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Fink

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[54] **ROLLER CUTTER**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 304,955, Nov. 9, 1972, abandoned.

[52] **U.S. Cl.** **175/363,** 175/364

[51] **Int. Cl.** **E21b 9/08,** E21c 13/00

[58] **Field of Search** 125/334, 335, 344, 376, 125/357–361, 363, 364, 367–372; 299/89; 308/8.2, 15

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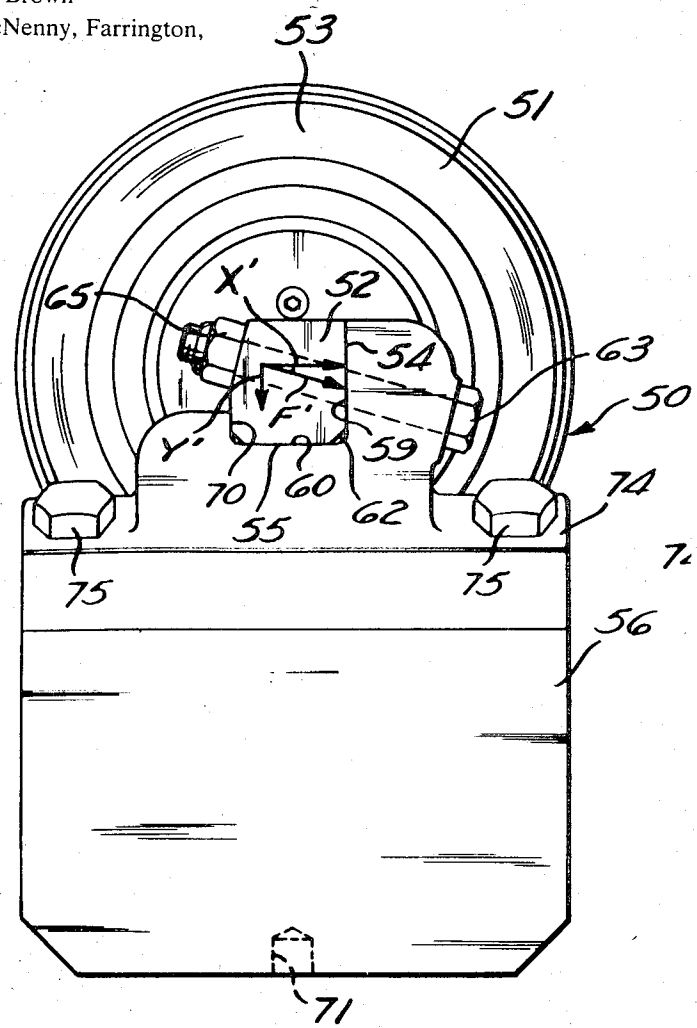
Primary Examiner—David H. Brown

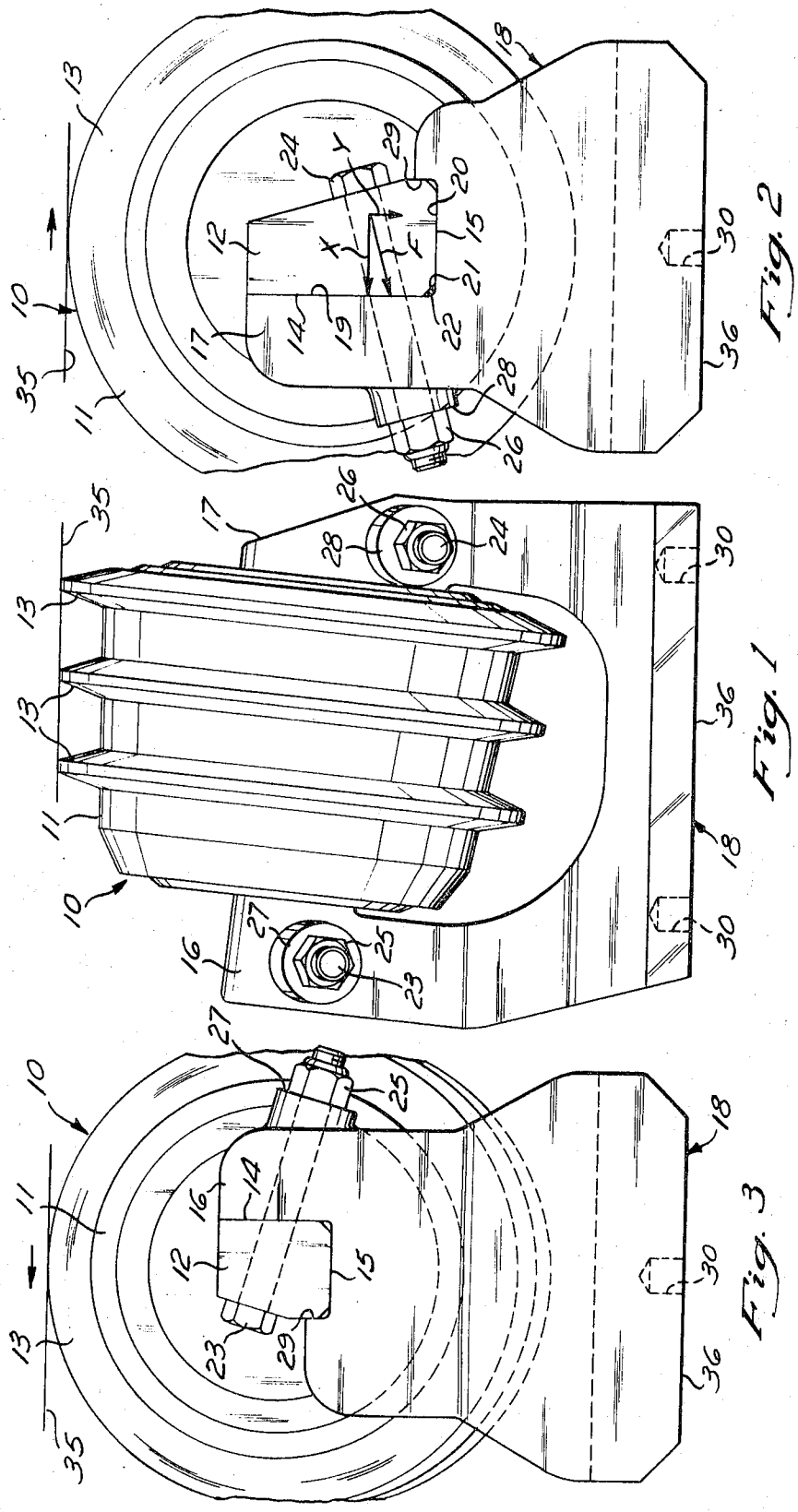
Attorney, Agent, or Firm—McNenny, Farrington, Pearne & Gordon

[57] **ABSTRACT**

A roller cutter assembly adapted to be fixed to the cutter head of a tunneling machine is disclosed. The cutter assembly includes a cutter rotatably mounted on a shaft so that end portions of the shaft project from the cutter. Each of those projecting end portions has a pair of flat faces the planes of which intersect at an angle of 90°. A generally U-shaped saddle having projecting arm portions mounts the shaft so that the cutter is rotatable on the shaft. Each arm of the saddle has a pair of flat faces the planes of which intersect at an angle of 90 degrees and which engage the faces on a projecting end portion of the shaft. The engaged faces are clamped together by bolts, each of which exerts a clamping force having components normal to the engaged faces and each of which is more nearly horizontal than vertical with respect to the intended cutting plane. According to one aspect of this invention, the cutter is a gauge cutter and one projecting arm portion of the saddle may be removed from the remainder of the saddle to facilitate removal and replacement of the gauge cutter.

15 Claims, 6 Drawing Figures




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Fig. 2
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Fig. 3

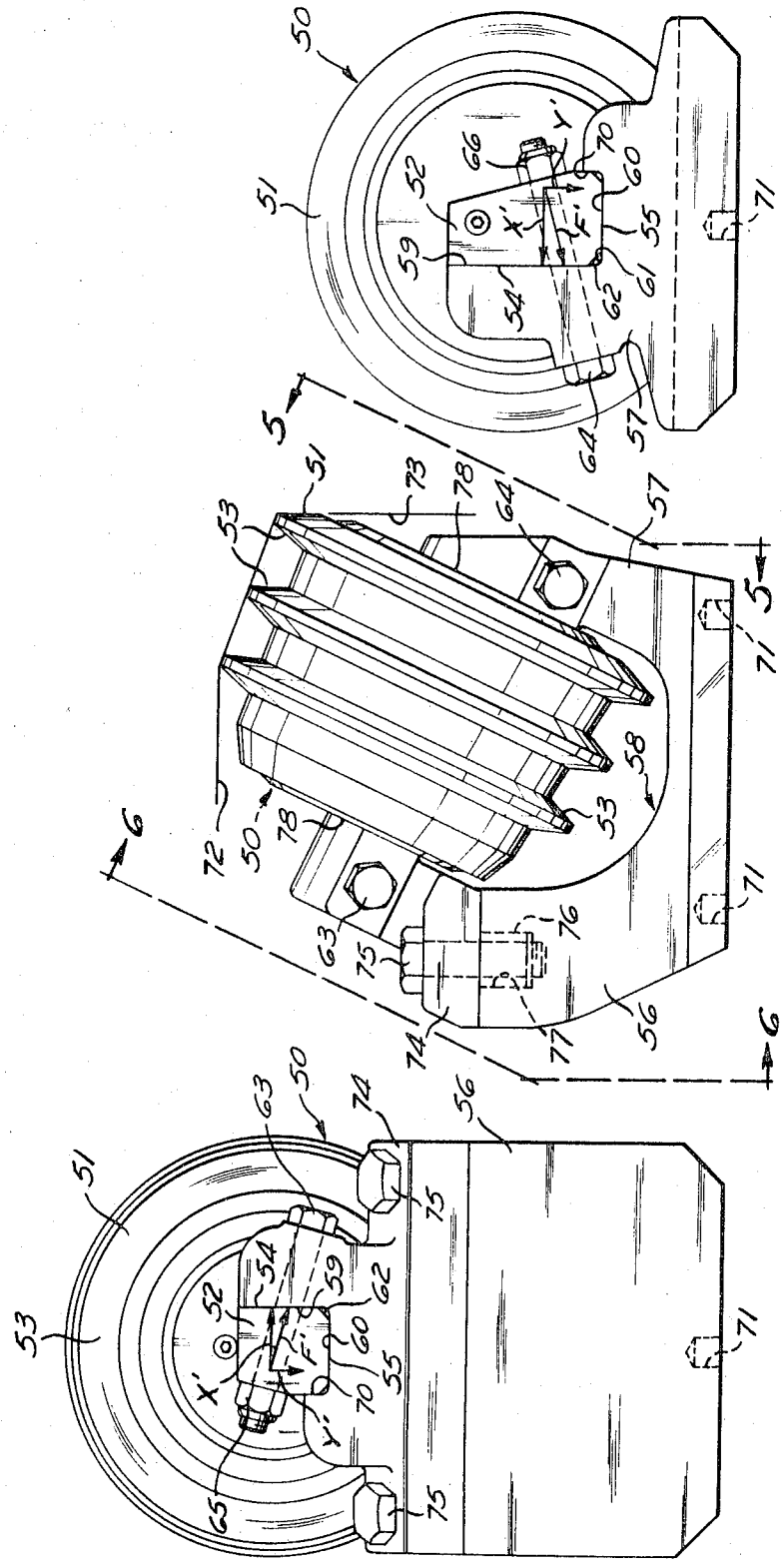


Fig. 5

Fig. 4

Fig. 6

ROLLER CUTTER

CROSS REFERENCE TO RELATED APPLICATION

The present application is a continuation-in-part of my copending application Ser. No. 304,955, filed Nov. 9, 1972 entitled "Roller Cutter" and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates generally to tunneling machines, and more particularly to tunneling machines having a rotatable cutter head and roller cutters mounted on the cutter head for engaging an end face of a tunnel with rolling contact in one direction and for engaging the juncture between the end face and the wall of the tunnel with rolling contact in that one direction. Those cutters which engage the end face of the tunnel are designated "inside cutters," and those cutters which engage the juncture between the end face of the tunnel and the wall are designated "gauge cutters." Still more particularly, the invention relates to an assembly which includes a cutter mounting saddle having a cutter mounting arrangement which minimizes wear between the shaft of the cutter and the saddle.

Tunneling machines generally include a support frame which is anchored in the tunnel and which supports a rotatable cutter head. Roller cutters are mounted on the cutter head, and rotation of the cutter head in one direction causes the cutters to travel about the end face of the tunnel with rolling contact to crush the formation encountered in a well known manner.

During the cutting operation, much of the rock is crushed to a fine, extremely abrasive powder. Because of the presence of this powder, care must be taken to minimize the number of loose fitting connections between removable portions of the tunneling machine. Since portions of the tunneling machine must be removed for replacement, care must be taken to provide tight connections between such members so that the amount of abrasive material between mating surfaces will be minimized and movement between such members will also be minimized to prevent wear between the surfaces.

Since the cutter teeth will in time wear, the cutters must be replaced. Therefore, the shaft on which the cutter is rotatably mounted is removably mounted on the projecting arms of a U-shaped saddle. Typically, the shaft extends through bores in the saddle arms and is restrained against rotation and axial movement relative to the saddle by shaft lock screws or lock bolts which extend transversely through the bored arm and through one end of the shaft. Since no clamping force exits between the saddle and the shaft, precise tolerances must be maintained between these members and between the saddle arm and the cross pin. To minimize wear between the saddle arm and the shaft, split bushings are normally provided to protect the load bearing area between the shaft and the saddle arm. This particular design has not been entirely successful in minimizing wear between the parts of the assembly. Furthermore, in order to replace a cutter, it is necessary to remove the cross pin and pull the shaft axially from the holes in the saddle arm, thus necessitating removal of the shaft from its cutter.

Other typical arrangements include saddle arms having projections which cradle the projecting shaft ends. In some of those arrangements, the cradle formed by the saddle arms is open-topped and each shaft end is retained therein by a bolt which extends through the arms and through the shaft end. In others of those arrangements, the cradled shaft end is retained therein by one or more clamping members which cover or substantially cover the non-cradled portion of the shaft end between the saddle arms and which are bolted to at least one of the saddle arms. Although all of these arrangements permit removal of the cutter and its shaft as a unit from the saddle, certain problems exist. No significant clamping force obtains where the bolt extends through the arms and the shaft and the employment of one or more clamping members increases the interface area which may collect abrasive powder.

SUMMARY OF THE INVENTION

The present invention overcomes these and other problems of prior art tunneling machines by providing a cutter assembly having an improved connection between the shaft and the saddle arms. According to the principles of the invention, the connection may be effected without maintaining precise tolerances between the mating surfaces and the connection itself positively clamps the shaft to the saddle arms. An inside cutter may be removed and replaced by removing two clamping bolts and lifting the cutter from the saddle.

According to the teachings of this invention, a cutter assembly comprises a cutter rotatably mounted on a shaft so that end portions of the shaft project from the cutter. Each of those projecting end portions has a pair of flat faces the planes of which intersect at an angle of 90°, with one face being substantially normal to the intended cutting plane. A generally U-shaped saddle having projecting arm portions mounts the shaft and has a face adapted to be secured to the cutter head. Each arm of the saddle has a pair of flat faces the planes of which intersect at an angle of 90° and which engage the faces on a projecting end portion of the shaft. The engaged faces are clamped together by bolts, each of which exerts a clamping force having components normal to the faces and each of which is more nearly horizontal than vertical with respect to the intended cutting plane and with respect to the mounting face of the saddle. A clamping bolt projects through each arm and through each end portion of the shaft at an angle so that force components force the faces into tight engagement, thus eliminating the maintenance of precise tolerances between those faces. Furthermore, if wear should occur between the mating faces, the bolt may be tightened to eliminate play and consequent abrasion between those faces. The orientation of the bolt is such that a larger force component obtains between the clamped faces which are substantially normal to the intended cutting plane, since greater magnitudes of load variation occur in directions substantially parallel to the intended cutting face.

According to one aspect of this invention, a gauge cutter is mounted in a similar assembly. However, in the case of a gauge cutter, removal of the cutter would normally be prevented by the tunnel wall. Therefore, according to this aspect of this invention, the saddle arm which is located radially inwardly of the tunnel wall is removable from the remainder of the saddle so that the cutter may be removed therefrom.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects, principles, and advantages of this invention will become readily apparent to those skilled in the art upon a comprehensive understanding of the preferred embodiment of the invention shown in the accompanying drawings, wherein:

FIG. 1 is an elevational view of an inside cutter assembly according to the principles of the invention;

FIG. 2 is a right end view of the cutter assembly shown in FIG. 1;

FIG. 3 is a left end view of the cutter assembly illustrated in FIG. 1;

FIG. 4 is an elevational view of a gauge cutter assembly according to the principles of another aspect of this invention, showing the cutter in engagement with the juncture between a tunnel wall and face;

FIG. 5 is an end view of the assembly illustrated in FIG. 4, the plane of the view being indicated by the line 5—5 in FIG. 4; and

FIG. 6 is an end view of the assembly illustrated in FIG. 4, the plane of the view being indicated by the line 6—6 in FIG. 4.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings in greater detail, and particularly to FIGS. 1 through 3, a cutter assembly **10** is illustrated. The assembly **10** includes a cutter **11** rotatably mounted on a shaft **12** so that end portions of the shaft project from the cutter. The illustrated cutter **11** is a circumferential disc, kerf-type cutter having a plurality of discs **13**. It should be appreciated, however, that other cutter configurations may be employed depending upon the type formation to be cut. Suitable conventional bearings and bearing seals are provided between the shaft **12** and the cutter **11** to permit relative rotation between the cutter **11** and the shaft **12**, while preventing abrasive grit from entering the bearing area.

Each of the projecting end portions of the shaft **12** has a pair of flat faces **14** and **15** which are angularly related to each other at an angle of 90°. The projecting end portions are mounted on the ends of projecting arm portions **16** and **17** of a U-shaped saddle **18** so that the cutter **11** may rotate relative to the shaft. Each arm of the saddle **18** has a pair of flat faces **19** and **20** which are angularly related at an angle of 90° and which respectively engage the flat faces **14** and **15** of the shaft. For ease of machining, a fillet **21** may be provided between the faces **19** and **20** and the intersection of the faces **14** and **15** may be provided with a chamfer **22** so as not to interfere with the fillet **21**.

Clamping means are provided at each end of the shaft to respectively clamp the faces **14** and **15** to the faces **19** and **20** of the projecting arms **16** and **17**. According to this invention, the clamping means comprises bolts **23** and **24**. The bolts **23** and **24** extend through the projecting ends of the shaft **12** and through the arms **16** and **17**. Locking type nuts **25** and **26** are threaded onto the projecting ends of the bolts **23** and **24** and bear against bosses **27** and **28** on the arms **16** and **17**.

It may be noted in FIGS. 2 and 3 that the bolts **23** and **24** are angularly related to the faces **14** and **19** and that an axial force F exerted by each bolt has components X and Y which are normal to and in the direction of the faces **19** and **20**, thus securely clamping all of the mating faces together. This clamping force is sufficient to maintain a tight seal between the mating faces of the shaft and the arms of the U-shaped saddle to minimize the entry of grit between these surfaces. It should also be noted that any play between the mating surfaces may be taken up by a simple tightening of the bolts **23** and **24**.

Each cutter assembly **10** is adapted to be driven in the direction of the arrows in FIGS. 2 and 3 as the cutter head (not shown) on which each cutter assembly **10** is mounted drives the assembly into the face **35** of the tunnel. During the cutting operation, there are substantially larger loads acting on the faces **15** and **20** than on the faces **14** and **19**. However, those larger loads are substantially constant while greater magnitudes of load variations occur on the faces **14** and **19** because of variations in rock density and types encountered by the cutter in the rolling direction. Therefore, the bolts **23** and **24** are mounted so that they are more nearly horizontal than vertical with respect to the tunnel face **35** and a face **36** of the saddle **18** which is adapted to be secured to the cutter head. As a result of this mounting arrangement, the force component X exceeds the component Y to more effectively resist load variations on the faces **14** and **19**, while the relatively small force component Y is added to by the relatively constant loads imposed normal to the face **36**.

To aid in locating the shaft **12** during installation, the arms **16** and **17** are provided with raised faces **29** which are parallel to the faces **19**. The faces **29** do not exert any clamping pressure on the shaft **12**, but may serve to retain the cutter in place if the bolts **23** or **24** should fail. Since the cutters are intended to be rotated only in the single indicated direction, a clamping force need not be applied by the saddle **18** to the face of the shaft **12** opposite the face **14** and this permits clear access to the heads of the bolts **23** and **24** for replacement of the cutter.

A plurality of inside cutter assemblies **10** are located in predetermined positions on the forward end face of the cutter head (not shown) by locating dowel pins (not shown) which project from the face of the cutter head and which enter dowel pin openings **30** in the bottom face **36** of the saddle **18**. After the saddles are located on the cutter head in this manner, the saddles are welded to the face of the cutter head.

Referring now to FIGS. 4 through 6, a gauge roller cutter assembly **50** according to a further aspect of this invention is illustrated. The assembly **50** includes a cutter **51** rotatably mounted on a shaft **52** so that end portions of the shaft project from the cutter. The cutter is provided with circumferential discs **53** which are similar to the discs **13** illustrated in FIGS. 1 through 3. Each projecting end portion of the shaft **52** is provided with flat faces **54** and **55** which are angularly related at an angle of **90** degrees, and those end portions are mounted on projecting arms **56** and **57** of a U-shaped saddle **58**. The arms **56** and **57** are provided with flat faces **59** and **60**, which are angularly related to an angle of **90** degrees and which respectively mate with the faces **54** and **55** on the ends of the shaft **52**. A fillet **61** is provided at the intersection of the faces **59** and **60** and a chamfer **62** is provided at the intersection of the faces **54** and **55** to clear the fillet **61**.

Clamping means are provided at each end of the shaft to respectively clamp the faces **54** and **55** to the faces **59** and **60** of the projecting arms **56** and **57**. Ac-

cording to this invention, the clamping means comprises bolts **63** and **64**. The bolts **63** and **64** extend through the projecting ends of the shaft **52** and through the arms **56** and **57**. Locking type nuts **65** and **66** are threaded onto the projecting ends of the bolts **63** and **64**.

It may be noted in FIGS. **5** and **6** that the bolts **63** and **64** are angularly related to the faces **54** and **59** and that an axial force F' exerted by each bolt has components X' and Y' which are normal to and in the direction of the faces **59** and **60**, thus securely clamping all of the mating faces together. This clamping force is sufficient to maintain a tight seal between the mating faces of the shaft and the arms of the U-shaped saddle to minimize the entry of grit between the surfaces. It should also be noted that any play between the mating surfaces may be taken up by a simple tightening of the bolts **63** and **64**.

To aid in locating the shaft **52** during installation, the arms **56** and **57** are provided with raised faces **70** which are parallel to the faces **59**. The faces **70** also serve to retain the shaft **52** during cutting operations, but it should be noted that the faces **70** do not exert any clamping pressure on the shaft **52**.

A plurality of gauge cutter assemblies **50** are located in predetermined positions on the outer rim of the forward end face of a cutter head (not shown) by locating dowel pins (not shown) which project from the face of the cutter head and which enter dowel pin openings **71** in the bottom face of the saddle **58**. After the saddles are located on the cutter head in this manner, the saddles are welded to the face of the cutter head. The predetermined positions of the gauge cutters are adjacent the periphery of the cutter head since they are intended to operate in the angular juncture of the face and walls of the tunnel. Furthermore, the saddle **58** supports the shaft **52** in such a manner that the axis of rotation of the gauge cutter is at an angle to the axis of rotation of the inside cutters.

To replace the cutter **51**, the tunneling machine is backed from the face **72** of the tunnel to allow access. However, since one end of the cutter **51** remains in contact with the tunnel wall **73**, it will be noted that the cutter **51** may not be removed from the saddle **58** merely by removing the bolts **63** and **64**, since in such a situation, the cutters must be moved in a direction parallel to faces **78** of the cutter **51** to permit the shaft to clear the faces **70**. Therefore, means are provided to permit removal of the cutter **51** in a direction parallel to the wall **73**. As may be seen most clearly in FIGS. **4** and **5**, this removal means includes a removable portion **74** of the arm **56**. The portion **74** is fixed to the remainder of the arm **56** by bolts **75** and by a projecting key portion **76** of the portion **74** which enters a key slot **77** in the remainder of the arm **56**. Thus, the cutter **51** may be removed from the saddle **58** by removing the bolts **75** and the bolts **64** and removing the assembly in a direction parallel to the wall **73**. It should be noted that the bolt **63** need not be removed to perform this operation.

While I have described my invention in connection with specific embodiments thereof, it is to be clearly understood that this is done only by way of example, and not as a limitation to the scope of my invention as set forth in the objects thereof and in the appended claims.

What is claimed is:

1. A roller cutter assembly comprising a cutter rotatably mounted on a shaft so that end portions of said shaft project from said cutter, said end portions having first and second flat angularly related faces, a generally U-shaped saddle having projecting arm portions mounting said shaft and a mounting face adapted to be secured to a cutter head, each projecting arm portion having first and second flat angularly related faces respectively engaging the first and second faces on each said end portion, means for clamping each arm to each end portion and for providing a clamping force between engaged faces having components normal to each face, said clamping means providing a greater force component parallel to said mounting face.

2. A roller cutter assembly according to claim **1**, wherein non-engaged portions of said projecting arm portions are substantially exposed to allow clear access to said clamping means.

3. A roller cutter according to claim **1**, wherein one of said projecting arms has means removably fixing it to the remainder of said U-shaped saddle.

4. A roller cutter assembly according to claim **1**, wherein the planes of said angularly related faces define an angle of about 90°.

5. A roller cutter assembly according to claim **4**, wherein said first and second faces intersect.

6. A roller cutter assembly according to claim **1**, wherein said means for clamping comprises a bolt extending through each end portion and at least one of said faces on said arm portion.

7. A roller cutter assembly according to claim **6**, wherein said bolts are more nearly horizontal than vertical with respect to said mounting face.

8. An inside roller cutter assembly adapted to be fixed to a rotatable cutter head, comprising a cutter rotatably mounted on a shaft so that end portions of said shaft project from said cutter, said end portions having first and second flat faces intersecting at an angle of about **90** degrees, a generally U-shaped saddle having projecting arm portions mounting said shaft and a mounting face adapted to be secured to a cutter head, each projecting arm portion having first and second flat faces intersecting at an angle of about **90** degrees, and respectively engaging the first and second faces on each said end portion, a bolt extending through each end portion and at least one of said faces on said arm portion, each bolt defining an acute angle with said at least one of said faces and clamping said first and second faces of said end portion to the first and second faces of said arm portion with a force having components normal to each face, each bolt being more nearly horizontal than vertical with respect to said mounting face.

9. An inside roller cutter assembly according to claim **8**, wherein non-engaged portions of said projecting arm portions are substantially exposed to allow clear access to said clamping means.

10. A gauge roller cutter assembly adapted to be fixed to a rotatable cutter head, comprising a cutter rotatably mounted on a shaft so that end portions of said shaft project from said cutter, said end portions having first and second flat faces intersecting at an angle of about 90°, a generally U-shaped saddle having projecting arm portions mounting said shaft and a mounting face adapted to be secured to a cutter head, each projecting arm portion having first and second flat faces intersecting at an angle of about **90** degrees and respec-

tively engaging the first and second faces on each said end portion, one of said arm portions having means removably fixing it to the remainder of said U-shaped saddle, a bolt extending through each end portion and at least one of said faces on said arm portion, each bolt defining an acute angle with said at least one of said faces and clamping said first and second faces of said end portion to the first and second faces of said arm portion with a force having components normal to each face, each bolt being more nearly horizontal than vertical with respect to said mounting face.

11. A gauge roller cutter assembly according to claim **10,** wherein said means removably fixing one of said arm portions includes bolt means.

12. A gauge roller cutter assembly according to claim **11,** wherein said means removably fixing one of said arm portions includes a key projecting from said one of said arm portions and a cooperating slot on said remainder of said U-shaped saddle.

13. A gauge roller cutter assembly adapted to be fixed to a rotatable cutter head, comprising a cutter rotatably mounted on a shaft so that end portions of said shaft project from said cutter, said end portions having first and second flat faces intersecting at an angle of about 90°, a generally U-shaped saddle having projecting arm portions mounting said shaft and a mounting face adapted to be secured to a cutter head, each projecting arm portion having first and second flat faces intersecting at an angle of about 90° and respectively engaging the first and second faces on each said end portion, one of said arm portions having means removably fixing it to the remainder of said U-shaped saddle, a bolt extending through each end portion and at least one of said faces on said arm portion, each bolt being more nearly horizontal than vertical with respect to said mounting face defining an acute angle with said at least one of said faces and clamping said first and second faces of said end portion to the first and second faces of said arm portion with a force having components normal to each face.

14. A gauge roller cutter assembly according to claim **13,** wherein said means removably fixing one of said arm portions includes bolt means.

15. A gauge roller cutter assembly according to claim **14,** wherein said means removably fixing one of said arm portions includes a key projecting from said one of said arm portions and a cooperating slot on said remainder of said U-shaped saddle.

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