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(54) **Title:** BINDING ELEMENTS AND METHODS OF FORMING BINDING ELEMENTS

(57) **Abstract:** A spiral binding element for binding a stack of perforated sheets wherein the wire has a cross-sectional area that is other than round, preferably rectangular, and a spiral binding element wherein the consecutive loops are substantially adjacently disposed such that they must be separated in order spiral the binding element into the stack of sheets. The binding elements have increased strength Jim the unbound form and the binding element having other than a round cross section provides increased strength and durability over traditional round cross-section spiral binding elements. Further, the wire may be formed of a polymer and/or metal. The invention further provides methods and apparatus for separating consecutive adjacent loops in a compressed binding element to obtain the desired pitch before or while the binding element is spiraled into the stack of sheets.

BINDING ELEMENTS AND METHODS OF FORMING BINDING ELEMENTS

FIELD OF THE INVENTION

[0001] The present invention relates to binding elements for holding a plurality of perforated sheets or the like, and methods of forming and assembling the same into a stack of perforated sheets. More specifically, the invention pertains to spiral type binding elements and their assembly and insertion into a stack of perforated sheets.

BACKGROUND OF THE INVENTION

[0002] Various types of binding elements have been utilized to bind a stack of perforated sheets or the like. Numerous types of binding elements include a spine from which a plurality of fingers extends which may be assembled through perforations in a stack of sheets. This spine may be linear, with or without a longitudinally extending hinge. Alternately, the spine may be formed by sequential bending of a wire, as with wire comb or hanger type binding elements.

[0003] Examples of such binding elements which are of a wire comb or hanger-type design are disclosed, for example, in U.S. Patent 2,112,389 to Trussell and U.S. Patents 4,832,370 and 4,873,858 to Jones, while machines for assembling such binders are disclosed in U.S. Patent 4,031,585 to Adams, U.S. Patent 4,398,856 to Archer et al., U.S. Patent 4,525,117 to Jones, U.S. Patent 4,934,890 to Flatt, and U.S. Patent 5,370,489 to Bagroky. Other binding devices are disclosed, for example, in the following references: U.S. Patents 2,089,881 and 2,363,848 to Emmer, U.S. Patent 2,435,848 to Schade, U.S. Patent 2,466,451 to Liebman, U.S. Patent 4,607,970 to Heusenkveld, U.S. Patent 4,904,103 to Im, U.S. Patent 5,028,159 to Amrich et al., U.S. Patent 4,369,013, Reexamination Certificate B1 4,369,013 and Re. 28,202 to Abildgaard et al. Machines for assembling plastic comb or finger binding elements are disclosed in patents such as U.S. Patents 4,645,399 to Scharer, U.S. Patent 4,900,211 to Vercillo, U.S. Patent 5,090,859 to Nanos et al., and U.S. Patent 5,464,312 to Hotkowski et al. The patents are included herein by reference.

[0004] An alternate type of binding element is a spiral binding element, which includes a plurality of spaced, continuous, consecutive loops, as shown, for example, in FIGS. 1 and 2. The end of the spiral binding element is spiraled into the consecutive perforations in the stack of sheets to advance the consecutive loops into the perforations. Because spiral binding elements have no longitudinally-extending, continuous spine, a spirally bound stack of sheets may be folded back on itself without any resulting separation in the sheets due to the spine being sandwiched between the sheets. Spiral bindings provide a relatively permanent book structure in that no additional sheets may be readily added to the book.

[0005] Spiral binding elements are typically made of wire or a polymeric material having a round cross-section. While each of these types of spiral binding elements has its advantages, each likewise has its disadvantages.

[0006] Spiral binding elements made of round metallic wire, for example, are typically relatively flimsy, and may be easily damaged and deformed by the application of an outside force exerted on the consecutive loops of the element. This damage may occur prior to spiraling it into a stack of sheets, rendering it difficult or impossible to spiral into the perforations in a stack or sheets. Alternately, such damage can occur to the binding element in a bound book, resulting in difficulties in use of the book and damaging the appearance of the bound book. Further, this flimsiness itself can cause difficulties in accurately spiraling the element into consecutive perforations in a stack of sheets.

[0007] In contrast, polymeric spiral binding elements are relatively durable in that the application of an outside force to the element will typically only elastically, as opposed to plastically, deforms a polymeric element. Polymeric spiral binding elements may also be formed in various colors, providing the user with options regarding the physical appearance of the resulting book. Polymeric coils, however, are sometimes viewed as being inexpensive looking and not sufficiently attractive for formal presentations. Further, polymeric spiral binding elements can be unstable to environmental effects, such as excessive heat, which can cause the coils to relax and can result in a change in the pitch and/or diameter of the spiral binding element. As a result, it can be difficult or even impossible to spiral the binding element into a perforated stack of sheets.

[0008] Machines for spirally binding sheets of paper generally involve one of two processes. Either the machine advances a preformed spiral binding element into the stack of sheets or the spiral binding element is formed at the binding machine itself, and advanced into the perforations in the stack of sheets as the element is formed.

[0009] A device that has been used to guide the feed of a spiral binding element into engagement with prepunched holes in a stack of sheets is a coiling tool. One such tool arrangement for forming a metal wire into a spiral binding element and immediately feeding the spiral binding element as it is formed is described in U.S. Patent No. 3,592,242 to Sickenger. The coiling tool includes a mandrel that is surrounded by a slotted member. Metal wire enters the slotted member at one end of the tool in the form of a wire which, as it turns, feeds successively through the series of punched holes in the sheet stack.

[0010] In contrast, polymeric spiral binding elements are typically extruded and then wrapped around a heated mandrel to cool. As a result, the formation of a polymeric spiral binding element as it is spiraled into a stack of sheets is relatively expensive, and requires the use of a relatively large machine. Such machines use a plurality of mandrels, typically on the order of five, around which heated filaments are consecutively wound, cooled, removed, and then spiraled into the stack of sheets. Moreover, because such polymeric spiral binding elements require cooling time, the process relatively slow. That being the case, polymeric spiral binding elements are generally extruded, and then cooled. The preformed coil length is then spiraled into the stack of sheets.

[0011] A machine that advances a preformed spiral binding element into a stack of sheets is disclosed in, for example, U.S. Patent No. 4,378,822 to Morris, which discloses the assembly of books on a commercial scale. Morris discloses driving a spiral coil between a mandrel and a drive wheel, both of which are disposed along one edge of the stack of sheets to be bound. In Morris, the mandrel guides the coil only until the coil actually commences to spirally engage the punched holes of the sheets. Accordingly, a critical difficulty in this type of arrangement is reliably guiding the spiraling free end of the coil along the length of the papers and through the punched holes in the sheets, particularly in view of the fact that spiral binding elements are generally relatively flimsy.

[0012] With both metal and polymeric spiral binding elements, guide members may be disposed along the length of the punched hole edge of the sheets to assist in directing the movement of the spiral wire as it spirally winds through the holes in the sheets. There still exist possibilities for jamming or mis-threading, however, due to tension building-up along the spiral wire.

[0013] Commercial-type spiral binding machines are relatively large and generally inappropriate for desktop or office use. U.S. Patent no. 5,785,479 to Battisti et al., which is assigned to the assignee of this application, is one attempt to provide a desktop spiral binding machine. The disclosed device includes a movable cartridge for feeding the spiral coil. U.S. Patent No. 5,934,340 to Anthony, III, et al., also assigned to the assignee of this application, similarly discloses a desktop binding machine. Each of these units feeds a preformed coil through a stack of sheets and crimps the coil ends to complete a single book at a time. U.S. Patent No. 6,527,016 to Todaro, also assigned to the assignee of this application, likewise discloses a spiral binding machine designed preferably for use in an office or copy service location. Todaro, however, includes separate stations for feeding the coil and crimping its ends, allowing the separate assembly processes to be performed on two books simulteneously. Additional devices are disclosed in U.S. Patent No. 5,584,632 to Stiles et al. and U.S. Patent 5,695,308 to

Hastings et al. Both the Hastings reference and Stiles reference use a feeding mechanism similar to those described above with regard to the commercial scale machines in that the spiral coil is driven into the punched holes of the sheets by a drive wheel at one end of the paper.

[0014] The structure of such preformed binding devices, whether they are spiral binding devices or binding devices that include elongated spines and fingers, commonly results in entanglement when stored in a group. Detangling the binding elements in order to assemble the element to a stack of sheets or lay the element into a binding machine can be a tedious and potentially time consuming process. Further, this tendency to become entangled may complicate or prevent the automated feeding of such preformed binding devices in automated binding processes or other machines wherein an automated feed is desirable. The time required to separate and manually feed binding elements into a machine would be prohibitive to efficient, high-volume automated binding operations. Moreover, the packaging, shipping, and storage of such preformed binding devices is inefficient in that the binding elements can consume relatively large volumes of space and, therefore, result in relatively high costs associated with the real estate in packaging a feed magazine into the automated machine, as well as such packaging, shipping, and storage of the binding elements themselves.

BRIEF SUMMARY OF THE INVENTION

[0015] The invention comprises a spiral binding element wherein the wire has a cross-sectional area that is preferably substantially rectangular, but may be any cross-section that provides increased strength over traditional round cross-section spiral binding elements. Such a spiral binding element provides more strength and durability than traditional, round cross-section wire binding elements. Further, the wire may be formed of a polymer and/or metal.

[0016] The invention further comprises a spiral binding element wherein the consecutive loops of the element are disposed substantially adjacent. In this way, the compact spiral binding element not only takes up considerably less space than expanded elements, it is highly resistant to entanglement with other such elements. As a result, efficiencies are realized not only in formation, packaging, shipping, and storing pluralities of the elements, the elements readily lend themselves to automated and semi-automated binding processes. Further, the compressed structure has increased strength over similar, but expanded binding elements, regardless of the cross-section of wire used or the material used.

[0017] According to another aspect of the invention, if such a compressed binding element is provided, the consecutive loops of the binding element can be separated or expanded to obtain the desired pitch before the binding element is delivered to a binding machine, or they can be separated immediately before the binding process. One such method and apparatus for separating the consecutive loops comprises passing a cam surface between the consecutive loops, or rotating the spiral binding element over a cam surface disposed between the consecutive loops. The separated, consecutive loops of the spiral binding element may then be directly spiraled into the perforations in a stack of sheets. The binding element itself may be a discrete length of binding element, or it may be a continuous length of binding element that is then cut to the desired length.

[0018] Alternately, the spiral binding element may be formed from a quantity of wire using structure similar to spring formers as the binding element is spiraled into the stack of sheets. Such formers could control both the pitch and diameter of the loops of the spiral binding element.

[0019] These and other objects and advantages of the invention will be apparent to those skilled in the art upon reading the following summary and detailed description and upon reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIGURE 1 is a perspective view of a binding element of the prior art.

[0021] FIG. 2 is a plan view of the prior art binding element of FIG. 1

[0022] FIG. 3 is a perspective view of a binding element constructed in accordance with teachings of the invention.

[0023] FIG. 4 is a plan view of the binding element of FIG. 3.

[0024] FIG. 5 is a plan view of the binding element of FIGS. 3 and 4 in a compressed condition.

[0025] FIG. 6 is a plan view of an alternate embodiment of the invention as illustrated in FIG. 5.

[0026] FIG. 7 is enlarged, fragmentary, plan view of an arrangement for altering the pitch of the consecutive loops of the binding element of FIG. 5 for assembly into a stack of sheets.

[0027] FIG. 8 is a fragmentary, elevational view of the arrangement of FIG.7.

[0028] FIG. 9 is a perspective view of the arrangement of FIGS. 7 and 8.

[0029] FIGS. 10A-C are enlarged, fragmentary, plan view of alternate camming surfaces in the arrangement of FIG. 7.

DETAILED DESCRIPTION OF THE INVENTION

[0030] Turning now to the drawings, there is shown in FIGS. 1 and 2, a spiral binding element 20 constructed according to the teachings of the prior art. The binding element 20 is formed of a wire having a round cross-section, and comprises a plurality of successive, loops 22 that are spaced to correspond to the spacing of the perforations of a stack of sheets to be bound (not shown, but known in the art). The spiral binding element 20 of the prior art is typically made of metal wire, comprises metal wire, or is formed of a polymeric material, such as polyvinylchloride.

[0031] In accordance with one aspect of the invention, a binding element 32 is formed of a wire 30 having a substantially rectangular cross-section, as shown in FIGS. 3 and 4. It will be appreciated that, while a substantially rectangular cross-section is presently preferably preferred, any cross-section that provides increased strength over round may be utilized. While the cross-section of the wire 30 may be any appropriate dimensions, a currently preferred embodiment has dimensions with a ratio on the order of 1 to 3, thickness to width. A binding element 32 having such a substantially rectangular cross-section is significantly stronger than a binding element (such as is shown in FIGS. 1 and 2) having a round cross-section in general, and, particularly, having a diameter that is the same as, smaller than, or even larger than the thickness of the rectangular cross-section element. As a result, a binding element 32 constructed in accordance with these teachings is more resistant to damage in formation, packaging and shipping, spiraling into a stack of sheets, and in an assembled book. The binding element 30 is preferably formed of metal. Further, it may be formed of any appropriate color whether it comprises metal or a polymer.

[0032] According to another aspect of the invention, a binding element 40 may be formed with the consecutive loops 42 disposed substantially adjacently, as shown, for example, in FIG. 5, providing a very compact binding element 40. (The ends of the binding element 40 are spread from the main compressed section to illustrate how the consecutive loops 42 may be separated for binding a stack of sheets.) As a result, the binding element 40 is extremely strong and resistant to damage due to outside forces placed on the loops 42. Because there is substantially no space between the consecutive loops 42, the binding elements 40 will typically not become entangled when grouped and stored as a plurality, simplifying the processing and minimizing the costs associated with fabrication, storage, packaging, and usage of the binding elements 40. Further, due to the compact nature of the binding element 40, the space necessary for packaging, storing and shipping of a plurality of such binding elements 40 is greatly reduced. This compact nature and resistance to tangling further facilitates automated binding processes inasmuch as the space for storage of a plurality of such binding elements at the binding machine is greatly reduced, and the binding elements 40 can typically feed by rolling into a desired position without tanglement. Additionally, because there is substantially no space between the consecutive loops 42, the length of the compact binding element 40 is considerably shortened relative to the expanded binding element (see 32 in FIG. 4). As a result, the space required for the binding element 40 itself at the binding machine is minimized, allowing for a smaller footprint binding machine.

[0033] While the binding element 40 shown in FIG. 5 comprises a rectangular cross-section, this aspect of the invention is likewise applicable to binding elements 50 having a round cross-section, as shown, for example, in FIG. 6, or any other cross-section. Although such round cross-section binding elements 50 may not exhibit the strength of a rectangular or other shaped cross-section binding element 40 (FIG. 5), some enhanced strength will be provided over a spaced consecutive loop design, as illustrated in FIGS. 3 and 4. Further, a compact binding element 50 having a round cross-section will exhibit enhanced resistance to tangling during fabrication, packaging, shipping, storage, and usage. Similarly, this compact arrangement may be utilized with both metal and polymeric binding elements.

[0034] According to another aspect of the invention, the consecutive loops 42, 52 of such compact binding elements 40, 50 may be separated either prior to assembly into a stack of sheets (to form longer lengths of the structures shown in FIGS. 3-4 and 1-2, respectively) or at the binding machine itself, just prior to spiraling the binding element 40, 50 into a stack of sheets. In order to space the consecutive loops 42, 52 of a compact binding element 40, 50, a cam surface 60 is provided, as shown in FIG. 7, for example, and heat may or may not be applied during the expanding process. The cam surface 60 is disposed between consecutive loops 42, 52 of the binding element 40, 50 and causes deformation of the loops 42, 52 to space them apart. While preferably the deformation is of a plastic nature such that consecutive loops 42, 52 permanently assume the spaced relation, it is possible that consecutive loops 42, 52 are only elastically deformed such that they are spaced only long enough to spiral the binding element into the stack of sheets. Clearly, such primarily elastic deformation would only be advisable in a binding element that is not particularly strong when spaced, such as the round cross-section binding elements of FIGS. 1-2.

[0035] It will be appreciated that one or the other of the binding element 40 or the cam surface rotate relative to the other such that the cam surface 60 passes along the length of the binding element 40, 50. For example, a simple handheld tool with a separating cam surface may be hand rotated about the compact binding element 40, 50, or the consecutive loops 42, 52 of the compact binding element 40, 50 may be hand rotated past such a simple cam surface. In the automated embodiment shown in FIGS. 7-9, the binding element 40 is rotated about it longitudinal axis as it progresses along the cam surface 60. To this end, a drive roller 62 is provided, disposed adjacent the compact binding element 40 as it proceeds through support surfaces 64. As the drive roller 62 rotates, it advances the binding element 40 along the cam surface 60 to cause the consecutive loops 42 to separate one from the other. While a drive roller 62 is provided in the illustrated embodiment, an alternate arrangement may be provided for yielding forward motion of the binding element, and such drive arrangement may be disposed at any appropriate location.

[0036] It will be appreciated by those of skill in the art that, in rotating the binding element 40, 50, the consecutive loops 42, 52 of the compact binding element 40, 50 may thus be separated and the resulting binding element spiraled directly into the perforations in a stack of sheets, allowing for relatively compact automated binding apparatus. Further, discrete lengths of compact binding elements 40, 50 may be so provided or a continuous length of compact binding element(s) may be provided which is subsequently cut to the desired length prior to consecutive coil separation, cut to the desired length at the time of separating the consecutive coils, or cut to length as the binding element is advanced through the perforations in a stack of sheets after consecutive coil separation.

[0037] As shown in FIG. 9, a support structure 66 may likewise be provided as the separated consecutive loops exit the vicinity of the cam surface 60 and drive roller 62. In order to ensure the proper advancement of the binding element 40 past the cam surface 60, the cam surface 60 may similarly be disposed about the perimeter of a rotating or driven roller 68, as may be seen in FIGS. 8 and 9. Alternately, the cam surface 60 may merely be a stationary surface past which the binding element 40 progresses.

[0038] In order to account for varied diameters of binding elements 40, 50 or various desired pitches, one or more of the cam surface 60, the drive surface of the drive roller 62 and/or structure holding the binding element 40, 50 may be moveably mounted relative to one another. As may be seen in FIG. 9, both the cam surface 60 and the drive roller 62 are mounted so that they may slide toward or away from the path of the binding element 40, 50. Alternately or additionally, varied cross-sectional cam surfaces may be provided in order to obtain the desired pitch. As may be seen in FIGS. 10A-10C, progressively narrower cam surfaces 60a, 60b, 60c result in a steeper pitch, or closer consecutive loops 40a, 40b, 40c. This modification of the width of the cam surface may result from moving an angled cam surface closer or further away from the binding element 40, 50, or it may be accomplished by moving a different cam surface into communication with the binding element 40, 50, as shown in FIGS. 10A-10C.

[0039] Alternately, the spiral binding element 20, 32 itself may be formed from a continuous length of wire at the binding machine by one or more appropriate cam surfaces and spiraled immediately into the perforations in a stack of sheets. In this regard, tools similar to custom spring formers may be utilized in the formation of the binding element 20, 32. Such custom spring formers are disclosed in the website of

BHS-Torin (www.bhs-torin.com/spring_machines/spring_coilers.htm), which is hereby incorporated by reference. In this regard, tools or camming surfaces controlling only pitch and diameter would be required, greatly simplifying the formation apparatus over such custom spring formers.

[0040] In summary, the invention provides for spiral binding elements having a rectangular cross-section or a cross-section other than round, compact spiral binding elements having substantially no separation between consecutive loops of the element, arrangements and methods for separating consecutive loops of a compact binding element, and an arrangement for forming a spiral binding element at a binding machine. While this invention has been described with an emphasis upon preferred embodiments, variations of the preferred embodiments can be used, and it is intended that the invention can be practiced otherwise than as specifically described herein. Accordingly, this invention includes all modifications encompassed within the spirit and scope of the invention as defined by the following claims.

[0041] All of the references cited herein, including patents, patent applications, and publications, are hereby incorporated in their entireties by reference.

WE CLAIM AS OUR INVENTION:

1. A binding element for binding a stack of perforated sheets, said binding element comprising an elongated continuous spiral of wire, said wire having a cross-section other than round.

2. The binding element of claim 1 wherein the spiral comprises a plurality of successive loops, and wherein said successive loops are disposed substantially adjacent one another such that the adjacent successive loops must be moved apart to allow spiraling into the stack of perforated sheets.

3. A binding element for binding a stack of perforated sheets, said binding element comprising an elongated continuous spiral of wire, the spiral comprises a plurality of successive loops, and wherein said successive loops are disposed substantially adjacent one another such that the adjacent successive loops must be moved apart to allow spiraling into the stack of perforated sheets.

4. The binding element of claim 3 wherein the wire has a substantially round cross-section.

5. The binding element of any of claims 1-3 wherein the wire has a substantially rectangular cross-section.

6. The binding element of either of any of claims 1-3 or 5 wherein the wire has a substantially square cross-section.

7. The binding element of any of claims 1-6 wherein the wire is metallic.

8. The binding element of any of claims 1-7 wherein the wire comprises plastic.

9. A plurality of binding elements as claimed in any of claims 1-8.

10. The plurality of binding elements of claim 9 wherein the plurality is deliverable to an automated machine for feedings and/or handling said elements, and/or binding said binding elements into said stacks.

11. A book bound using a binding element as claimed in any of claims 1-9.

12. A method of forming a spiral binding element for binding a stack of perforated sheets, the method comprising the steps of providing a wire having other than

a round cross-section and forming the wire into a spiral having a plurality of successive loops.

13. The method of claim 12 further comprising the step of forming the binding element with consecutive loops disposed substantially adjacent one another such that the adjacent consecutive loops must be moved apart to allow spiraling into the stack of perforated sheets.

14. A method of forming a spiral binding element for binding a stack of perforated sheets, the method comprising the steps of providing a wire, and forming the wire into a spiral having a plurality of successive loops with consecutive loops disposed substantially adjacent one another such that the adjacent successive loops must be moved apart to allow spiraling into the stack of perforated sheets.

15. The method of claim 14 wherein the wire comprises a round cross-section.

16. The method of any of claims 12-14 wherein the wire comprises a rectangular cross-section.

17. The method of any of claims 12-14 and 16 wherein the wire comprises a square cross-section.

18. The method of any of claims 12-17 wherein the wire is metallic.

19. The method of any of claims 12-18 wherein the wire comprises plastic.

20. An arrangement for spreading consecutive loops of spiral binding element comprising a plurality of successive loops wherein at least a portion of the consecutive loops of the plurality are disposed substantially adjacent one another such that the adjacent consecutive loops must be moved apart to allow spiraling into the stack of perforated sheets, the arrangement comprising a cam surface, the cam surface being disposable between consecutive loops to cause the consecutive loops to move from an adjacent position to a separated position.

21. The arrangement of claim 20 wherein the cam surface is adjustable to vary a distance between consecutive loops in the separated position.

22. The arrangement of claim 20 further comprising a support for the spiral binding element, and wherein at least one of the support or the cam surface is adjustable to vary a distance between consecutive loops in the separated position.

23. The arrangement of any of claims 20-22 further comprising a cam, the cam comprising a plurality of cam surfaces, a distance between consecutive loops in the separated position being dependent upon the cam surface in contact with consecutive loops.

24. The arrangement of claim 23 wherein the cam is movable to position a desired one of the cam surfaces in position to contact the spiral binding element.

25. The arrangement of any of claims 20-24 wherein the cam surface positioned to contact the spiral binding element comprises an angled surface.

26. The arrangement of any of claims 20-25 wherein at least one of the binding element is rotatable, or the cam surface is rotatable around the binding element.

27. A machine for binding a stack of sheets having a plurality of perforations, the machine comprising any of the arrangement of any of claims 20-26.

28. A method of spreading successive, adjacently disposed loops of wire of a binding element for binding a stack of perforated sheets, said method comprising the steps of providing a cam surface, and moving at least one of the binding element along the cam surface or the cam surface along the binding element to cause a separation between successive loops of the binding element to allow spiraling into the stack of perforated sheets.

29. The method of claim 28 wherein the providing step comprised the steps of determining an appropriate cam surface to provide the desired separation between successive loops.

30. The method of either of claims 28 or 29 wherein the moving step comprises the step of spiraling the binding element along the cam surface.

31. The method of any of claims 28-30 wherein the moving step comprises rotating the cam surface around the binding element.

32. The method of any of claims 28-31 wherein the providing step comprises the step of providing a master cam having a plurality of varied cam surfaces and determining an appropriate cam surface to provide the desired separation between successive loops.

33. A method of binding a stack of sheets having a plurality of perforations using a spiral binding element, the method of binding comprising any of the methods of claims 29-33.

34. A method of binding a stack of sheets having a plurality of perforations, the method comprising the steps of providing a continuous length of wire having a cross-section other than rectangular, forming the wire into a spiral, and spiraling the wire into the perforations as it is being formed into a spiral.

35. The method of claim 34 wherein providing step comprises the step of providing a continuous length of wire having a substantially rectangular cross-section.

36. A book bound using any of the methods, arrangements, or machines of any of claims 12-35.

FIG. 1

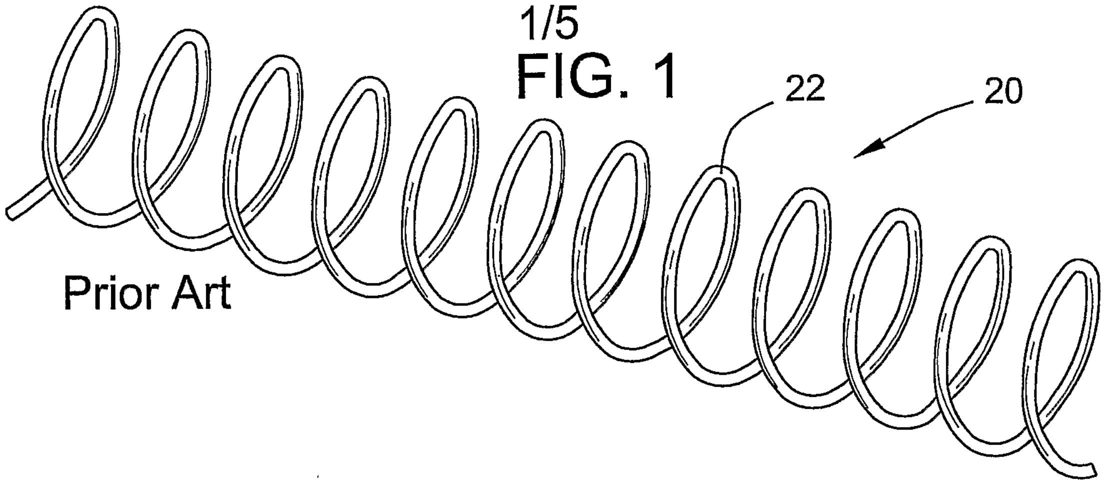

FIG. 2

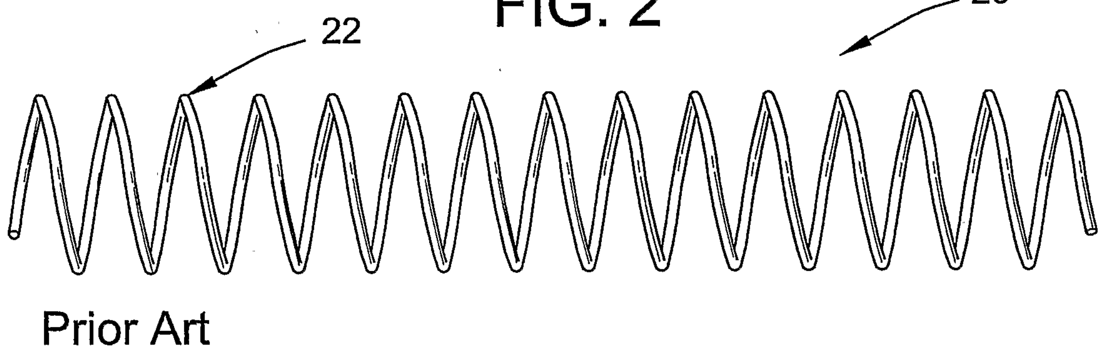

FIG. 3

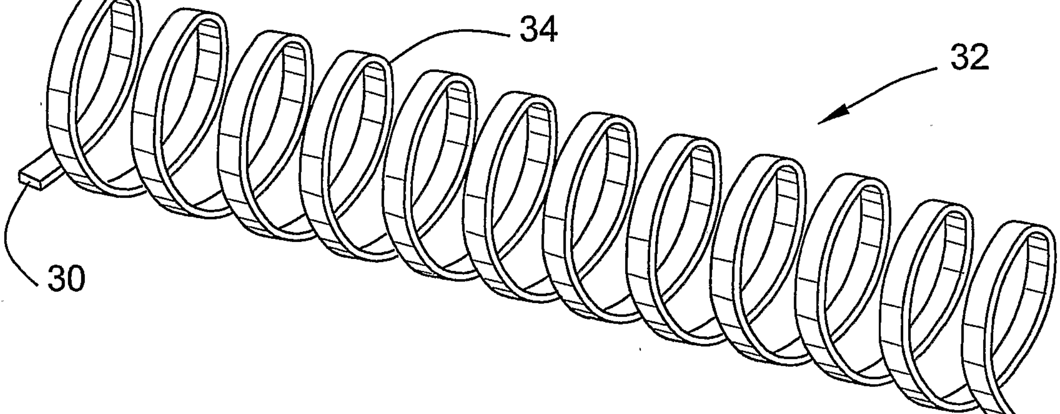

FIG. 4

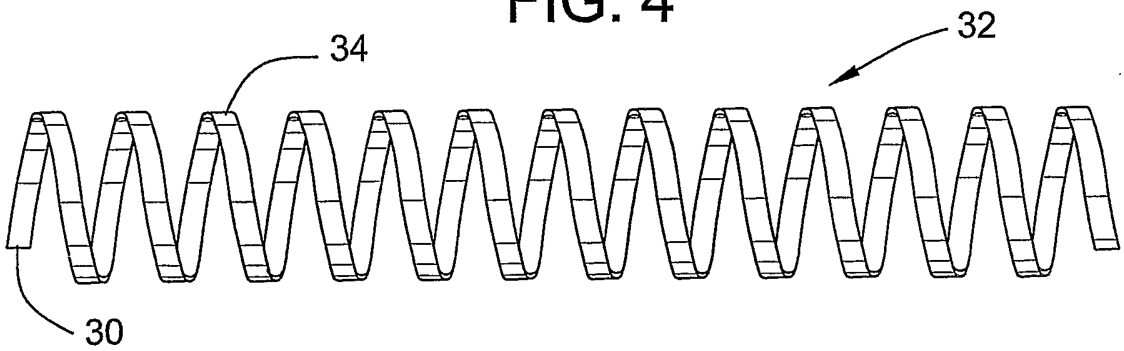

FIG. 5

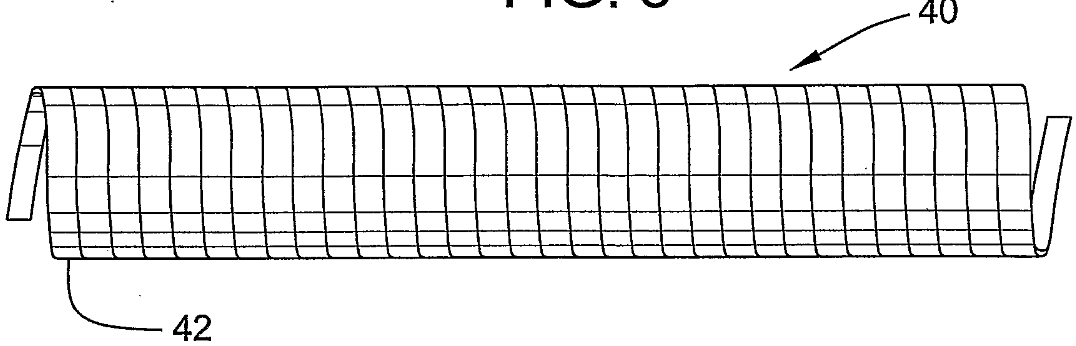

FIG. 6

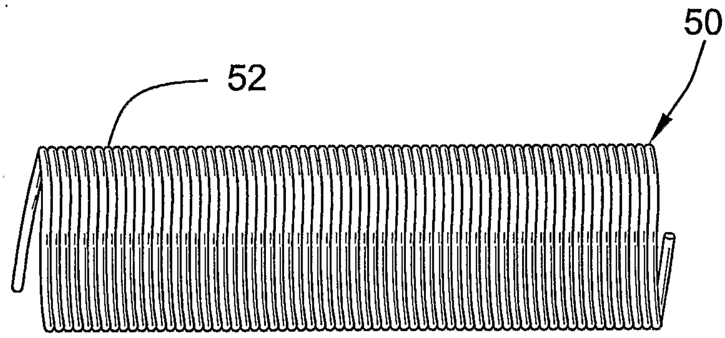

FIG. 7

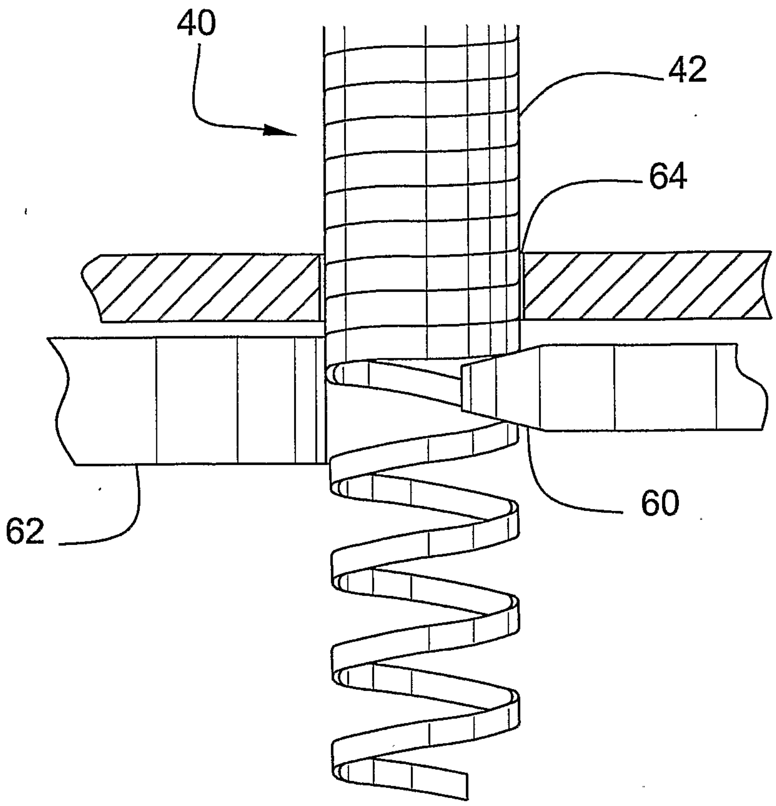

FIG. 8

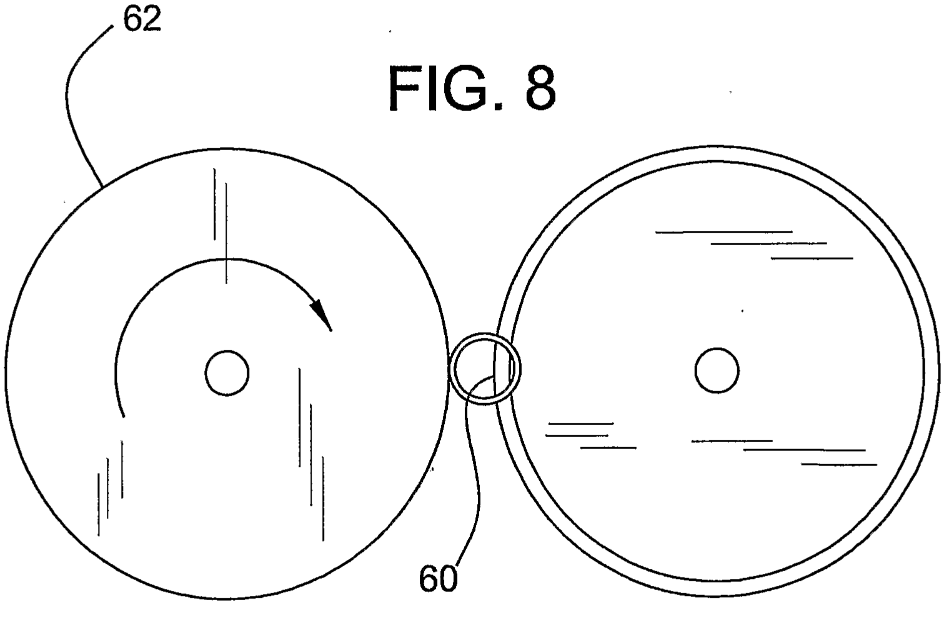

FIG. 9

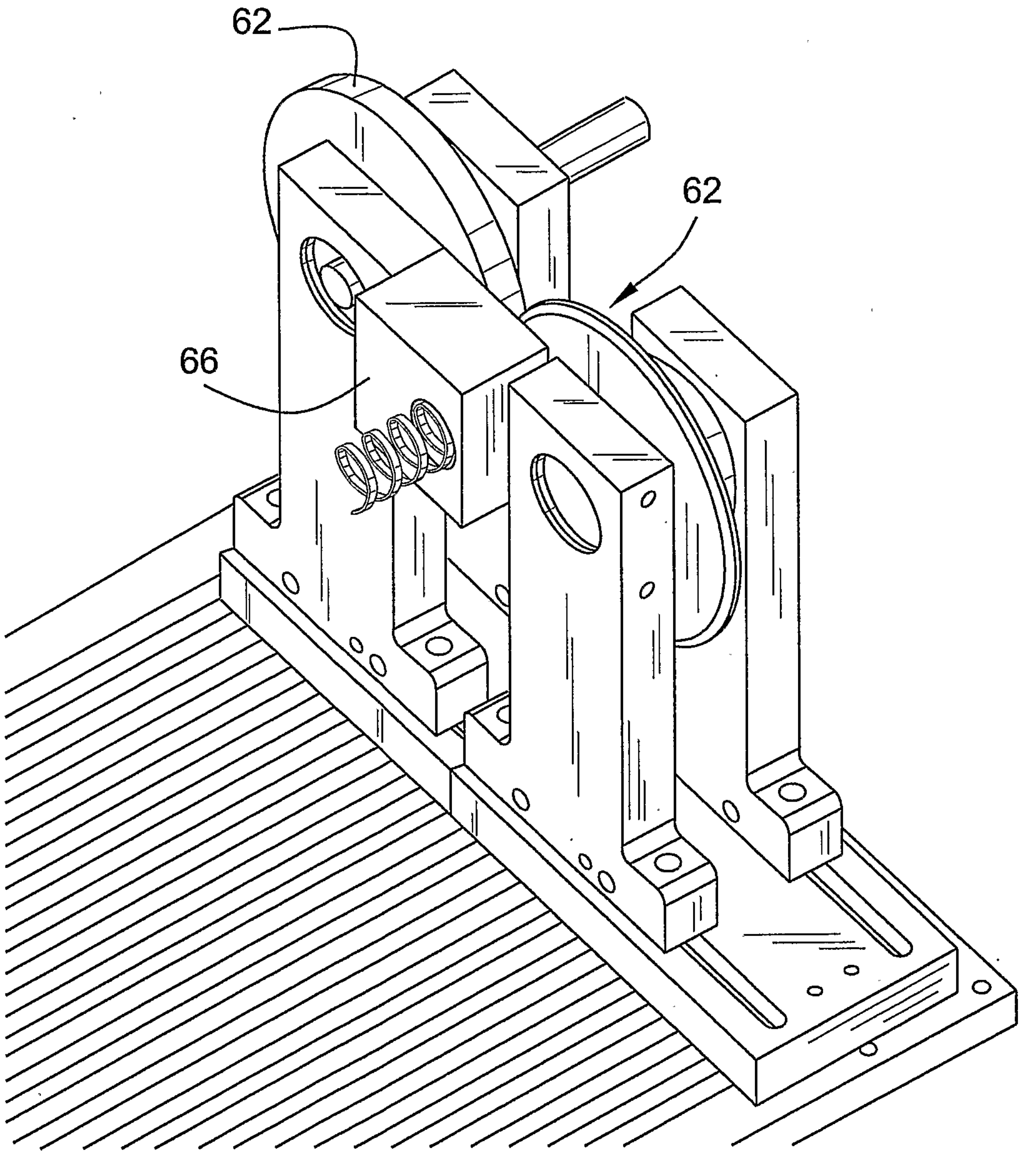

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FIG. 10A

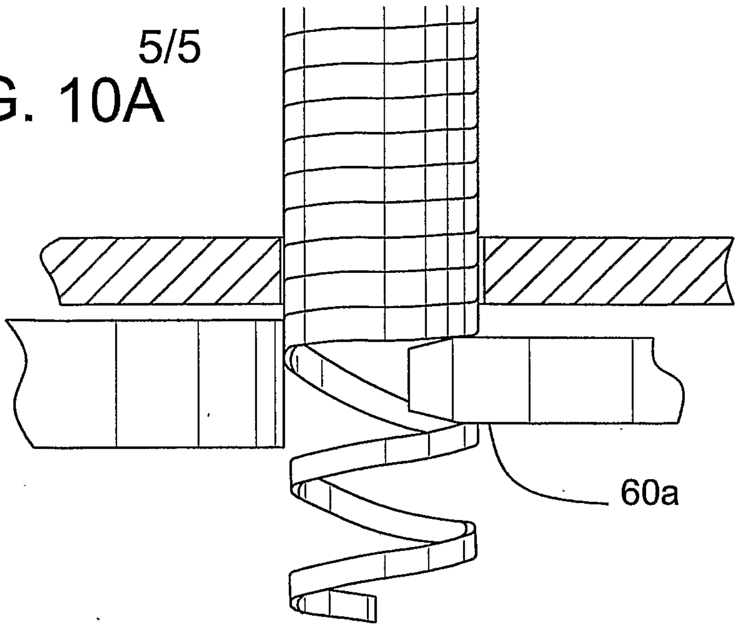

FIG. 10B

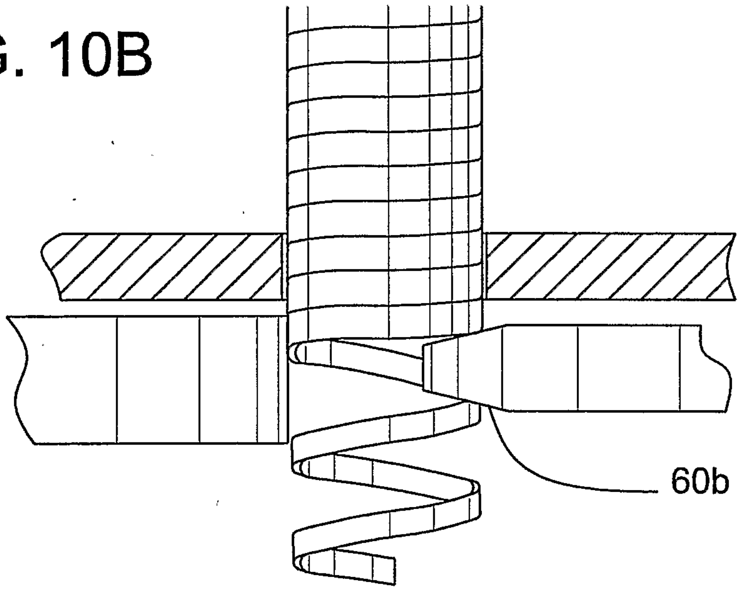

FIG. 10C