Jan. 12, 1937. M. I. KILLMER 2,067,711

APPARATUS FOR ERECTING TUNNEL LININGS

Filed Sept. 16, 1936 2 Sheets-Sheet 1

Fig. 1.

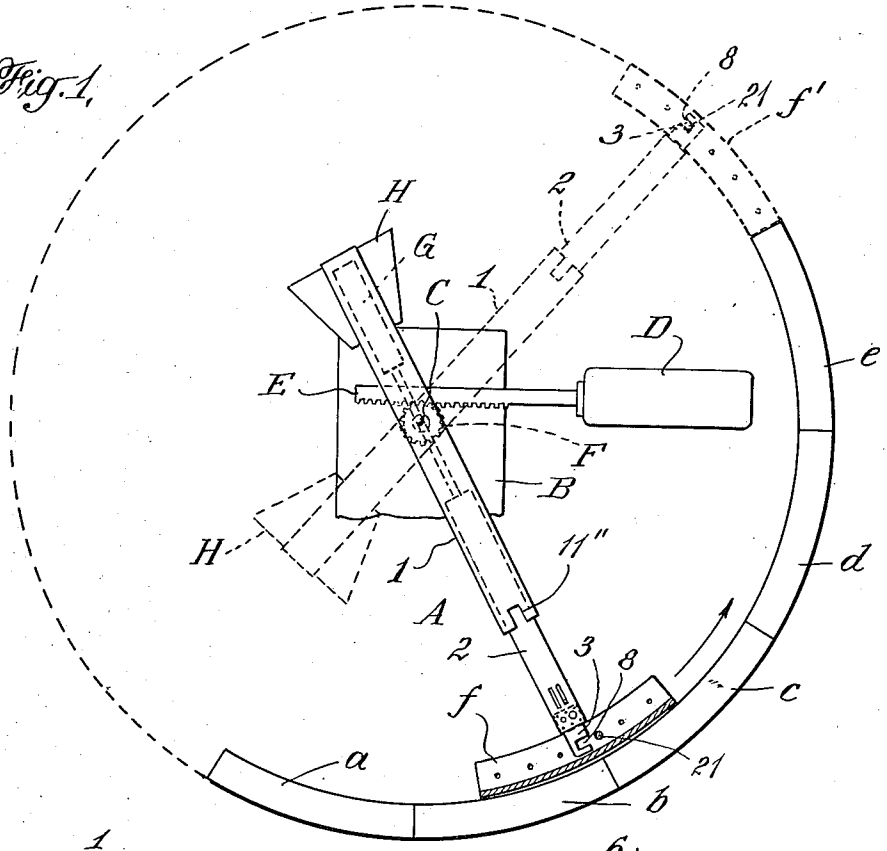


Fig. 2.

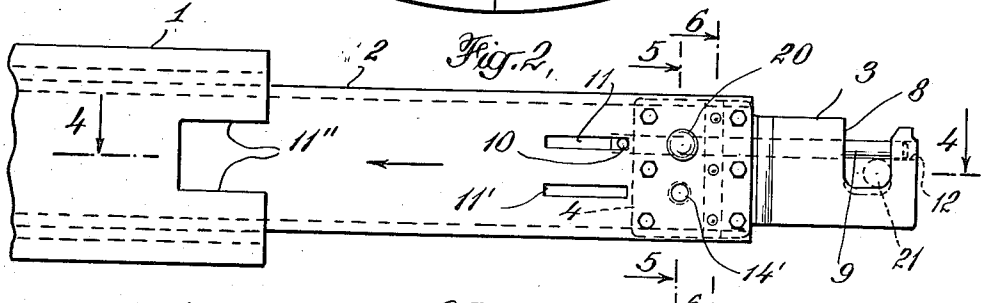
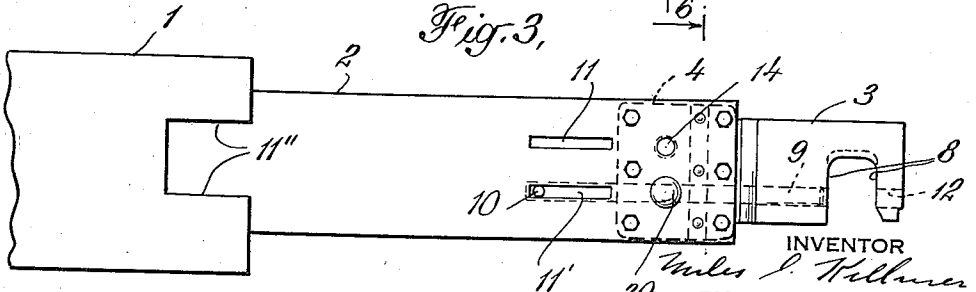


Fig. 3.



INVENTOR
Miles I. Killmer
BY
Dennie, Davis, Warren & Edmonds
ATTORNEYS

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Fig. 4,

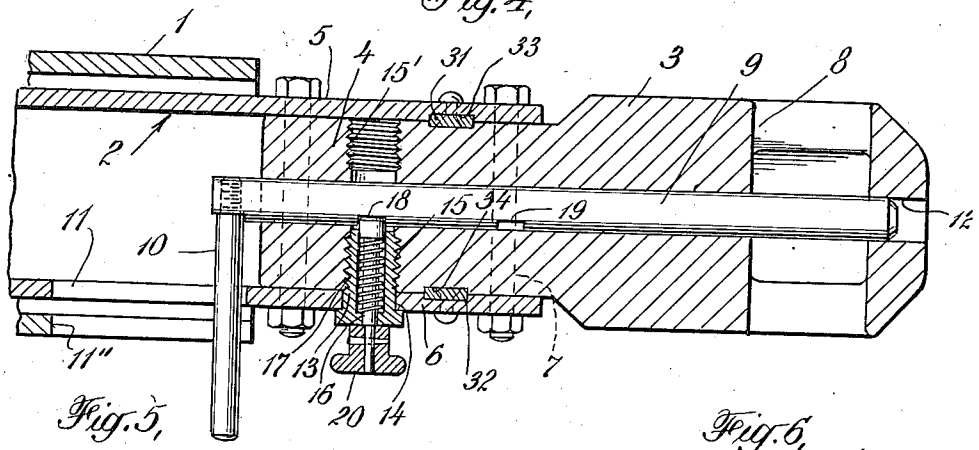


Fig. 5,

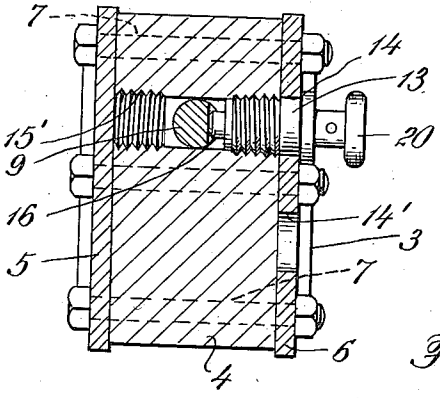


Fig. 6,

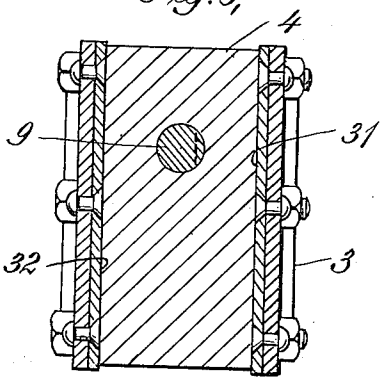
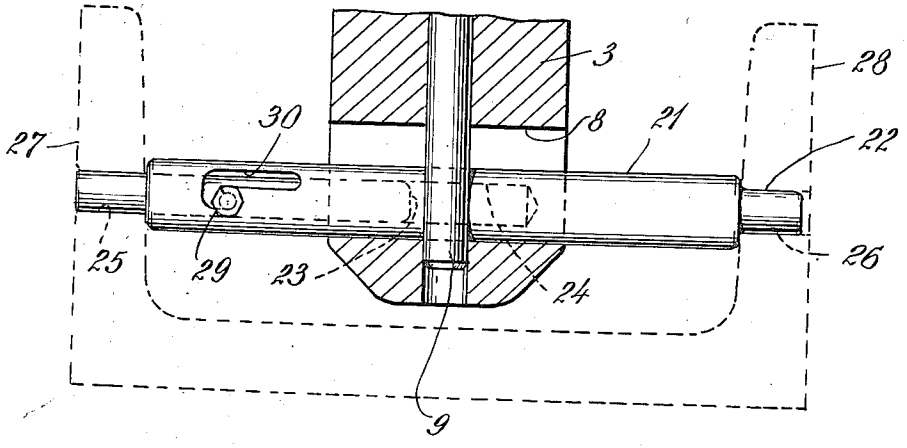


Fig. 7.



Miles I. Killmer INVENTOR

BY

Pennie, Davis, Marvin & Edmonds

ATTORNEYS

UNITED STATES PATENT OFFICE

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APPARATUS FOR ERECTING TUNNEL LININGS

Miles I. Killmer, New York, N. Y.

Application September 16, 1936, Serial No. 100,985

8 Claims. (Cl. 61—84)

This invention relates to apparatus for erecting tunnel linings.

In constructing a tunnel it is customary to advance a shield through the ground and to build up the lining of the tunnel at the rear of the shield. The lining is usually composed of metallic segments about six feet long and about two or three feet wide. They have perforated flanges along their side edges by which the segments are bolted or riveted together. The segments are quite heavy so it is customary to place them in position by means of an erector mounted in the shield. The erector has an arm which is pivotally mounted to swing about an axis parallel with the axis of the shield and this arm is provided with a telescopic section. In this way the erector head, located at the outer end of the telescopic section, may be swung circumferentially of the shield, and also moved in a radial direction to enable the head to pick up a segment and move it to the place where it is to be fitted into the tunnel lining. The swinging of the erector arm to move the head circumferentially, and the movement of the telescopic section to move the head radially, are usually accomplished by fluid pressure operated mechanism.

The erector head is ordinarily provided with an opening, or slot, extending through the head in the direction of the axis of the shield. When it is desired to attach the erector head to the segment to be positioned, the erector arm is rotated and the head is moved radially until the head occupies a position between the side flanges of the segment to be positioned. A so-called "gadget bar" is then threaded through two opposite bolt holes in the segment flanges and through the opening in the erector head so that subsequent rotation of the erector arm, accompanied by a radial movement of the head, will lift the segment and place it in the position in which it is to be bolted to the previously constructed portion of the lining.

In order to make it possible to insert the gadget bar through the bolt holes in the segment flanges and through the opening in the erector head the three openings must be in exact alignment. This involves a great deal of effort, a waste of time, and considerable annoyance as it is usually necessary to rotate the arm, and move the head radially, a number of times before the three openings will assume the exact position of alignment such as is required before the gadget bar can be inserted through them. It is purely a "hit or miss" procedure.

It is the principal object of the present invention to eliminate this waste of time and effort. This I accomplish by so constructing the erector head that the gadget bar may first be completely positioned in the bolt holes of the segment flanges quite independently of the erector head, this being an easy and quick operation as only two holes are being dealt with, and the subsequent attachment of the erector head to the gadget bar is effected solely by the movement of the head in its circular path toward the gadget bar and by a quickly and easily accomplished closing of a retaining member on the head.

One embodiment of the invention is illustrated in the accompanying drawings in which:

Figure 1 is a side elevation of the improved erector as viewed when looking toward the shield and into the tunnel;

Fig. 2 is a side elevation of the outer end portion of the erector arm and its telescopic section.

Fig. 3 is a view similar to Fig. 2 showing the manner in which the erector head may be reversed on the arm;

Fig. 4 is a longitudinal section through the arm and the head taken on the line 4—4 of Fig. 2;

Fig. 5 is a transverse section taken on the line 5—5 of Fig. 2;

Fig. 6 is a transverse section taken on the line 6—6 of Fig. 2; and

Fig. 7 is a section taken transversely through one of the tunnel segments showing the gadget bar applied to the segment and showing the head, partly in section, in position ready to lift the segment.

The erector shown in the drawings comprises an arm A pivotally mounted on a support B so as to swing about an axis C parallel with the axis of the tunnel. The support B is mounted in the usual manner within the shield (not shown). The arm A is in two sections, an inner section 1 which is the part that is pivotally mounted, and an outer section 2 which is telescopically mounted with respect to the section 1. The swinging movement of the arm A about the axis C, and the telescopic movement of the section 2 of the arm, may be effected by any suitable power operated mechanism. The details of this mechanism constitute no part of the invention, the only requirement being that some means be provided for swinging the erector arm about its axis and for moving the telescopic section of the arm to produce movement of the erector head in a radial direction. The actuating mechanism has therefore been shown more or less diagrammatically as comprising a fluid pressure cylinder D for reciprocating a rack E meshing

with the gear F secured to the section 1 of the arm. Fluid under pressure admitted to the cylinder D will swing the arm A about its axis in the desired direction as will be well understood. The telescopic section 2 of the arm may be actuated by admitting fluid under pressure to a cylinder G mounted on, or within, the section 1 of the arm.

The erector head which picks up the tunnel segments is located at the outer end of the arm A, the inner end of the arm being counterweighted as represented at H to facilitate the lifting of the heavy segments.

The details of the head and the manner in which it is attached to the telescopic section 2 of the erector arm are best shown in Figs. 2, 4, 5, and 6. The head comprises a block 3 having a shank portion 4 (Fig. 4) the side walls of which are parallel so that the shank may be gripped between the side plates 5 and 6 of the arm section 2. The erector head may be secured in place by a number of bolts 7 passing transversely through openings in the shank 4 and through openings in the side plates 5 and 6 of the arm section 2.

A face of the head that extends parallel with the axis of the tunnel is provided with a transverse recess shown at 8. This recess is of sufficient width and depth to receive the gadget bar as hereinafter described.

Mounted in the head for longitudinal sliding movement is a lock-bar 9 having a handle 10 which projects laterally from the head as shown in Fig. 4. A slot 11 is provided in the side plate 6 of the arm section 2 to accommodate the handle. The handle 10 makes it possible to slide the lock-bar 9 to an extreme right hand position, as viewed in Fig. 4, or to an extreme left hand position. The right hand position is its operative position in which the end of the bar spans the recess 8, as shown in Fig. 2. In this position the extreme end of the bar projects into a bore 12 provided in the portion of the head which lies outward of the recess. In the left hand position of the bar 9, or its retracted position, the bar 9 clears the recess 8 and leaves it fully open.

A spring latch is preferably employed to retain the lock-bar 9 in either its operative position or in its retracted position. This latch may comprise a bushing 13 passing through an opening 14 in the side plates 6 of the arm section 2 and threaded into an opening 15 extending laterally into one side of the shank portion 4 of the head. Mounted in the bushing 13 is a plunger 16 the head of which is urged by a coil spring 17 toward the lock-bar 9. When the lock-bar 9 is in its operative position the head of the plunger engages in a recess 18 in the lock-bar 9, and when it is in its retracted position the head of the plunger engages in a second recess 19 in the lock-bar. When it is desired to shift the lock-bar the plunger 16 is manually retracted by means of a knob 20 secured to the outer end of the plunger.

Fig. 1 shows a numer of positioned lining segments *a*, *b*, *c*, *d* and *e*. At *f* there is shown a segment ready to be lifted by the erector arm and moved in a counterclockwise direction toward its final position represented by dotted lines at *f'*. When it is desired to pick up a segment and position it a gadget bar is first attached to the segment so that it will span its flanges. The gadget bar may be of any approved form, but in the present instance, it comprises a main portion 21 (Fig. 7) having a reduced end 22, and a telescopic portion 23 slidably mounted in a central bore 24 of the portion 21. The outer end of the telescopic portion 23, and the reduced end 22, are of such a size that they may be received within two opposite bolt holes 25 and 26 which exist in the side flanges 27 and 28 of the tunnel section. A knob 29 is attached to the sliding portion 23 by means of which the portion 23 may be actuated. The stem of the knob may operate in a bayonet slot 30 in the member 21. To position the gadget bar the telescopic portion 23 is retracted within the main body portion and the reduced end 22 is then inserted into one of the bolt holes, the bar lowered to its proper position between the flanges, and then the knob 29 is moved to the left to cause the end of the part 23 to engage in the corresponding bolt hole in the opposite flange of the segment.

The attachment of the gadget bar to the segment is a quick and easy operation as it is only necessary to insert its ends in the opposite bolt holes of the segment flanges. After this has been done the fluid pressure mechanism is operated to move the erector head radially until the recess 8 is in proper radial position to pick up the gadget bar when the head is moved circumferentially. The fluid pressure mechanism which turns the arm about the axis C is then actuated to swing the arm in a counterclockwise direction, as viewed in Fig. 1, whereupon the recess 8 will straddle the gadget bar. Fig. 1 shows the parts in a position in which the recess is just about to straddle the bar. It will be understood that at this time the lock-bar 9 is in its retracted position so that the recess 8 is fully open. After the recess has straddled the gadget bar the lock-bar 9 is manually shifted by means of the handle 10 to close the recess, and the lock-bar then overlies the gadget bar, as shown in Fig. 2. The erector head is now attached to the segment as effectively as if the head had been provided with the usual opening or slot passing through it, and as if the gadget bar had been threaded through this opening and through bolt holes in the segment flanges in the customary way, but this result has been attained in a much easier and quicker way. The erector arm is now swung farther in a counterclockwise direction until the segment *f* reaches the position *f'* where it is to be bolted to the adjoining segments. To move the segment to its final position the telescopic section 2 of the arm is actuated to move the head in a radial and outward direction. After the positioned segment has been bolted in place the lock-bar 9 is retracted so that the erector arm may be swung back to its initial position.

It is customary to bring the lining segments into the tunnel on cars running on a track located either at the right or left side of the tunnel. To lift the segment off the car and move it to the position where it is to be picked up and positioned by the erector arm (for instance, the position *f* in Fig. 1) one end of a chain is usually attached to the segment, while it is on the car, and the other end of the chain is inserted in the recess 8 of the head. The arm is then swung around its axis C to lift the segment off the car whereupon the segment hangs vertically below the head. Then when the head is lowered the segment is deposited in the position corresponding to the position *f*. Fig. 1 shows the recess 8 facing to the right. While this position of the recess is suitable, when positioning the segment in the lining, for swinging the segment either in

a counterclockwise direction as described above, or in a clockwise direction, nevertheless it is not wholly suitable for lifting segments off of the cars when the track happens to be on the left side of the tunnel. In that case the arm would be swung in a clockwise direction to hoist the segments off the car and the position of the head, when the chain is attached to it, would be above the car. Consequently, the recess 8 would be facing downwardly and it would be difficult to insert the end of the chain in the recess. The erector head is therefore made reversible so that when the track is located at the left side of the tunnel the recess 8 will be facing upwardly thereby facilitating the placing of the end of the chain over the head and in the recess 8. To reverse the head the bolts 7 are removed and the shank 4 is withdrawn from its position between the side plates 5 and 6 of the arm section 2. The head is then turned upside down and the shank 4 is again inserted between the side plates 5 and 6. Inasmuch as the longitudinal axis of the lock-bar 9 normally lies above the central longitudinal axis of the head, the reversal of the head will bring the axis of the lock-bar below the axis of the head. A second slot 11' is therefore provided in the side plate 6 of the arm section 2 to receive the handle 10 when the head is reversed. As it is desirable to be able to operate the lock-bar 9 from the outer side of the erector arm even after the head is reversed, the bolt 9 is turned on its own axis during reversal of the head so that the handle 10 will project in the same direction as it did before but this time through the lower slot 11' instead of the upper slot 11. Likewise to retain the spring latch on the same side of the arm after the head is reversed the shank 4 of the head is provided with a second threaded opening 15' directly opposite the corresponding threaded opening 15, into which the bushing 13 may be screwed after the head is reversed. It will be noted, however, that the reversal of the head lowers the position of the spring latch along with the lock-bar 9. Therefore a second and lower opening 14' is provided in the plate 6 of the arm section 2 (Fig. 2) to receive the bushing 13 when the head is reversed.

The near side of the main section 1 of the erector arm is recessed as shown at 11'' to receive the handle 10 when the section 2 is fully telescoped in the section 1. This recess is wide enough to receive the handle regardless of whether it is operating in the upper slot 11 or the lower slot 11'.

A pair of keys 31 and 32 are riveted to the inner surfaces of the plates 5 and 6. They engage in keyways 33 and 34 provided in the side walls of the shank portion 4 of the head. These keys and keyways insure that the bolt holes in the shank and in the plates 5 and 6, as well as the other openings, come into proper alignment for the reception of the parts that fit into them when the shank is positioned between the plates. They also effect a more rigid connection between the plates 5 and 6 and the head.

It will now be seen that with my improved erector the lining segments may be positioned with much greater facility than heretofore. To effect the connection between the head and the lining segment it is only necessary to move the recess in the head laterally over the middle portion of the gadget bar after the latter has been completely positioned and then slide the lock-bar to its closed position. The positioning of the gadget bar in the two bolt holes of the segment is a simple and quick operation when it is not necessary to thread it through a third opening in the erector head, and this may be done at any convenient time without holding up other operations and, therefore, without any loss of time. The movement of the head to bring the recess over the positioned gadget bar is easily and quickly effected as this does not involve the skill and accuracy that has heretofore been required when it was attempted to bring the central opening of the head into exact alignment with the bolt holes in the segment flanges. The sliding of the lock-bar to its closed position is, of course, a simple operation and requires very little time or effort.

I claim:

1. Apparatus for positioning tunnel segments which have been provided with gadget bars spanning the flanges thereof, comprising an erector head, means for swinging the head circumferentially of the tunnel, means for moving the head radially of the tunnel, a face of said head which is parallel with the axis of the tunnel being provided with a transverse recess adapted to straddle the gadget bar when the head is properly positioned radially and when it is moved circumferentially into engagement with the gadget bar, and a locking member movable to a position in which it spans said recess and overlies the gadget bar, whereby the gadget bar may be retained in said recess during positioning of a segment.

2. Apparatus in accordance with claim 1 in which said locking member comprises a longitudinally slidable bar having means whereby the bar may be moved manually to an operative position in which it spans the recess in the erector head or to a retracted position in which it does not span said recess.

3. Apparatus in accordance with claim 1 in which said locking member comprises a longitudinally slidable bar having means whereby the bar may be moved manually to an operative position in which it spans the recess in the head or to a retracted position in which it does not span said recess, and in which the head is provided with a spring latch for retaining the bar either in its operative position or in its retracted position.

4. Apparatus in accordance with claim 1 in which said locking member comprises a longitudinally slidable bar provided with a pair of notches, and in which the head is provided with a spring latch comprising a manually retractible spring-pressed plunger adapted to engage in one of said notches to retain the bar in an operative position in which it spans the recess in the head and adapted to engage in the other notch to retain the bar in a retracted position in which it does not span said recess.

5. Apparatus for positioning tunnel segments comprising an erector arm provided with an erector head, a face of said head which is parallel with the axis of the tunnel being provided with a transverse recess, and a locking member carried by said head and movable to an operative position in which it spans said recess or to a retracted position in which it does not span said recess, said head being reversibly mounted on the erector arm whereby said recess may be made to face in the opposite direction.

6. Apparatus for positioning tunnel segments comprising an erector arm, an erector head reversibly secured to the arm, said head having a

recess extending transversely across one face thereof, a lock bar mounted for longitudinal sliding movement in the head and having a laterally projecting handle whereby the lock bar may be moved to an operative position in which it spans said recess or to a retracted position in which it does not span said recess, the erector arm having one slot in which said handle is adapted to operate when the head is in one position on the arm and a second slot in which the handle is adapted to operate when the head is reversed on the arm.

7. Apparatus for positioning tunnel segments comprising an erector arm, an erector head reversibly secured to the arm, said head having a recess extending transversely across one face thereof, a lock bar mounted for longitudinal sliding movement in the head and movable either to an operative position in which it spans said recess or to a retracted position in which it does not span said recess, a spring latch for holding said lock bar either in its operative position or in its retracted position, said latch comprising a spring-pressed plunger and a bushing in which the plunger operates, the head and the arm being provided with one set of openings to receive said bushing when the head is in one position on the arm and a second set of openings to receive said bushing when the head is reversed on the arm.

8. Apparatus for positioning tunnel segments comprising an erector arm, an erector head reversibly secured to the arm, said head having a recess extending transversely across one face thereof, a lock bar mounted for longitudinal sliding movement in the head and having a laterally projecting handle whereby the lock bar may be moved to an operative position in which it spans said recess or to a retracted position in which it does not span said recess, a spring latch for holding said lock bar either in its operative position or in its retracted position, a bushing in which said latch operates, the arm being provided with one slot in which said handle is adapted to operate when the head is in one position on the arm and a second slot in which the handle is adapted to operate when the head is reversed on the arm, and the head and the arm being provided with one set of openings to receive said bushing when the head is in one position on the arm and a second set of openings to receive said bushing when the head is reversed on the arm.

MILES I. KILLMER.