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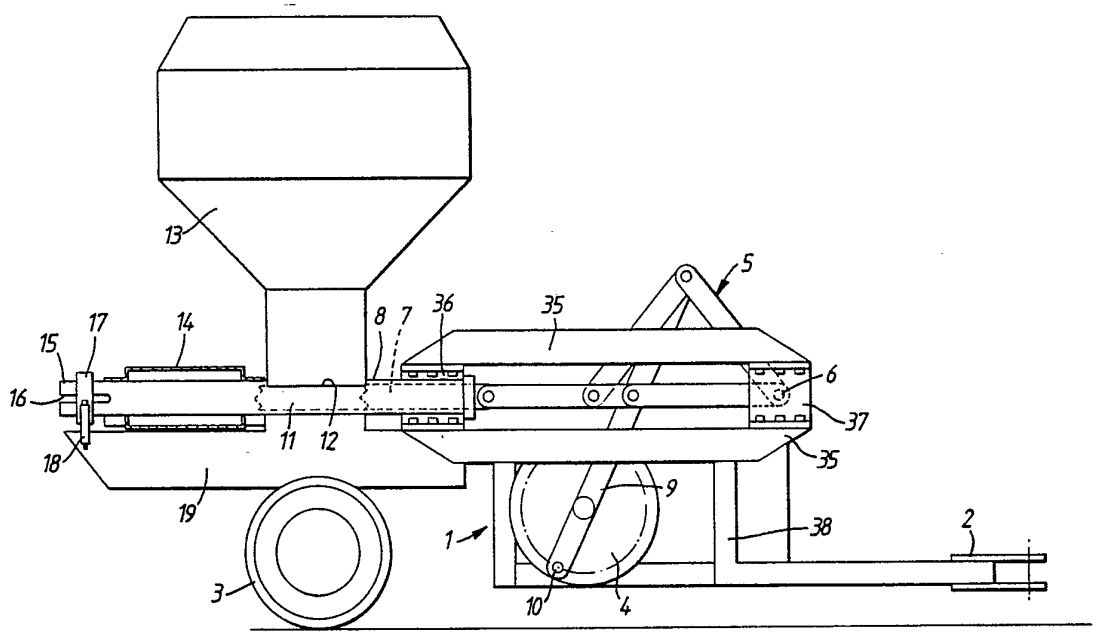
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(54) Title: A STRAW COMPRESSION APPARATUS



(57) Abstract

A straw compressor has a piston (7) reciprocal in a tube (8), the piston being actuated by a flywheel (4) driven toggle linkage (5) which straightens at the end of each working stroke. Straw is delivered laterally into a compression chamber section (11) of the tube (8) when that is clear of the piston so that batches are progressively impacted against the tail of a continuous log being despatched through a restricted delivery end (15) of the tube. This restriction may have adjusting means (17, 18). The delivery into the tube may be by toothed drums (21) drawing straw from the base of a hopper (13). The apparatus may be mobile, to be towed and powered by a tractor, or stationary.

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"A Straw Compression Apparatus"

This invention relates to straw compression apparatus.

After the cereals harvest, the straw is mostly either baled up or burnt in the fields. Occasionally, it is ploughed in. Burning is dangerous and anti-social, and represents colossal waste of potentially useful material. In any event, in the United Kingdom there are now severe restrictions on burning and on occasions a total ban.

Baled straw has extensive uses, mostly agricultural such as litter for cattle, strawberry beds and frost protection, although it is also used industrially to make slabs for roofing. However, present supplies are more than sufficient to meet these needs, and indeed it is quite common to see barns still well stocked with bales shortly before the next harvest. It is unlikely that any larger quantity of bales in their present form can be absorbed by agriculture and industry.

It has long been proposed to use straw as a source of heat or energy, and there have been occasional practical examples. For example, straw burning traction

or stationary engines were built, and they could consume what was discarded from the threshing machines that they were driving. However, any furnace or stove that burns straw in loose form has an insatiable appetite. For a more manageable fuel, it is desirable to compact the straw so that it resembles logs or lumps or coal. Various devices have been proposed, but mostly for small quantities, and operated by hand. The real problem that now needs solving is a large field with tons of straw which should be compacted on the spot, before rain can affect it and preferably without the expense and trouble of preliminary baling. It is this that the present invention aims to answer.

According to the present invention there is provided apparatus for compressing straw or other vegetable matter characterised by a compression chamber, a piston reciprocal in and out of one end of the chamber, means for feeding straw laterally into the compression chamber, a delivery conduit leading from the other end of the chamber with a restriction through which compacted straw or vegetable matter is forced in steps by the piston, and drive means for the piston including a toggle linkage which is substantially aligned with the piston at the end of each working stroke.

This means that, as that position is

approached there is very high mechanical advantage, resulting in a great compressive force. The actuation of the toggle linkage is preferably by means of an eccentric on a flywheel coupled to its break point.

Means may be provided for adjusting the restriction in the delivery conduit to suit conditions and the type of straw. Conveniently it has a split end, and a member surrounding this end may have an adjustable embrace to vary the size of the split.

Preferably, the piston face will not be flat, which might cause the straw to laminate in discs, thus allowing the eventual log to fall apart too easily. In the preferred form, it will have an annular indent, with a central fowardly projecting conical portion and an outer, bevelled cutting edge portion.

The feeding means conveniently comprise two counter-rotating toothed drums which entrain the straw or vegetable matter and feed it positively into the compression chamber. The drum teeth preferably interdigitate with fixed combs for parting the straw or vegetable matter from the drums at the entry to the compression chamber. Also, the drum teeth tips may co-operate with sharp edges between the roots of the comb fingers to chop the straw or vegetable matter entering the compression chamber.

A cooling jacket will preferably be provided to co-operate with the compression chamber, and it may be used to keep the temperature at an optimum for promoting cohesiveness of the log.

For a better understanding of the invention one embodiment will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic side elevation of a straw compressor,

Figure 2 is a divided vertical section and rear end view of the lower portion of a hopper and compression chamber, and

Figure 3 is an axial section of the compression chamber.

The compressor to be described is designed to be towed by a tractor and operated from the power take-off (PTO) now standard on such vehicles. However, other versions are contemplated; for example it could be adapted to operate in conjunction with a combine or a forage harvester, so that straw could be fed straight into it. However, its power requirement is quite high and it would then probably need an independent power unit.

It could also be a static installation, for straw to be brought to it.

The compressor has a chassis 1 with a hitch 2 at the forward end and a pair of wheels 3 towards the rear. Drive from the PTO (not shown) of a tractor, is transmitted to a flywheel 4. The transmission may take various forms, and is not illustrated as it does not form a critical part of the invention. Preferably, it will incorporate a slipping clutch assembly which will allow free-wheeling in one direction, and a shear bolt designed to break on excessive loading.

A toggle linkage 5 has one end pivoted to a forward fixed point 6 on the chassis and the other end to a horizontal piston rod 7 reciprocal in a tube 8 extending to the rear. The centre pivot or break point of the toggle linkage 5 is coupled by a rod 9 to an eccentric 10 on the flywheel 4, which acts as a crank alternately to straighten and bend the toggle linkage as it rotates and thus reciprocate the piston rod 7. Figure 1 shows the linkage in the two extreme positions, and when it is straight, it is aligned with the piston rod 7. Thus, at the end of the rearward stroke, the piston rod is being moved slowly but with great mechanical advantage.

The tube 8 develops into a compression chamber 11 over its middle section, having an opening 12 through which straw is delivered from a hopper 13. This

contains a feed mechanism, to be described below, which is also driven from the tractor PTO. Downstream of the hopper 13 the tube 8 extends through a water jacket 14 and terminates in a collet 15. This has two diametrically opposed longitudinal slits 16 and it is embraced by a collar 17 which can be tightened or relaxed by a hydraulic actuator 18 to alter the amount of coning of the collet and the diameter of its outlet end. Such alteration may be made according to the condition of the straw and the density required. It is amenable to automatic control using the hydraulic pressure in the actuator 18.

This assembly of parts 8 to 18 is mounted on a massive box section beam 19, forming part of the chassis 1.

Referring now to Figure 2, the base of the hopper has nacelles 20 partially to accommodate two parallel drums 21 constituting the feed mechanism referred to above. These have annular sets of teeth 22 of saw tooth form and they counter-rotate so that straw in the hopper is drawn downwardly between them. Just below their minimum spacing they interdigitate with fingers 23 of combs projecting upwardly from blocks 24 defining a slot 25 over the opening 12 into the compression chamber 11. The base 26 of each gap

between the comb fingers 23 is curved concentrically with the associated drum to give minimal clearance with the tips of the teeth 22, and at the upstream ends there are sharp edges or lips 27. The width of the slot 25 is somewhat less than the diameter of the chamber 11 so that straw parting from the drums at the lips 27 can be easily urged by straw above into that chamber once it is vacated by the piston rod 7.

The annular sets of teeth 22 may be at the same circumferential position along the whole length of each drum, or adjacent sets may be circumferentially off-set to create, in effect, interrupted shallow helical ribs.

With an overhead hopper 13, gravity assists the feed into the compression chamber 11. A cyclone could be substituted, giving more ordered delivery. It would also be possible to arrange for horizontal feed through an opening in the side of the piston tube 8.

Referring to Figure 3, the rear end of the piston rod has a profiled head 28. Its working face has a central conical formation 29, pointing rearwardly, while near the periphery the cone is reversed so that there is an annular bevelled knife edge 30. This indented shape ensures that the straw is not compacted in flat disc sections, which would make the resulting

log break too easily, but provides a form of interlock between sections compressed on each stroke. The knife edge 30 gives clean action, scraping straw from the wall of the tube 8. The head 28 is, however, of the same diameter as the rod 7 so that there is no danger of straw being entrained by a shoulder at the junction of the head and rod and being forced forwardly towards the toggle mechanism on the return stroke.

Upstream of the hopper 13, the rod 7 passes through an enlarged portion of the tube 8 fitted with a lubricating sleeve 31 fed from oil reservoir 32. Its connection to the toggle linkage 5 is by means of a cross pin 33 which is extended laterally to mount two wheels 34 These run between longitudinal members 35 of box-section bolted to massive cross-members 36 and 37 at opposite ends. The member 36 at the rear end provides an anchorage for the leading end of the tube 8, while the member 37 at the forward end provides the fixed point 6. This structure is carried on framing 38 forming part of the chassis 1.

In operation, provided the hopper 13 is kept charged with straw, the reciprocating piston will repeatedly ram the material fed into the chamber during its backstroke up against the continuous log disappearing down the tube 8 into the collet 15. The constriction

provided by the collet ensures that the log will consolidate and offer firm abutment for the compression of each batch, although on each stroke of the piston it will extrude a little further from the mouth of the collet.

When the log is projecting a certain amount, its own weight will cause it to break off, and this may happen with a consistent and convenient length. However, it would be possible to add a chopping device which would cut off logs of predetermined length,or act each time so many strokes of the piston have been completed.

The water jacket 14 will be in circuit with a radiator (not shown), which may be thermostatically controlled. It prevents excessive heat being generated, but the temperature in that region will still be considerable. This will have a beneficial action on the cellulose in the straw, for the latter will become "sticky" and thus promote the cohesiveness of the log.

Although described as a straw compressor it will be understood that it could be used to compact and "log" other vegetable material into cylindrical briquettes.

While it will be preferred to feed in straw directly, to save the time and expense of baling, it is possible to use the compressor with bales. As a

stationary installation, for example, it might be used in the winter months transforming bales into logs as demand dictated.

The piston 7 and its tube 8 are circular in the embodiment described. Other shapes are possible, such as square or hexagonal, with the collet 15 made to match. Alternatively, the nascent log may be of circular section, but the collet may be configured to change this to a different section as it extrudes.

CLAIMS

1. Apparatus for compressing straw or other vegetable matter characterised by a compression chamber (11), a piston (7,28) reciprocal in and out of one end of the chamber, means (13,21) for feeding straw laterally into the compression chamber, a delivery conduit (15) leading from the other end of the chamber (11) with a restriction through which compacted straw or vegetable matter is forced in steps by the piston (7,28), and drive means for the piston including a toggle linkage (5) which is substantially aligned with the piston (7) at the end of each working stroke.

2. Apparatus as claimed in Claim 1, characterised in that an eccentric (10) on a flywheel (4) is coupled to the break point of the toggle linkage (5).

3. Apparatus as claimed in Claim 1 or 2, characterised in that means (17,18) are provided for adjusting the restriction in the delivery conduit (15).

4. Apparatus as claimed in Claim 3, characterised in that the delivery conduit (15) has a split end, and a member (17) surrounding this end has an adjustable embrace to vary the size of the split.

5. Apparatus as claimed in any preceding claim, characterised in that the piston face (15) is indented.

6. Apparatus as claimed in Claim 5, characterised in that the indentation is annular, the end face having a central forwardly projecting conical portion (29) and an outer, bevelled cutting edge portion (30).

7. Apparatus as claimed in any preceding claim, characterised in that the feeding means comprise two counter-rotating toothed drums (21) which entrain straw or vegetable matter and feed it positively into the compression chamber (11).

8. Apparatus as claimed in Claim 7, characterised in that the drum teeth (22) interdigitate with fixed combs (23) for parting the straw or vegetable matter from the drums at the entry to the compression chamber (11).

9. Apparatus as claimed in Claim 7 or 8, characterised in that the drum teeth (22) tips co-operate with sharp edges (27) between the roots of the combs fingers (23) to chop the straw or vegetable matter entering the compression chamber (11).

10. Apparatus as claimed in any preceding claim, characterised in that a cooling jacket (14) co-operates with the compression chamber (11).

1/3

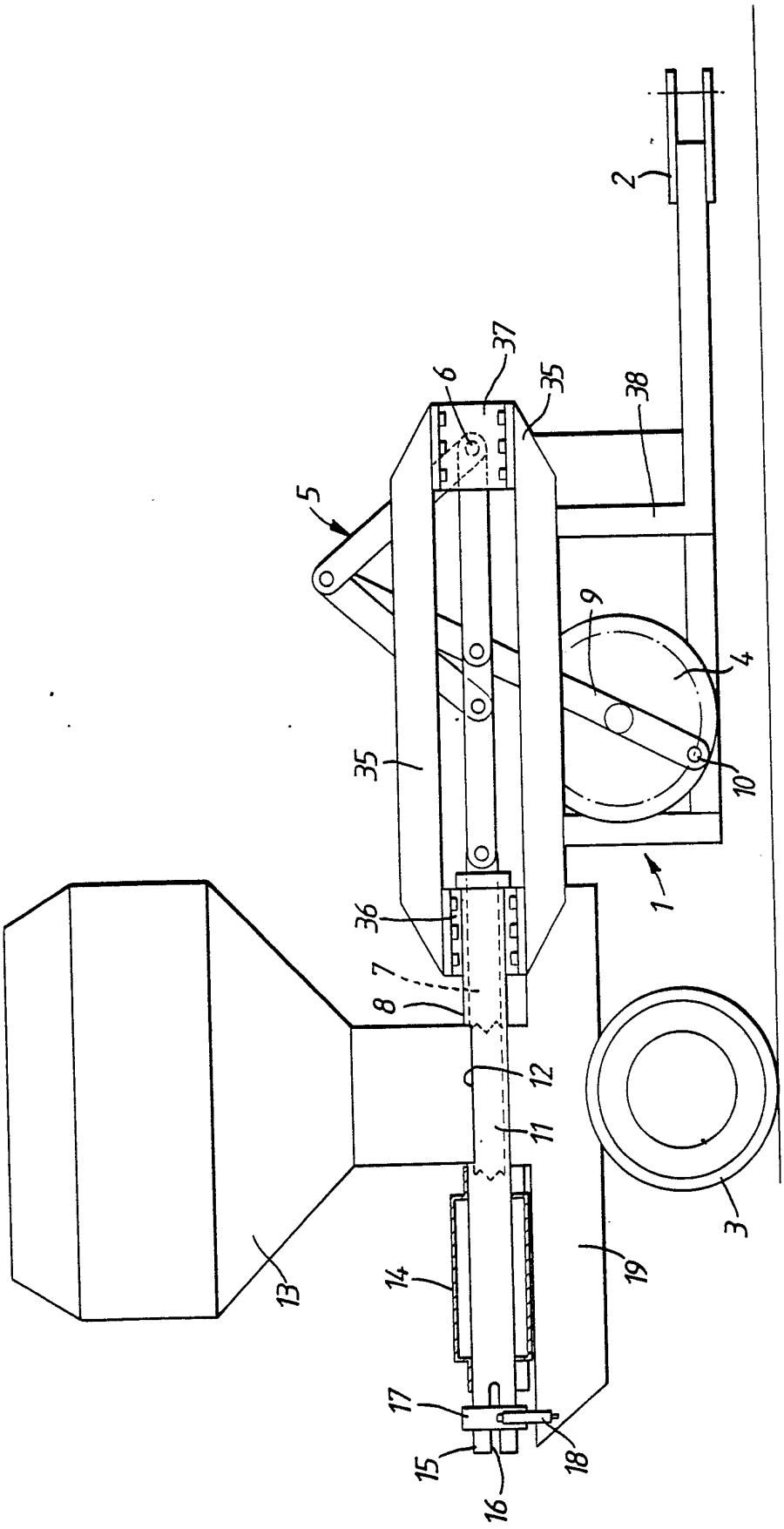


FIG. 1.

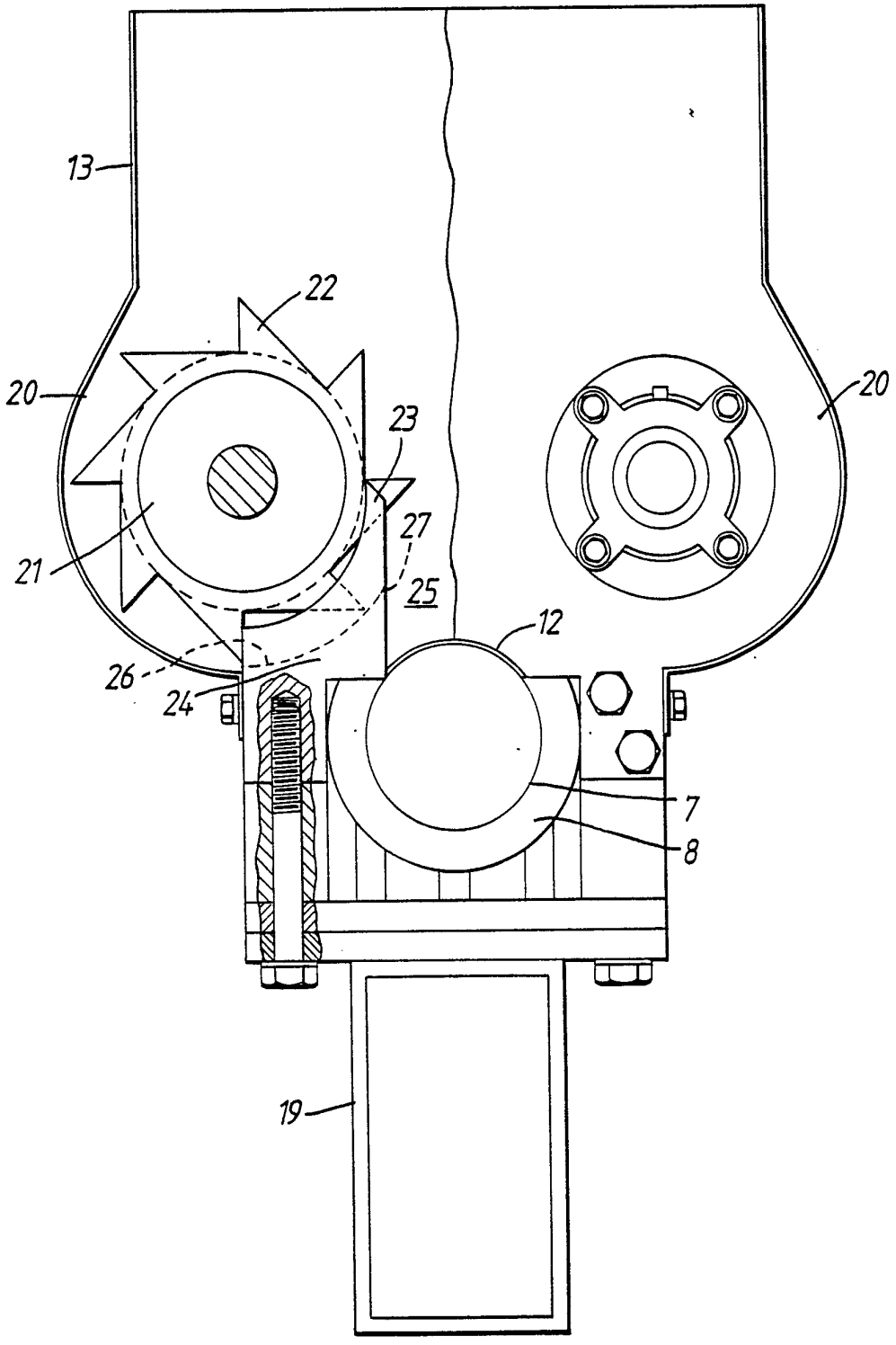


FIG. 2.

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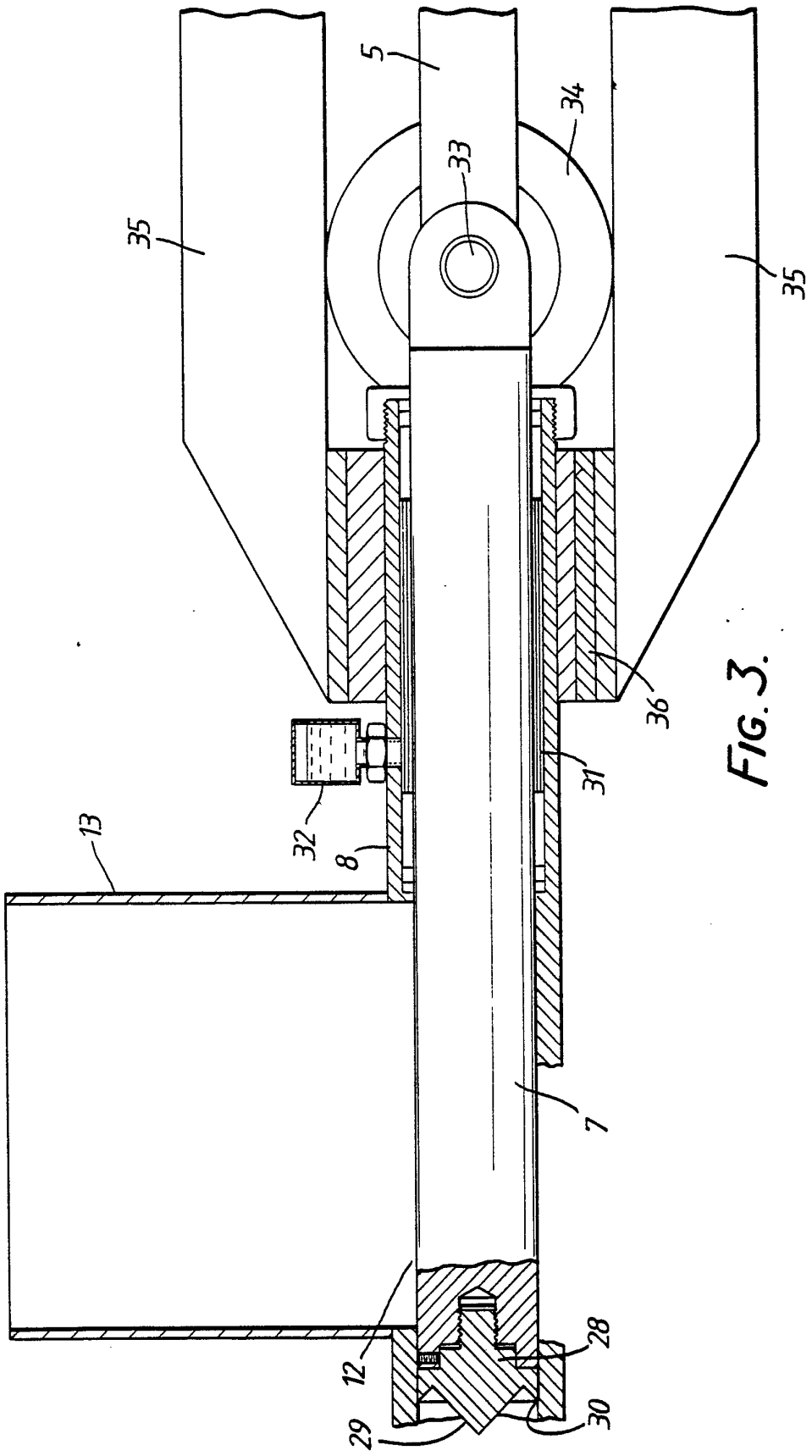


FIG. 3.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 86/00106

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: B 30 B 11/26; B 30 B 15/30; B 30 B 15/06

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 30 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 2507491 (CREA) 16th May 1950, see the whole document --	1,2,5,10
Y	DE, C, 552749 (ZEITZER EISENGIESSEREI UND MASCHINENBAU) 17th June 1932, see the whole document --	1,2
Y	US, A, 1490162 (DOW) 15th April 1924, see page 1, lines 72-81; page 2, lines 89-109; figures 1,6 --	1,3,4,10
Y	US, A, 4174933 (MITCHELL) 20th November 1979, see column 1, lines 46-52; column 2, lines 38-47; figure 1 --	1,5,6
Y	US, A, 2622510 (LETTS) 23rd December 1952, see the whole document --	1,5,6
Y	CH, A, 217167 (DEFRÊNE) 16th January 1942, see the whole document --	1,7,10
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
22nd May 1986	19 JUIN 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	L. ROSSI

International Application No. PCT/GB 86/00106

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 1469429 (NEUMAIER) 2nd October 1923, see page 2, lines 57-96; figure 2 --	1
A	DE, A, 2401666 (OBERMEYER) 24th July 1975, see the whole document	1

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 86/00106 (SA 12334)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 29/05/86

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 2507491		None	
DE-C- 552749		None	
US-A- 1490162		None	
US-A- 4174933	20/11/79	None	
US-A- 2622510		None	
CH-A- 217167		None	
FR-A- 563186		None	
US-A- 1469429		None	
DE-A- 2401666	24/07/75	None	