generally at **60** by which the two arbors are maintained with their respective slitting knives in proper working relationship. This lock mechanism comprises a pair of parallel spaced locking disks **61** and **62** fixed on arbor **10** and a single pilot locking disk **63** fixed on arbor **11.**

The alignment and spacings of these disks is such that when the slitter is in operation, with knives **16** and **17** in optimum axial cutting relation, disk **63** will be engaged between disks **61** and **62.** It is essential that these disks be firmly secured in axially fixed relation on their respective arbors, by means such as the spacer or locking rings **65** and **66** shown in FIG. **3.** Also, these disks as well as the knives, may be driven by their respective arbors, as indicated by the keyway **67** in FIG. **1.**

To insure that the proper working relationship between paired slitter knives exists before they are brought into proper radial cutting relation, disks **61, 62** and **63** should be of larger diameter than the knives. The precise difference in diameter is not critical so long as the desired relationships for given operations are maintained, as now described.

In some instances, e.g., plunge cutting, the disks should be of sufficient diameter to remain radially engaged even when the knives are not in slitting or shearing engagement. This will prevent loss of axial alignment at all times. For thin stock, it is usually desired that the slitter knives overlap to some extent during the slitting operation, but for thick stock, the knives may be spaced radially from each other by a distance constituting a substantial fraction of the thickness of the stock, e.g., ⅛ inch for quarter-inch stock. Therefore, it is also important that the locking disks be of sufficiently greater diameter than the knives to maintain them in interlocking relation throughout the normal range of radial adjustment of the knives. For example, disks 8.5 inches in diameter have proved satisfactory in one case where 8 inch knives were used.

The axial clearance between pilot disk **63** and the pair of disks **61–62** should be held within tolerances which do not exceed the allowable relative axial movement of the knives. For example, if the clearance between the slitter knives is to be about 10 percent of the thickness of sheet 0.005 inch thick, in accordance with the common working practice noted above, a total clearance of 0.0004 inch for disk **63** between disks **61–62** will allow relative axial movement of the arbors of plus or minus 0.0002 inch, which is well within the optimum range while insuring against contact between paired slitter knives.

The dimensions given are only by way of example and so can be changed depending upon the precision desired and the thickness of the sheet material being worked upon. Also, the guide disks do not have to be placed on any particular arbor. Therefore, the parallel disks can be placed on the fixed arbor, while the single disk is placed on the floating arbor.

Initially in operation, arbors **10** and **11** and knives **16** and **17** may be out of engagement. If so, motor **50** via shaft **52** rotates sleeves **40–43** from their positions of maximum separation of arbors **10** and **11** (shown in FIG. **2**) to cause the arbors to move toward one another. As arbors **10** and **11** approach each other, pilot disk **63** becomes engaged between disks **61** and **62.** Since disks **61–63** are secured axially to arbors **10** and **11,** the effect is to interlock the arbors axially. Thus when slitter knives **16** and **17** finally come into their proper radial relation, their proper working spacing has been insured.

FIGS. **4** and **5** illustrate another embodiment of the invention, as well as an embodiment of lubrication means which if necessary could be used for the locking mechanism of FIGS. **1** and **2,** but which are not shown in FIGS. **1** and **2.** In FIG. **4,** instead of utilizing the intermediate portion of a shaft as an arbor for supporting the slitter disks, slitter knives **70–72** are mounted on sleeves **75** and **76,** which are in turn mounted on parallel shafts **77** and **78** to form composite arbor means. Stripper material **80,** of resilient material such as rubber, which will remove the cut strip from between the slitter knives automatically, is provided on spacers **81** between the slitter knives. Nuts **82** and **83** lock the knives and spacers in place on the respective sleeves, and positive driving of all of these parts can also be assured by a keyed connection indicated by the keyway **84** in each sleeve.

Instead of allowing one of the shafts **77–78** to float axially at both ends, as in the embodiment of FIG. **1,** both shafts can be fixed axially at one end and one sleeve is fixed axially on its supporting shaft, with the other sleeve allowed to float axially on its supporting shaft. A running lock mechanism is provided between the two sleeves. Both of shafts **77** and **78** are shown as journalled at their drive ends in housing **85** by tapered roller bearings **86,** although the shaft **78** could be mounted by radial bearings like arbor **10,** and their opposite ends are journalled in housing **87** by radial bearings **88.** The sleeve **75** is fixed on shaft **77** by lock nuts **90** which hold the sleeve against shoulder **91** on the shaft in driven engagement with the key **92** on collar **93** secured on the shaft.

Sleeve **76** has similar driven engagement at its right hand end in FIG. **4** with key **95** on collar **96** secured to shaft **78,** but the lock nuts **99** at its left hand end could be removed or backed off to provide definite clearance for axial floating of sleeve **76** along the shaft, e.g. a total clearance of a quarter inch, while still remaining in driven relation with key **95.** Such floating is limited, however, by a running lock mechanism of the same character already described in connection with FIGS. **1** and **3.**

The running lock mechanism in FIG. **4** comprises a pilot disk **100** secured on sleeve **76** for engagement between the opposed pair of disks **101** and **102** secured on sleeve **75.** The disks **100–102** are so located and proportional that when they are engaged, the axial clearance for disk **100** will provide for correspondingly limited travel of sleeve **76** in either direction. Spacers **153** are provided to locate properly disks **100–102.** Otherwise the operation is the same as described in connection with FIGS. **1–3,** the disks and knives on the sleeves **75–76** being moved into and out of engagement by means of eccentric sleeves **105** and **108** having gears thereon through which they are driven by the drive **110.**

It is apparent that in operation, floating movement of the sleeve **76** may result in face to face engagement between pilot disk **100** and one or both of disks **101–102,** and it is therefore desirable that means be provided for lubricating the surfaces of these disks. As discussed

earlier, lubricating means or techniques including using a spray, using a wick, using a lubricant impregnated metal (a so called permanent lubricant) or other well known technique or means.

FIGS. **4–6** show one embodiment of such lubrication means, which includes a two-piece casing **111–112** held together by bolts **113** in enclosing relation with the disks **100–102.** Casing **111–112** may be bolted to the base of the slitter by, e.g., bolts **114.** A lubricant spray nozzle **115,** having a supply line **116,** is mounted on casing **111–112** by nuts **117** to extend into the interior of the casing, and preferably into the space between the disks **101–102,** in order to spray lubricant directly between these disks in the area where they interfit with disk **100** in the operation of the apparatus. Disks **120** on the sleeves block escape of spray lubricant from the casing **111–112,** and a drain port **121** is provided at the bottom of the casing. A similar or other lubrication unit, as discussed above, can be similarly used in the embodiment of FIG. **1.**

FIG. **7** shows another embodiment of the invention which is in effect a variant of the arrangement shown in FIGS. **1–3,** and certain of the same reference characters are accordingly used therein. The difference is that the lock mechanism **130,** comprising disks **131–133,** is located on the journal portions of the arbors **135** and **136.** More specifically, the journal portion **137** of arbor **136** is extended to provide a longer portion **138** between the collar **139** and the tapered roller bearing **19.** Pilot disk **131** is mounted on section **138** by means of spacers **148** and locking means **151,** which also holds bearing **19** and seal **149** in place. The other two disks **132–133** are mounted on a similar extension **140** of the journal portion of arbor **145,** along with spacers **148,** seal **150** and radial bearing **26,** and are held in place by collar **141** and locking means **152.** Otherwise, the operation of this embodiment is essentially the same as described in connection with FIGS. **1–3.**

While the forms of apparatus herein described constitute preferred embodiments of this invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention.

What is claimed is:

1. Web slitting apparatus of the character described comprising:

a. a machine base,

b. first rotatable arbor means having disk-shaped shearing blades mounted thereon,

c. second rotatable arbor means having disk-shaped shearing blades mounted thereon,

d. means on said base supporting said first arbor means for rotation and including means restricting one end of said first arbor means against axial movement with respect to said base,

e. means on said base supporting said second arbor means for both rotationally and axial movement in parallel spaced relation with said first arbor means, said blades on said arbor means cooperating to slit a web traveling therebetween, and

f. means forming a rotating lock connection between said arbor means establishing predetermined limits on the axial movement of said second arbor means with respect to said first arbor means.

2. Web slitting apparatus as defined in claim **1** wherein said lock means comprises a pilot disk secured on one of said arbor means and a pair of disks secured on the other said arbor means in predetermined spaced relation with each other and predetermined aligned relation with said pilot disk to receive said pilot disk therebetween, the spacing between said pair of disks being predeterminedly slightly greater than said pilot disk and providing for radial overlapping thereof without engagement therebetween.

3. Web slitting apparatus as defined in claim **2** further comprising means for effecting relative movement of said arbor means to bring said disks into and out of overlapping relation and said blades into and out of shearing engagement, said disks being of greater diameter than said blades for radial overlapping thereof in advance of said blades coming into shearing engagement.

4. Web slitting apparatus as defined in claim **2** further comprising means on said base for effecting substantially continuous lubrication of the overlapping surfaces of said disks.

5. Web slitting apparatus as defined in claim **1** wherein each said arbor means comprises a shaft having a portion of portions intermediate its ends whereon said shearing blades are mounted.

6. Web slitting apparatus as defined in claim **1** wherein each said arbor means comprises a shaft supported on said base, and a sleeve having said shearing blades mounted thereon and in turn mounted on said shaft, and further comprising means restricting one end of at least said shaft of said first arbor means against axial movement relative to said base, and means restricting said sleeve of said first arbor means against axial movement relative to said supporting shaft therefor.

7. In a web slitting apparatus of the character described wherein said slitting apparatus comprises parallel, supported, rotating arbor means having disk-shaped shearing blades mounted thereon in cooperative axially and radially aligned shearing engagement, the improvement comprising means for directly interlocking said arbor means against relative axial movement, said interlocking means comprising relatively rotatable means on respective said arbor means providing for relative rotation of said cooperative shearing blades.

8. Web slitting apparatus as defined in claim **7** wherein said interlocking means comprises a pilot disk secured on one of said arbor means and a pair of disks secured on another of said arbor means in predetermined spaced relationship with each other and predetermined aligned relation with said pilot disk to receive said pilot disk therebetween, the spacing between said pair of disks being predeterminedly slightly greater than said pilot disk and providing for radial overlapping thereof without engagement therebetween.

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