



(22) Date de dépôt/Filing Date: 2001/03/07

(41) Mise à la disp. pub./Open to Public Insp.: 2001/09/06

(45) Date de délivrance/Issue Date: 2005/04/12

(51) Cl.Int.<sup>7</sup>/Int.Cl.<sup>7</sup> E01C 19/28

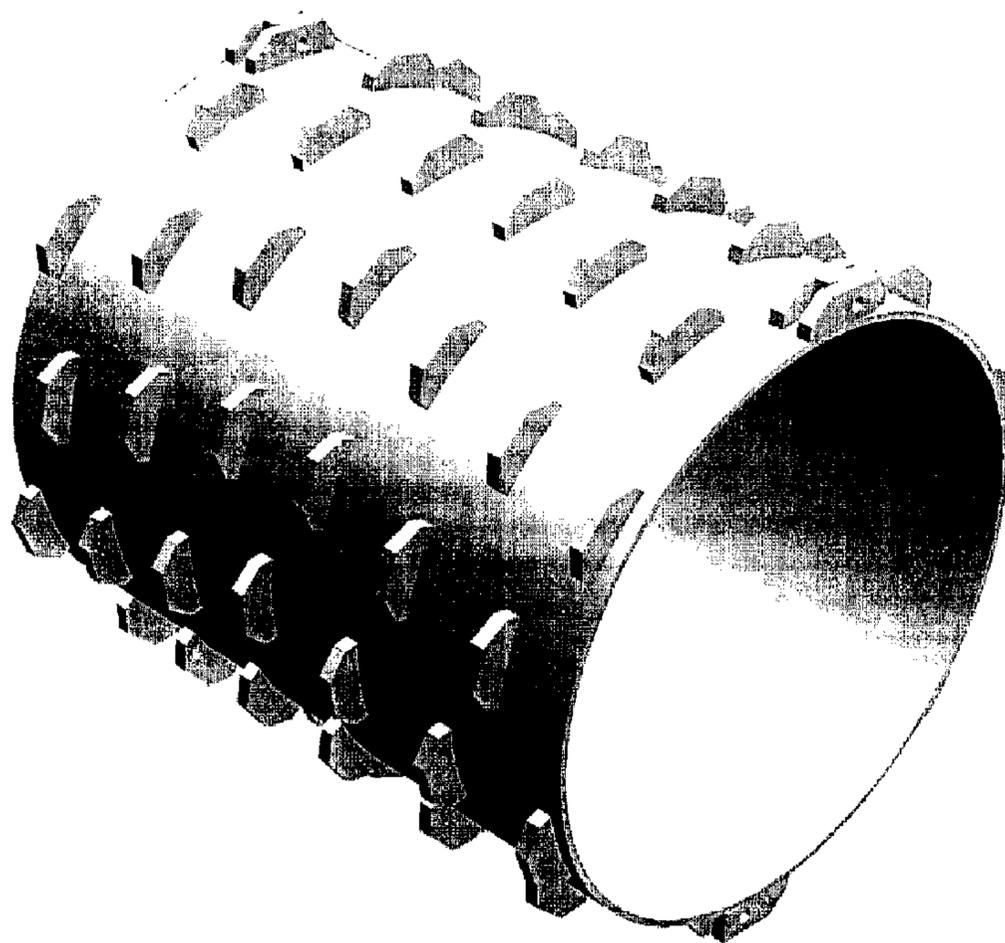
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(54) Titre : DISPOSITIF ET PROCÉDE POUR LA PRÉPARATION D'UNE NOUVELLE COUCHE DE BASE À PARTIR  
D'UNE VOIE PAVÉE DÉGRADÉE

(54) Title: APPARATUS AND METHOD FOR PREPARING A NEW ROADBASE FROM A DETERIORATED PAVED  
ROAD



(57) **Abrégé/Abstract:**

Apparatus for preparing a new roadbase from a deteriorated paved road is described. The deteriorated road comprises a layer of deteriorated pavement atop a gravel roadbed atop a soil sublayer. The apparatus comprises a smooth drum roller selectively operable in a vibratory rolling mode or in a non-vibratory rolling mode and a plurality of roller cams mountable on the drum roller. The roller cams are sized to crumble substantially all of the layer of deteriorated pavement into fragments when the drum roller is operated in a non-vibratory rolling mode, and to drive substantially all of the fragments into mixture with the roadbed when the drum roller is operated in a vibratory rolling mode. A method of preparing a new roadbase from such a deteriorated paved road comprises crumbling substantially all of the layer of deteriorated pavement into fragments with a drum roller having a plurality of roller cams mounted thereon, driving the fragments downwardly into the gravel roadbed to produce a mixture of substantially all of the fragments with the roadbed, and compacting said mixture into consolidation with said sublayer to produce a new roadbase.



# **APPARATUS AND METHOD FOR PREPARING A NEW ROADBASE FROM A DETERIORATED PAVED ROAD**

## **ABSTRACT**

Apparatus for preparing a new roadbase from a deteriorated paved road is  
5 described. The deteriorated road comprises a layer of deteriorated pavement atop a gravel  
roadbed atop a soil sublayer. The apparatus comprises a smooth drum roller selectively  
operable in a vibratory rolling mode or in a non-vibratory rolling mode and a plurality of  
roller cams mountable on the drum roller. The roller cams are sized to crumble  
substantially all of the layer of deteriorated pavement into fragments when the drum roller  
10 is operated in a non-vibratory rolling mode, and to drive substantially all of the fragments  
into mixture with the roadbed when the drum roller is operated in a vibratory rolling  
mode.

A method of preparing a new roadbase from such a deteriorated paved road  
comprises crumbling substantially all of the layer of deteriorated pavement into fragments  
15 with a drum roller having a plurality of roller cams mounted thereon, driving the  
fragments downwardly into the gravel roadbed to produce a mixture of substantially all of  
the fragments with the roadbed, and compacting said mixture into consolidation with said  
sublayer to produce a new roadbase.

## **APPARATUS AND METHOD FOR PREPARING A NEW ROADBASE FROM A DETERIORATED PAVED ROAD**

### **FIELD OF THE INVENTION**

The present invention relates to road construction and, more particularly, to  
5 apparatus and methods for preparing a new roadbase from a paved road having  
deteriorated pavement.

### **BACKGROUND TO THE INVENTION**

Compacting rural gravel roads prior to first paving the roads was unknown 40  
years ago at the start of greatest paving activity on such roads. This has led to problems  
10 because a paved but uncompacted gravel roadbed resting on sublayer soils of varying  
densities and permeabilities, and subject to vibration and the cumulative compacting effect  
of wheeled traffic, eventually settles at random within its gravel layers. Subsidence in the  
paved surface then develops, and is followed by varying degrees of pavement  
deterioration.

15 Many paved rural roads show extensive pavement deterioration and repairs. Costs  
for reconstructing uncompacted, settled roadbeds, which have become prohibitive in  
recent years, have prompted resort to several processes of road surface rehabilitation prior  
to repaving. These procedures give the appearance of long-term improvement, but fail to  
compact an existing roadbed into its sublayers to produce maximum density in a  
20 reconsolidated roadbase structure.

Current methods of roadbed reconstruction and road surface rehabilitation include:

reconstruction	reconstruction of roadbed;
rehabilitation	gravel overlay (covering over pavement);
rehabilitation	asphalt mix overlay on deteriorated pavement (recapping);

rehabilitation        'mulching' pavement into roadbed gravel;  
 rehabilitation        grinding pavement in place and repaving ('mill-and-fill').

5        However, the durability of such reconstructed or rehabilitated roadbases is relatively limited and there is a need for a reconsolidation method which produces a denser, more durable roadbase, and which raises the prospect of prolonging pavement service life beyond the unmet technical goal of 20 years.

### **SUMMARY OF THE INVENTION**

10        The present invention includes a method and apparatus to reconsolidate an uncompacted gravel roadbed and its deteriorated pavement. The method includes an intensive compacting effort from the deteriorated surface downward. Preferably, the method is implemented with a vibratory smooth-drum roller fitted with a shell on which cams are welded. The roller cams are sized to crumble rutted and deteriorated pavement in situ, and to drive pavement fragments into the roadbed gravel.

15        More particularly, the main component of asphaltic concrete pavement is crushed gravel; therefore deteriorated pavement when crumbled into fragments is wholly compatible with roadbed gravel. A drum roller in accordance with the present invention serves to intensively compact the mix of fragments and roadbed gravel, and to drive the compacted mix into consolidation with the roadbed's sublayer soils. The purpose of such intensive compacting is to develop resistance in the sublayer soils equivalent to the load  
 20        imposed by the mix of pavement fragments and roadbed gravel which is displaced into sublayers, and by the weight of gravel to be added to restore zones of displacement in the road surface.

25        In one aspect of the present invention, there is provided a method of preparing a new roadbase from a deteriorated paved road, the road comprising a layer of deteriorated pavement atop a gravel roadbed atop a soil sublayer. The method comprises crumbling substantially all of the layer of deteriorated pavement into fragments with a drum roller

having plurality of roller cams mounted thereon; driving the fragments downwardly into the gravel roadbed to produce a mixture of substantially all of the fragments with the roadbed; and, compacting the mixture into consolidation with the sublayer to produce the new roadbase.

5 Preferably, the drum roller is selectively operable in a vibratory rolling mode or a non-vibratory rolling mode. The step of crumbling the layer of deteriorated pavement into fragments is performed with the roller operating in its non-vibratory mode. The step of driving the fragments into the gravel roadbed to produce the specified mixture is performed with the same drum roller, still fitted with the roller cams, but now operating in  
10 a vibratory rolling mode.

Preferably the method of the present invention comprises providing a smooth drum roller selectively operable in a vibratory rolling mode or a non-vibratory rolling mode and removably mounting a plurality of roller cams on the smooth drum roller. As above, the roller cams are sized to crumble the layer of deteriorated pavement into fragments. Then,  
15 while the roller cams are mounted on the smooth drum roller, substantially all of the layer of deteriorated pavement is crumbled into fragments with the roller operating in its non-vibratory rolling mode - followed by the step of driving the fragments downwardly into the gravel roadbed with the roller operating in its vibratory rolling mode to produce a mixture of substantially all of the fragments with the roadbed. Next, the roller cams are  
20 dismantled from the roller drum to provide a smooth drum surface and, while the roller cams are dismantled, the mixture is compacted into consolidation with the soil sublayer with the drum roller operating in its vibratory rolling mode.

Preferably, compaction is continued until further compaction with the drum roller is substantially refused (viz. a stage where the compacting drum roller makes negligible  
25 impression in the road surface). Density of the roadbase may be measured by geotechnical instruments. The condition of 'refusal' to continued compacting effort is desirable to

prevent settling of the roadbase, and eventual subsidence in a layer of new pavement applied thereto.

In cases where a smooth drum roller is used in vibratory and non-vibratory operating modes, and where roller cams are removably mountable on the roller, it will be  
5 evident that the steps of crumbling a layer of deteriorated pavement into fragments, driving the fragments into mixture with the gravel roadbed, and compacting the resulting mixture into consolidation with the soil sublayer, advantageously can be performed using a single drum roller.

In another aspect of the present invention, there is provided apparatus for preparing  
10 a new roadbase from a deteriorated paved road, the road comprising a layer of deteriorated pavement atop a gravel roadbed atop a soil sublayer. The apparatus comprises a smooth drum roller selectively operable in a vibratory rolling mode or in a non-vibratory rolling mode, and a plurality of roller cams mountable on the drum roller. The roller cams are sized to crumble substantially all of the layer of deteriorated pavement into fragments  
15 when the drum roller is operated in a non-vibratory rolling mode, and to drive substantially all of the fragments into mixture with the roadbed when the drum roller is operated in a vibratory rolling mode.

Preferably, the roller cams are removably mountable on the drum roller so that drum roller may be used either with or without the roller cams, in the latter case offering a  
20 smooth drum surface for the purpose of compacting operations. To enable the roller cams to be quickly and efficiently mounted on or dismounted from the smooth drum roller, they advantageously may be affixed to semi-cylindrical or half shells that are in turn removably mountable to the drum roller.

The foregoing and other features and advantages of the present invention will now  
25 be described with reference to the drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a perspective view of a steel shell with roller cams welded thereto in accordance with the present invention.

FIG. 2 is a perspective view of a conventional smooth drum roller which is selectively operable in a vibratory rolling mode or a non-vibratory rolling mode.

FIG. 3 is a perspective view of one of two semi-cylindrical or half shells used to form the shell shown in FIG. 1.

FIG. 4 is a detail view, in perspective, showing on one end of one side the half shells shown in FIG. 1 locked by a steel pin through the double and single locking cams.

FIG. 5 is a view in plan, elevation and perspective of a roller cam in accordance with the present invention.

FIG. 6 is a perspective view of a conventional padfoot vibratory roller.

FIG. 7 is a photographic view of a vibratory soil-compactor crumbling deteriorated pavement.

FIG. 8 is a photographic view of pavement fragments.

FIG. 9 is a photographic view of pavement fragments in a mix with uncompacted roadbed gravel.

FIG. 10 is a photographic view of a road compacted to a stage approaching 'refusal'.

FIG. 11 shows a cross-section A of pavement on an uncompacted roadbed gravel resting on sublayer soils, and a cross-section B, of pavement fragments and roadbed gravel reconsolidated in sublayer soils.

**DETAILED DESCRIPTION OF PREFERRED EMBODIMENT**

The steel shell shown in FIG. 1 comprises two longitudinal semi-cylindrical half shells like the half shell shown in FIG. 3 and is sized to be removably mounted to the drum of the smooth drum roller shown in FIG. 2. A plurality of roller cams 6 as shown in  
5 detail in FIG. 5 are affixed by welding on the shells and are circumferentially positioned around the shells. Roller cams 6 are sized to crumble deteriorated pavement into fragments when the drum roller is operated in a non-vibratory rolling mode, and to drive substantially all of the fragments into mixture with a gravel roadbed when the drum roller is operated in a vibratory rolling mode. Since the half shells are removably mountable to  
10 the drum roller, it follows that roller cams 6 which are affixed to the shells may be considered as removably mountable to the drum roller.

To enable each half shell to be locked on the drum to the other half shell, each half shell includes two pairs of single roller cams 1 which serve as locking cams, and two pairs of double roller cams 2, 2 which cooperatively serve as locking cams. As shown in FIG.  
15 4, roller cams 2, 2 are spaced to enable a roller cam 1 to fit therebetween and to be locked with the roller cam 1 by a removable steel pin 3. From FIG. 2, it will be appreciated that the two half shells overall include four sets of single roller cams 1 and double roller cams 2, 2.

Each roller cam as shown in FIG. 5 preferably has a contact area of about 1 inch by  
20 3 inches which is substantially less than the contact area (e.g. 3 inches by 6 inches) of cams 7 on a conventional padfoot roller (FIG. 6) which are not designed to crumble deteriorated pavement into fragments suitable for mixing with a gravel roadbase. More particularly, a roller cam with a contact area of about 1 inch by 3 inches is considered to be particularly suited to the present invention because it provides about 6 times the loading  
25 or crumbling effort of a conventional padfoot roller, and the resulting fragments have a workable size for mixing purposes.

As noted above, the conventional drum roller shown in FIG. 2 is selectively operable in a vibratory rolling mode or a non-vibratory rolling mode. Operating in a non-vibratory mode with the half shells mounted, the drum roller is passed over a layer of deteriorated pavement 8 and underlying roadbed gravel 9 resting on sublayer soils 10 (which may be of varying densities and permeabilities) as shown in cross-section A of FIG. 11 to crumble substantially all of the deteriorated pavement into fragments.

Then, operating in a vibratory mode with the half shells still mounted, the drum roller is passed over the crumbled pavement to drive substantially all of the fragments into mix with uncompacted roadbed gravel 9.

Later (e.g. one day), on the section of pavement previously crumbled into fragments and mixed with roadbed gravel 9, the drum roller with the shell now removed and operating in a vibratory mode is used to compact the mix of pavement fragments and roadbed gravel 9 downwardly to 'refusal' in consolidation with sublayer soils 10 as depicted in cross-section B of FIG. 11 where the consolidated mix is depicted by the numeral 11. By reason of the compacting effort, it can be seen in FIG. 11 not only that mix 11 includes sublayer soils 10 within the mix but also that the sublayer base has been compressed downwardly in relation to the level of soils 10 on either side of the road. It follows that the resulting roadbase is both dense and durable.

On the resulting reconsolidated roadbase, fresh crushed gravel 12 as shown FIG. 11 normally will be spread, graded evenly and compacted, preparatory to repaving.

The method of the present invention may be considered as a dynamic 'preloading' of a roadbed with its sublayer soils by mechanically displacing pavement fragments and roadbed gravel therein. The method may be likened to a static 'preload' of a building site on which granular materials are spread in depth to compact site sublayers over time.

Environmentally, the method of the present invention can conserve gravel stocks by re-using, rather than replacing roadbed gravel, by reducing machine fuel use and

exhaust emissions, and by eliminating the wasting of excavated road material with its asphalt content, from leaching into groundwater.

Various modifications and changes to the embodiment that has been described can be made without departing from the scope of the present invention. The invention is not to  
5 be construed as limited to the particular embodiment that has been described and should be understood as encompassing all those embodiments that are within the spirit and scope of the claims that follow.

**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE  
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. A method of preparing a new roadbase from a deteriorated paved road, said road comprising a layer of deteriorated pavement atop a gravel roadbed atop a soil sublayer,  
5 said method comprising:
- (a) crumbling substantially all of said layer of deteriorated pavement into fragments with a drum roller having a plurality of roller cams mounted thereon;
  - (b) driving said fragments downwardly into said gravel roadbed to produce a  
10 mixture of substantially all of said fragments with said roadbed; and,
  - (c) compacting said mixture into consolidation with said sublayer to produce said new roadbase.
2. A method as defined in claim 1, wherein:
- (a) said drum roller is selectively operable in a vibratory rolling mode or a  
15 non-vibratory rolling mode;
  - (b) said crumbling step is performed with said drum roller operating in a non-vibratory rolling mode; and,
  - (c) said driving step is performed with said drum roller operating in a vibratory rolling mode.
- 20 3. A method as defined in claim 1 or 2, wherein said compacting step is performed with a smooth drum roller operating in vibratory rolling mode and is continued until further compaction by said smooth drum roller is substantially refused.
4. A method as defined in claim 1 or 2, further comprising dismounting said roller  
25 cams from said drum roller and, while said roller cams are dismounted, performing said compacting step with said drum roller operating in said vibratory mode until further such compaction is substantially refused.

5. A method of preparing a new roadbase from a deteriorated paved road, said road comprising a layer of deteriorated pavement atop a gravel roadbed atop a soil sublayer, said method comprising:

- 5 (a) providing a smooth drum roller selectively operable in a vibratory rolling mode or a non-vibratory rolling mode,
- (b) removably mounting a plurality of roller cams on said drum roller, said roller cams being sized to crumble said layer of deteriorated pavement into fragments;
- (c) while said roller cams are mounted on said drum roller:
- 10 (i) crumbling substantially all of said layer of deteriorated pavement into fragments with said drum roller operating in said non-vibratory rolling mode; and,
- (ii) driving said fragments downwardly into said gravel roadbed with said drum roller operating in a vibratory rolling mode to produce a mixture
- 15 of substantially all of said fragments with said roadbed;
- (d) dismounting said roller cams from said drum roller to provide a smooth drum surface; and,
- (e) while said roller cams are dismounted from said drum roller, compacting said mixture into consolidation with said sublayer with said drum roller
- 20 operating in said vibratory rolling mode.

6. A method as defined in claim 5, wherein said compacting step is continued until further compaction with said drum roller is substantially refused.

7. A method as defined in any one of claims 1 to 6, wherein said roller cams each have a contact area of about one inch by three inches.

25 8. Apparatus for preparing a new roadbase from a deteriorated paved road, said road comprising a layer of deteriorated pavement atop a gravel roadbed atop a soil sublayer, said apparatus comprising:

- (a) a smooth drum roller selectively operable in a vibratory rolling mode or in a non-vibratory rolling mode; and,
- (b) a plurality of roller cams mountable on said drum roller, said roller cams being sized each with a contact area substantially less than 3 inches by 6 inches to crumble substantially all of said layer of deteriorated pavement into fragments when said drum roller is operated in said non-vibratory rolling mode, and to drive substantially all of said fragments into mixture with said roadbed when said drum roller is operated in said vibratory rolling mode.

5

10 9. Apparatus as defined in claim 8, wherein said roller cams each have a contact area of about one inch by three inches.

10. Apparatus as defined in claim 8 or 9, wherein said roller cams are removably mountable on said drum roller.

15 11. Apparatus as defined in claim 8 or 9, wherein said roller cams are affixed to a pair of semi-cylindrical shells removably mountable on said drum roller.

*Fig. 1*

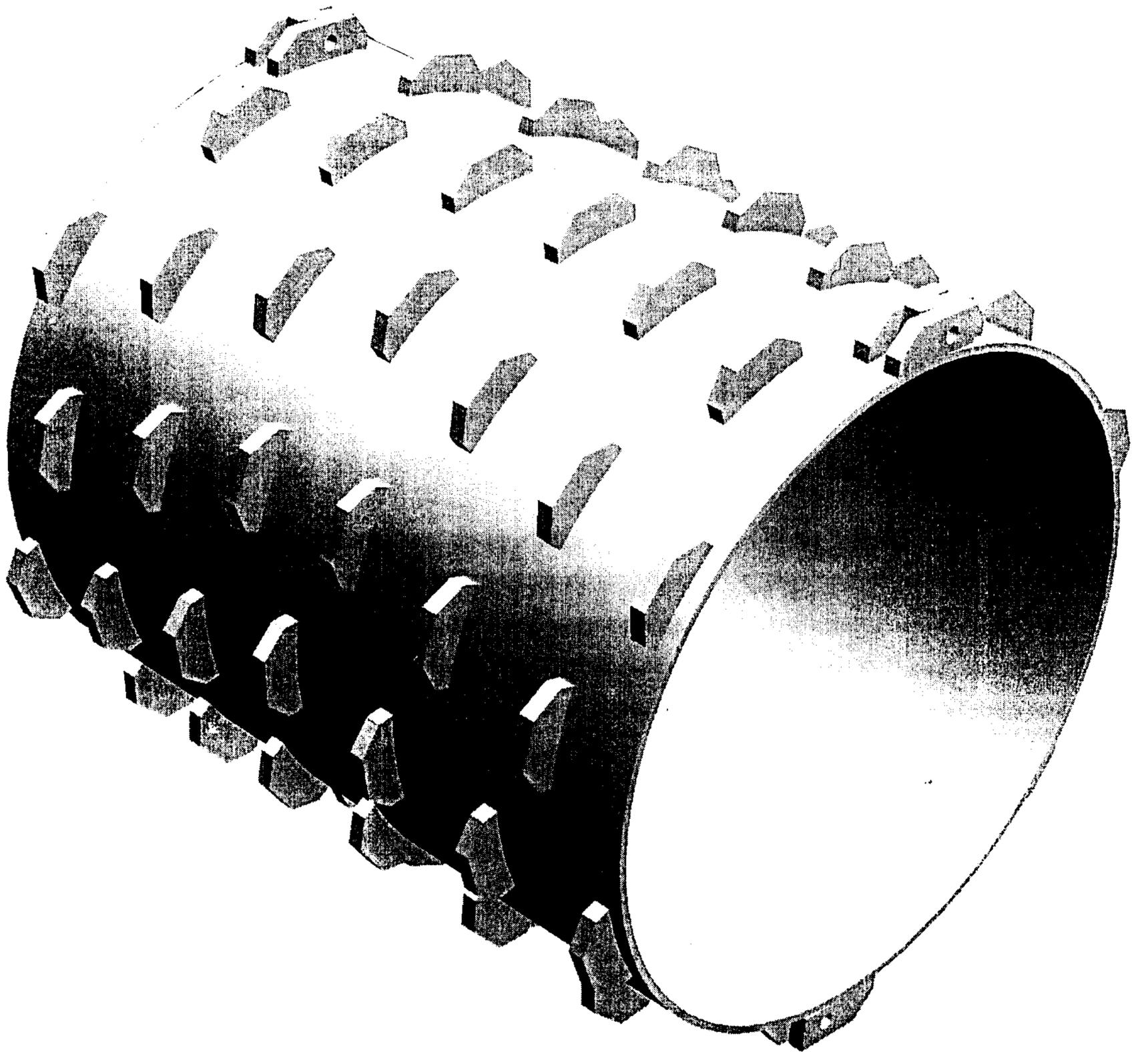


Fig. 2

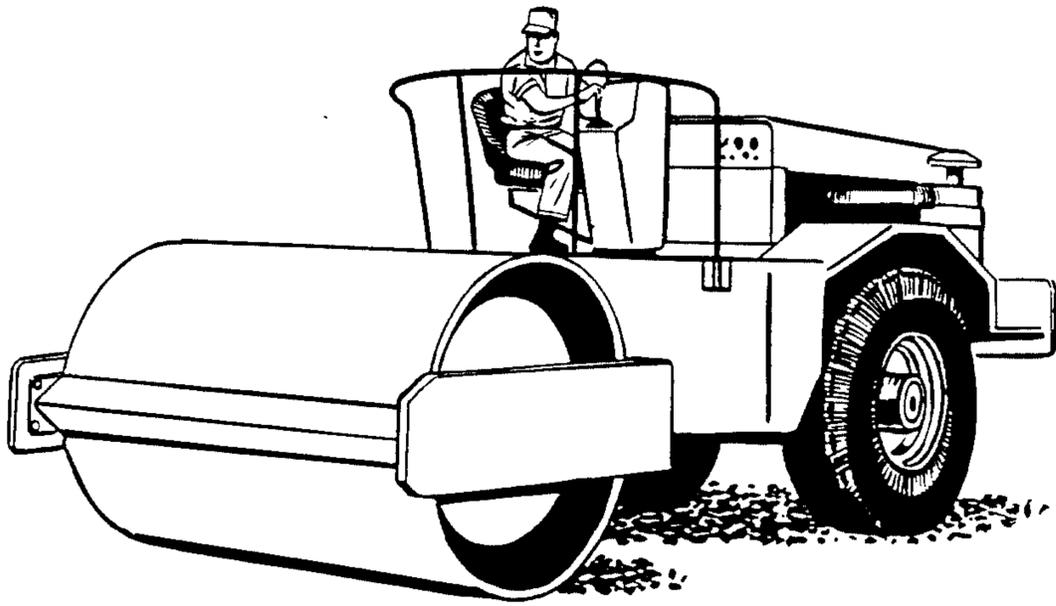


Fig. 3

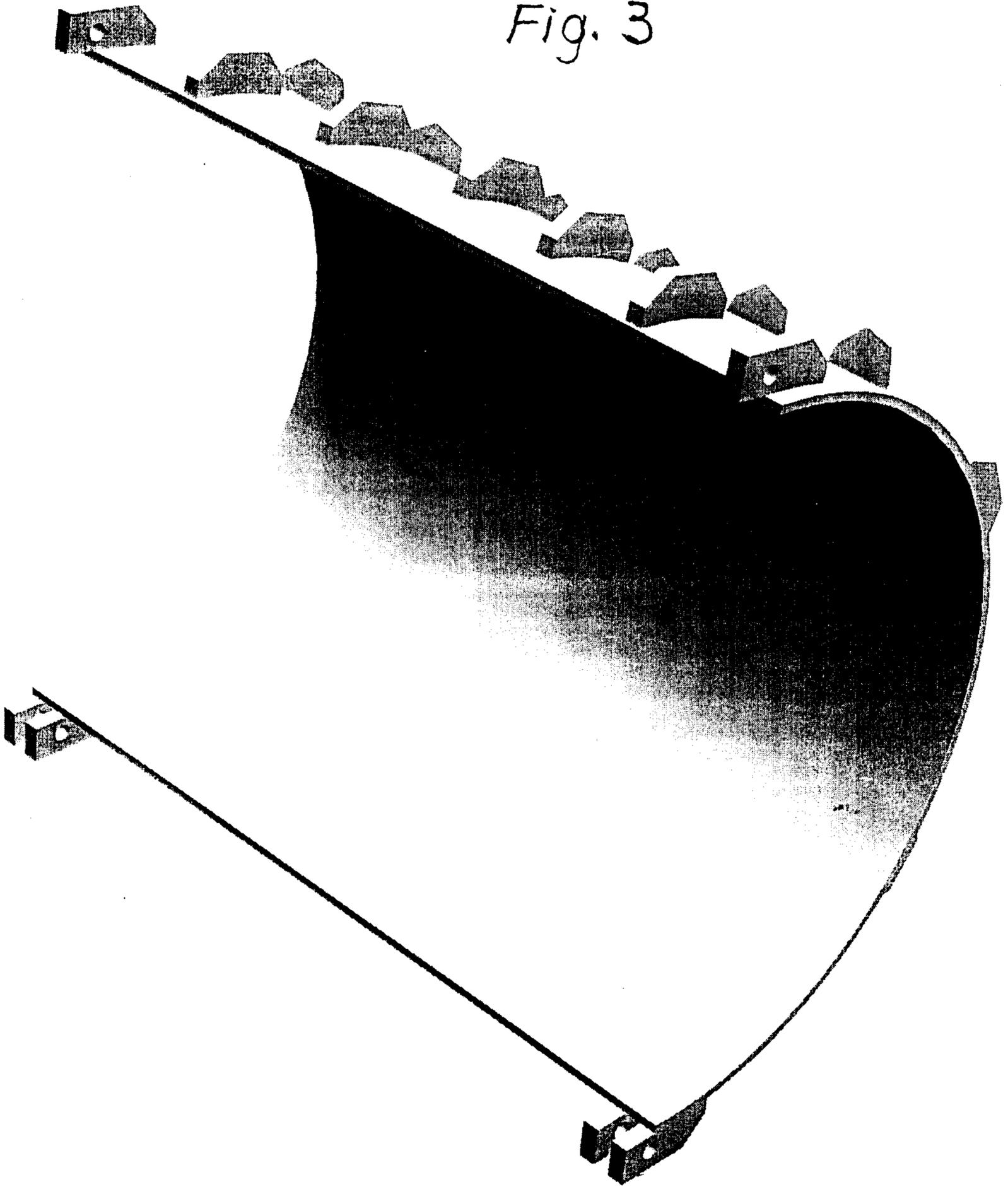


Fig. 4

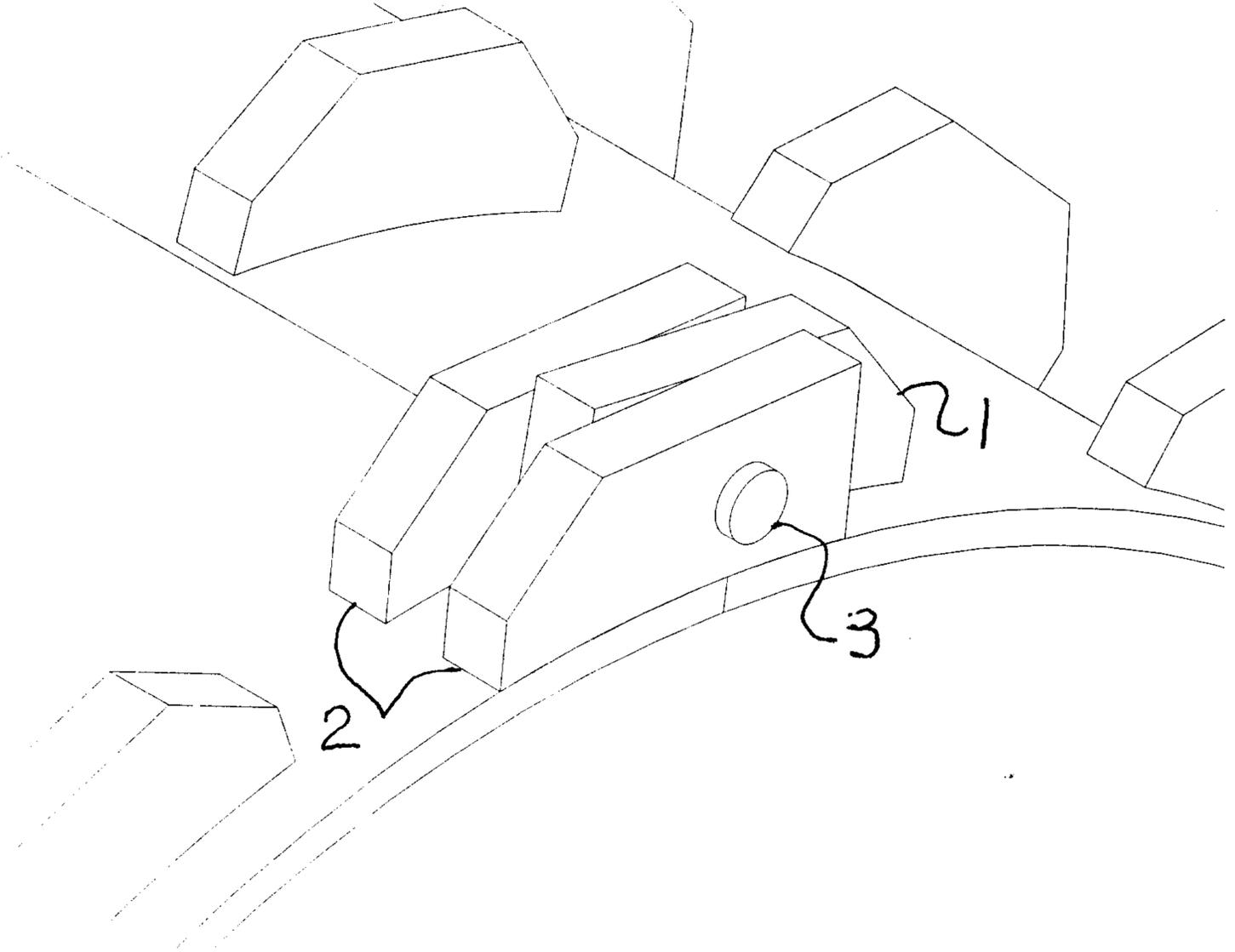


Fig. 5

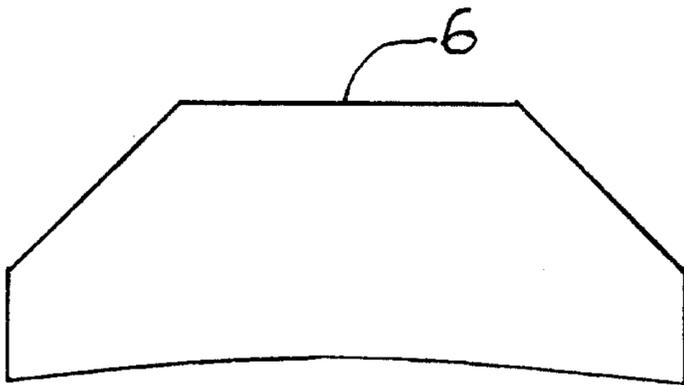
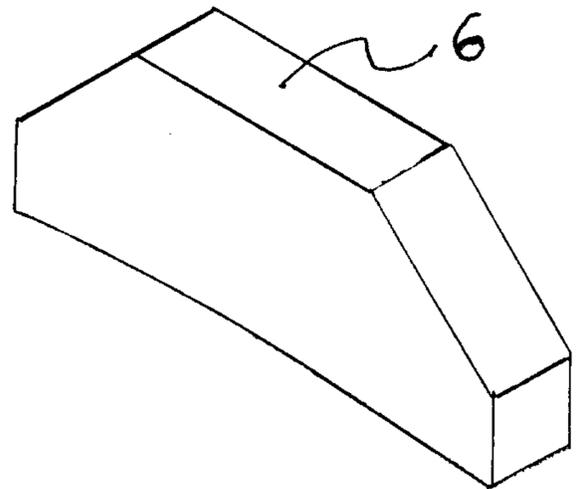
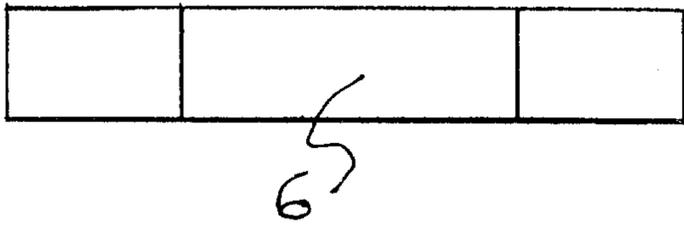


Fig. 6



Fig. 7

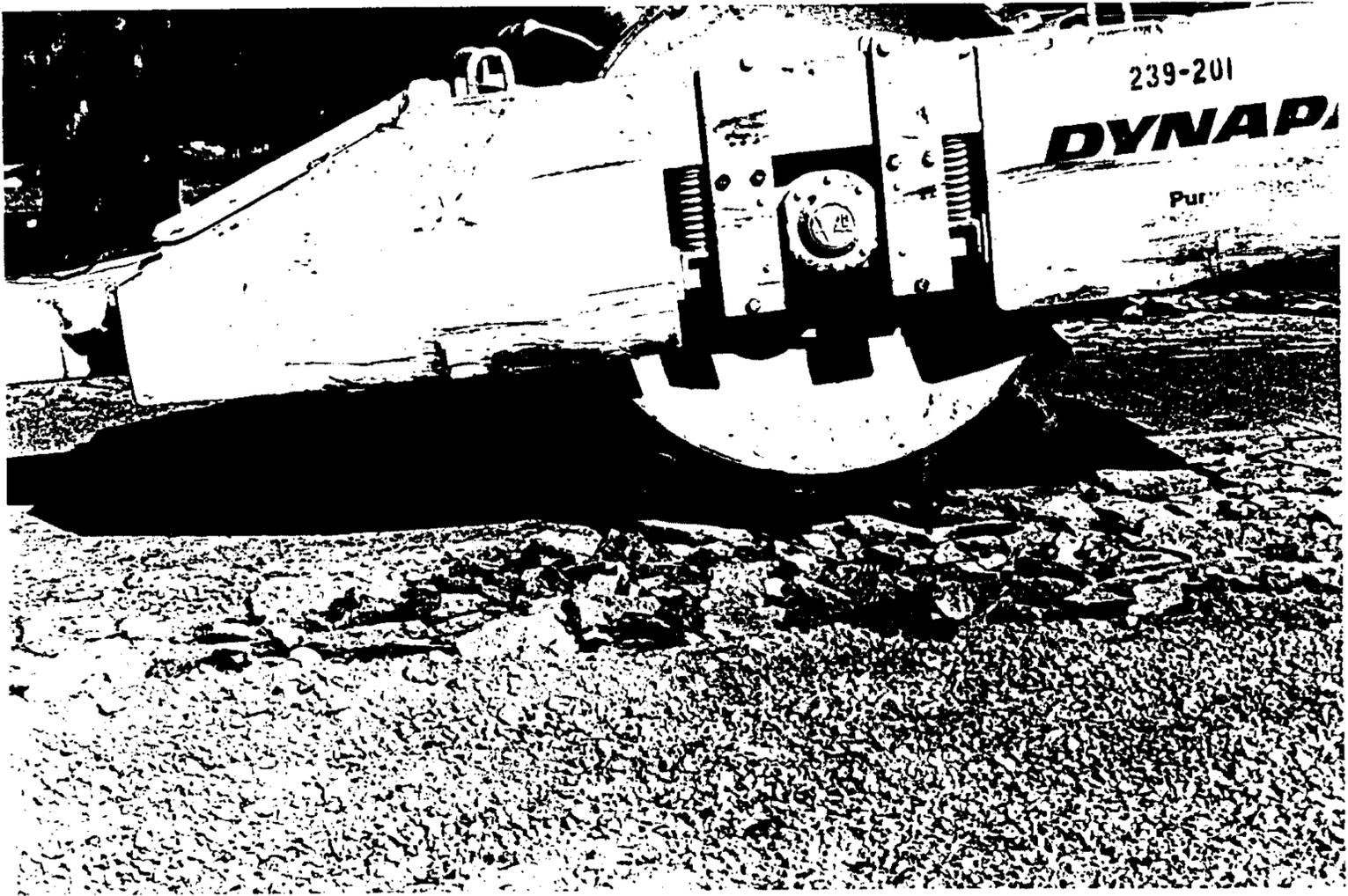


Fig. 8



Fig. 9



*Fig. 10*



Fig. 11

