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SELF-CUTTING KEY STRUCTURE

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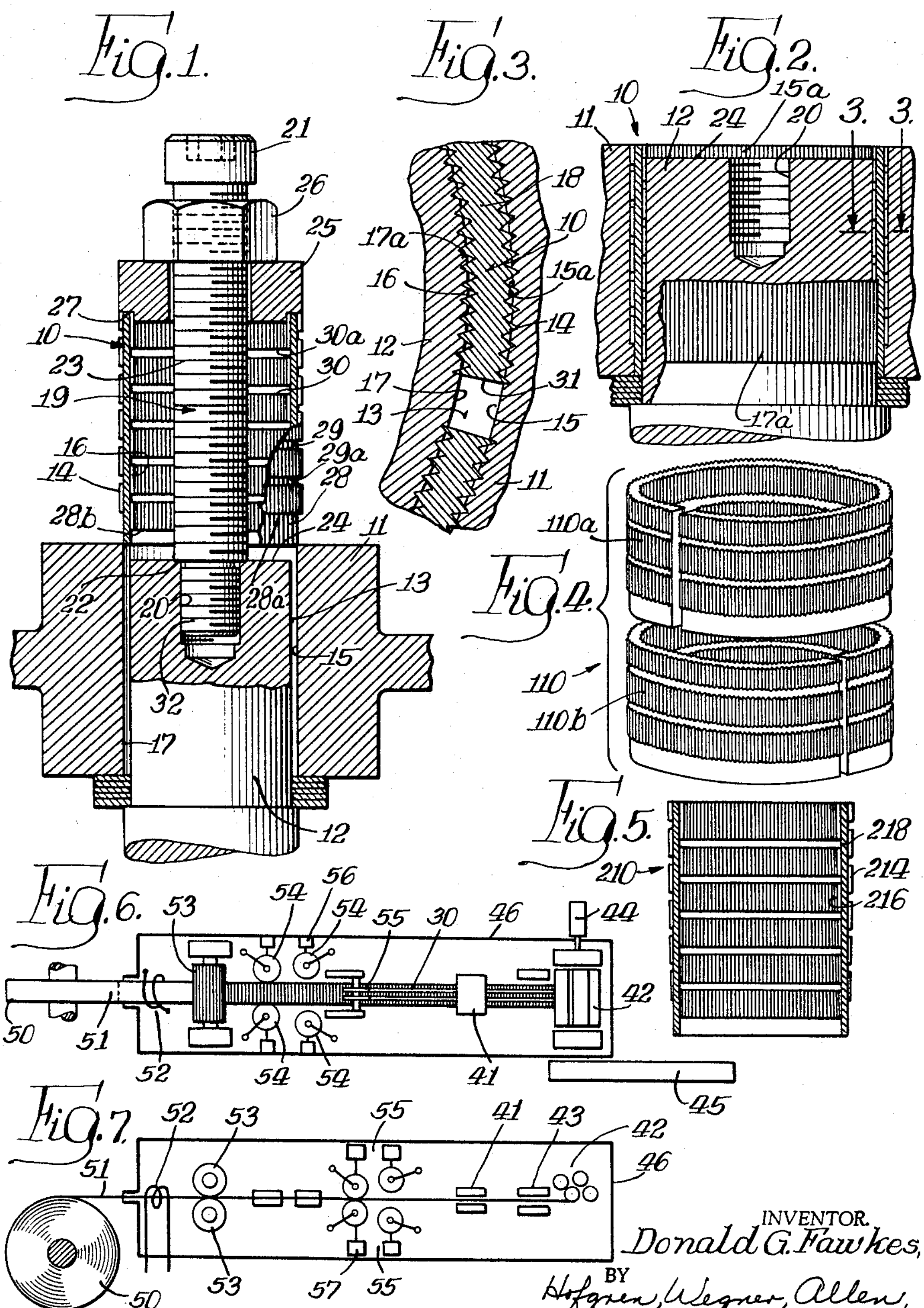

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SELF-CUTTING KEY STRUCTURE

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ABSTRACT OF THE DISCLOSURE

A structure for rotationally affixing a female member to a concentric male member. The structure is defined by an arcuate member having both inwardly and outwardly projecting keyway cutters thereon which cut keyways concurrently in each of the female and male members as an incident of insertion of the arcuate member therebetween. The keyway cutters further define keys in the thusly cut keyways for accurately maintaining the fixed association between the female and male members.

This invention relates to key structures and in particular to key structures for use in connecting members against rotation relative to each other.

One conventional method of connecting a female member to a male member, such as a hub to a shaft, against relative rotation therebetween is to provide confronting keyways in the members, and subsequently install as with a force fit, a key projecting partially into each of the keyways. Such a keying arrangement has the serious disadvantage of limited strength as the relatively small area of shear of the key limits the torque of which the connection is capable of handling. Further, such a conventional key arrangement has the serious disadvantage of relatively high cost, as each of the elements must be firstly suitably machined to the degree of accuracy required in the force fit of the key therein, and the subsequent costly step of installing the key in the aligned keyways must then be effected. A still further disadvantage of such conventional key arrangements is the difficulty of positioning the members accurately in a preselected relative angular relationship. Illustratively, where the hub carries an arm which must be in a preselected position relative to a preselected position of the shaft, extremely high angular accuracies may be required in the cutting of the respective keyways to provide the desired accuracy because of the multiplication of any inaccuracy by the machined extent of the arm.

The present invention comprehends an improved key structure eliminating the above discussed disadvantages of the conventional known key structures in a novel and simple manner.

Thus, a principal feature of the invention is the provision of a new and improved key structure.

Another feature of the invention is the provision of such a key structure wherein the key means is constructed to comprise also the means for cutting the keyway.

A further feature of the invention is the provision of such a key structure wherein a plurality of keys are provided circumferentially related to each other and extending in a series about the axis of the connection.

Still another feature of the invention is the provision of such a key structure for rotationally fixing a female member to a concentric male member, including an arcuate member having an outer portion defining means for cutting a keyway in the female member and an inner portion defining means for cutting a keyway in the male member, the outer and inner portions further defining key means for fixed retention in the keyways for rotationally fixing the female member to the male member.

A still further feature of the invention is the provision of such a key structure wherein the inner and outer portions define means for concurrently cutting a plurality of keyways in the male and female members.

A yet further feature of the invention is the provision of such a key structure wherein the arcuate member comprises a split cylinder.

Still another feature of the invention is the provision of such a key structure wherein the arcuate member decreases in thickness from one end to the opposite end.

A further feature of the invention is the provision of such a key structure wherein the arcuate member further defines an arcuate channel means intermediate the ends thereof for providing additional cutting edges from each keyway groove and for receiving material cut by the cutting means.

A yet further feature of the invention is the provision of such a key structure wherein the outer and inner portions of the key are harder than the radially intermediate portion.

Still another feature of the invention is the provision of a new and improved method of forming a key structure.

Still another feature of the invention is the provision of such a method of forming a key structure including the steps of moving a strip of metal longitudinally to dispose portions thereof of seriatim in preselected positions, heating the strip in a first position for facilitated working thereof, serrating the strip on each of its opposite faces in a second position, grinding the strip in a third position to provide channels intersecting the serrations thereof, forming each of the portions at a fifth position into a cylindrical configuration, cutting the cylindrical portion from the strip to define a completed discrete key structure, and hardening selectively the entire key structure or only the serrated portion of the key structure.

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIGURE 1 is a fragmentary vertical diametric section of a hub and shaft structure with a key structure disposed for installation therebetween by means of an illustrative installing device;

FIGURE 2 is a fragmentary enlarged diametric section illustrating the arrangement of the hub and shaft with the key structure installed for connecting the hub and shaft against relative rotation therebetween;

FIGURE 3 is a fragmentary further enlarged transverse section taken substantially along the line 3—3 of FIGURE 2;

FIGURE 4 is an exploded isometric view illustrating the arrangement of a key structure embodying the invention comprising a pair of axially short key structures adapted for joint installation in securing the hub to the shaft;

FIGURE 5 is a diametric section illustrating another form of key structure embodying the invention wherein the wall of the arcuate member is tapered from one end to the other;

FIGURE 6 is a schematic plan view of an apparatus for practicing a method of manufacturing a key structure embodying the invention; and

FIGURE 7 is a schematic side elevation thereof.

In the exemplary embodiment of the invention as disclosed in FIGURES 1 through 3 of the drawing, a key structure generally designated **10** is provided for connecting a female member, such as a hub **11**, to a male member, such as a shaft **12**. The key structure **10** is adapted to be received in an annular clearance space **13** between the hub and shaft and includes an outer portion **14** defining a plurality of keys engaging the inner wall portion **15** of the hub **11**, and an inner portion **16** defining a plurality of keys engaging the outer wall portion **17** of the shaft **12**. As shown in FIGURE 3, the radial mid-portion **18** of the key structure may have a width of in the range of from substantially less than to substantially the radial dimension of the clearance space **13** between the hub and shaft.

The key structure **10** is arranged to be installed without the necessity of precutting of the keyways in the hub and shaft, as is required in the conventional key installations. Rather, the invention comprehends the provision of the keys **14** and **16** in the form of hard cutting teeth which when forced against the wall portions **15** and **17** of the hub and shaft respectively cut the keyways therein. Thus, when the key structure is fully inserted to the position of FIGURE 2 in the space **13**, the cutting teeth **14** and **16** become the keys for locking the hub to the shaft. In order to permit such cutting action by the key-teeth portions **14** and **16**, the teeth portions are made to be harder than the respective hub and shaft materials. Preferably, the difference in hardness is approximately 10 units or more on the Rockwell C-scale to provide facilitated cutting during the installation of the key structure.

To install the key structure **10** between the hub and shaft, any conventional pressure applying means may be employed. Illustratively, as shown in FIGURE 1, a reduced end portion **32** of a drive stud **19** may be threadedly secured in a threaded portion **20** opening axially through the end of the shaft **12**. The drive stud is provided with a head **21** for use in threading the drive stud downwardly until the portion **32** is fully threaded into bore **20** and an annular shoulder **22** defining the lower end of the enlarged mid-portion **23** of the drive stud seats on the end face **24** of the shaft **12**. A drive washer **25** is disposed, prior to the installation of the drive stud on the shaft **12**, in abutting engagement with a drive nut **26** threaded on the portion **23** of the drive stud adjacent the head **21**.

As shown in FIGURE 1, the drive washer may be provided with an annular chamber **27** receiving one end of the key structure **10** to hold it in coaxial alignment with the drive stud **19**. Thus, by rotating the nut **26** suitable to advance it toward the shaft end face **24**, the washer **25** is forced toward the shaft face **24** and forces the key structure **10** into the space **13** between the hub **11** and shaft **12**. As shown in FIGURE 1, the end of the key structure **10** may have the cutting teeth portions **14** and **16** removed, as by grinding to provide channels **28**, so as to provide a thin entrance portion facilitating the insertion of the key structure into the space **13**, and providing sharp cutting edges **28*a*** and **28*b*** for cutting keyways **15*a*** and **17*a*** in the hub portion **15** and shaft portion **17**, respectively. Further, the key structure **10** may be provided with circumferential channels, such as outwardly opening channels **29** and inwardly opening channels **30**, to provide additional keyway-cutting edges **29*a*** and **30*a*** and for receiving the metal which is cut by the portions **14** and **16** during the movement of the key structure into the space **13**, during which movement the portions **14** and **16** function as key-cutting tools displacing metal from the hub and shaft respectively to define keys therein. In the illustrated embodiment, the outer channels **29** are offset relative to the inner channels **30** by approximately one-half the spacing between the respective channels.

The key structure comprehended by the present invention comprises an arcuate structure which may have any desired circumferential extent; in the illustrated embodiment, the key structure comprises a generally cylindrical sleeve extending substantially 360°. Further, as shown in the illustrated embodiment, the sleeve may be split as at **31** to permit a constrictive or expansive adaptation of the key structure to the space **13** in the installation thereof and for facilitated manufacture. As illustrated, it is desirable to provide key structure portions diametrically opposed to each other relative to the axis of the shaft **12**; in the illustrated embodiment the opposed relationship is provided by virtue of the extent of the sleeve over 180°. Further, as shown in FIGURE 3, the portion of the inner wall **15** of the hub **11** between the opposite faces **31** defining the split of the key structure **10** and the outer portion **17** of the shaft between faces **31** define keys of increased circumferential extent cooperating with the key structure **10** to provide augmented locking of the hub **11** to the shaft **12** against relative rotation therebetween.

Illustratively, the shaft **12** may comprise a two inch shaft having a tolerance of +0—.005 inch with the hub being provided with a bore of 2.240 inches +0—.020 inch. The sleeve thickness may be approximately ⅛ inch with the teeth **14** and **16** extending thereinto approximately 1/32 inch or less, and arranged circumferentially at approximately 20 or more per inch. The length of the sleeve may be approximately two inches. The sleeve may be formed of a low carbon steel with the toothed portions **14** and **16** being case hardened, or of medium or high carbon steel through-hardened by suitable through-hardening methods.

To permit improved economy in manufacture, the key structures may be made in standard short lengths permitting a plurality thereof to be utilized in a given installation to provide the desired total connection strength. Thus, for example, as illustrated in FIGURE 4, in lieu of a single sleeve two inches in length, the sleeve structure **110** may comprise a pair of sleeve structures **110*a*** and **110*b***, each similar to key structure **10** but having a length of one-half that of key structure **10**, or illustratively one inch. Obviously, where additional connection strength is required a suitable additional number of key structures may be provided as dictated by the total strength requirements.

In the embodiments of the invention illustrated in FIGURES 1 and 4, the mid-portion **18** of the key structure is substantially cylindrical having a uniform thickness throughout, and the toothed portions **14** and **16** define serrated portions having substantially uniform depth throughout their lengths, although interrupted by the intersecting channels **29** and **30** as discussed above. Another form of key structure generally designated **210**, however, is illustrated in FIGURE 5 to comprise a key structure differing from key structure **10** in the provision of a mid-portion **218** having a tapered wall thickness, decreasing from one end to the other. Similarly, the serrated, or toothed, portions **214** and **216** are tapered so as to have maximum depth at the thick end of the structure and minimum depth at the thin end. Key structure **210** functions generally similar to key structure **10** while permitting a somewhat more facilitated installation as a result of the tapered configuration.

The specific configuration and size of the teeth defined by the key portions **14** and **16** may be varied suitably in accordance with the needs of the particular installation. Similarly, the number of channels **29** and **30**, and the necessity of providing any of the channels, is dictated by the specific requirements of the particular installation. Further, the hardness of the serrated, or toothed, portions **14** and **16** is a function of the hardness of the hub and shaft structures with which the key structure is to be used and may be selected suitably for the purpose.

A novel apparatus for forming key structures, such as key structures **10**, **110** and **210**, is shown in FIGURES 6 and 7. Thus, the key structures may be formed from a roll **50** of strip stock **51** which may be of suitable steel material. The strip stock is fed firstly through a conventional induction heater **52** to heat the stock for facilitated working. In the next position, the stock is serrated, or toothed, by suitable serrating rolls **53** arranged to engage both the underside and topside of the stock and provide transverse teeth in the stock as it moves between the rolls. In the next position, a pair of side grinders **54** are provided for grinding the opposite edges of the strip. In the next position, channel grinders **55** are provided for cutting the channels **28**, **29** and **30** in the underside and top surface of the strip, respectively, and thereby form the cutting teeth **28**, **28*b***, **29*a*** and **30*a***. The side grinders **54** and channel grinders **55** may be provided in pairs to permit dressing of one set, as with dressers **56** and **57**, while the other set of grinders is in operation.

A gauging station **41** may be provided for automatically sensing the characteristics of the resultant serrated, edged and grooved stock to provide automatic control of these operations by suitable feedback signals in the conventional manner, thereby maintaining a high accuracy in the manufacture of the key structures. From the gauging device position, the stock moves on to a position wherein power rolls **42** receive the stock and form it into a cylindrical configuration whereupon a flying shear structure **43** juxtaposed to the power rolls cuts the resultant cylindrical key structure from the roll permitting it to be ejected by a suitable ejection cylinder **44** for subsequent hardening which may comprise through-hardening where the steel is medium or high carbon steel or case hardening where the steel is low carbon steel. Illustratively such hardening may be effected in a suitable conventional hardening apparatus **45**. The processing of the strip may be conducted within a suitable enclosure **46** wherein a controlled atmosphere may be maintained to prevent scaling. The housing **46** is illustrative only, and, obviously, other suitable methods of hardening the key structure may be employed.

The serrations effected by the rolls **53** may be extremely sharp so as to provide improved cutting tool action in the installation of the key structure, as described above. The use of the apparatus of FIGURES 6 and 7 provides facilitated manufacture of the split cylinder form of the key structure. If desired, the split cylinders may be secured as continuous cylinders by suitable welding of the confronting faces **31**. Thus, the apparatus of FIGURES 6 and 7 provides an improved method of forming key structures wherein a high degree of efficiency and economy is obtained, while yet assuring highly accurate controlled manufacture thereof.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A key structure for rotationally fixing a female member to a concentric male member comprising an arcuate member having an outer portion defining means for cutting a keyway in the female member and an inner portion defining means for cutting a keyway in the male member, said outer and inner portions further defining key means for fixed retention in said keyways for rotationally fixing the female member to the male member, said arcuate member further defining an annular channel in each of said outer and inner portions intermediate the ends thereof for receiving material cut by the cutting means.

2. A key structure for rotationally fixing a female member to a concentric male member, comprising a generally cylindrical member having a longitudinally serrated outer portion defining means for cutting a plurality of circumferentially related keyways in the female member and a longitudinally serrated inner portion defining means for cutting a plurality of circumferentially related keyways in the male member, said outer and inner portions further defining key means for fixed retention in said keyways for rotationally fixing the female member to the male member, said cylindrical member further defining annular channels intersecting the serrated portions.

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