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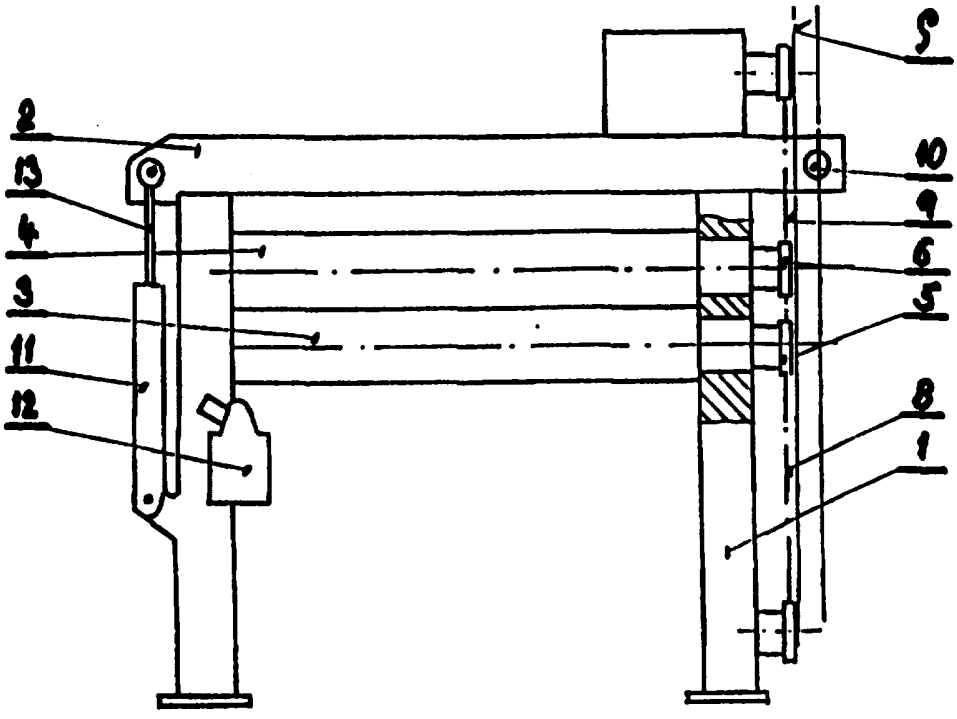
(54) Title: METHOD AND DEVICE FOR RELEASING OF LONG FIBERS FROM THE STEMS OF PLANT MATERIALS

(57) Abstract

The stems are exposed along their full length to a pressure and a force couple which acts in planes perpendicular to the direction in which the pressure is applied wherein the stems are deformed and their circular section is changed to oval one. The surface of the stem is thus disintegrated and the fibers released. To the solid bottom frame (1) smooth surface cylinders (3) driven by the bottom driving mechanism (8) are secured. Upper smooth surface cylinders (4) are driven through an upper driving mechanism (9). The upper frame (2) is mounted for swinging motion on the bottom frame (1) by means of pivots (10). The axis of the pivots (10) is disposed behind a plane (ρ) of the front faces of the cylinders (3, 4). The upper driving mechanism (9) of the upper cylinders (4) is independent of the bottom driving mechanism (8) of the bottom cylinders (3).



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Method and device for releasing of long fibers from the stems of plant materials

Field of invention

The invention relates to a method of releasing long fibers from the stems of plant materials, for example from the flax, and a device for performing this method.

Description of prior art

Under one of the known methods of separating fibers out of the stems of plant materials, for example from flax, the stems are broken along a plane which is perpendicular or substantially perpendicular to the axis of the stem. The inner wood of the stem as well as the outside shell covering the fibers are disintegrated just on the breaking points. In the step by step process as many of breaking points as possible are created in order to disintegrate the shell of the stems and the inner wood. In this way the plant fibers are successively released. The problem of this method is that in the area between the individual breaking points the shell and the inner wood are not properly disintegrated. The shell and the wood have to be removed from this area in the following operations in the course of the fiber processing.

A breaking device for performing this method is provided on its surface which comes into contact with the stems by profiles matching each other. The profiles execute rotational movement on the side engaging the plant material and a linear movement on the opposite side or alternatively the profiles perform rotational movement on both sides.

The breaking device described in the Czech AO (Invention authorship certificate) No.159105 comprises cylinders and endless driving belt provided by such profiles.

The breaking device under the Belgium patent No. 271405 consists of cooperating pair of breaking profile bearing cylinders. Similar breaking methods are performed through devices where the cylinders are provided by projections and corresponding recesses. The projections of one cylinder match the corresponding recesses in the other cylinder. The gap between the matching surfaces of breaking device is filled with the passing carpet-like layer of stems. Upon entry of the carpet layer into the device the stems are forced to decline in such a manner that their axis is not parallel to the axes of the breaking cylinders. When passing through the breaking device the teeth urge the stems into the teeth spaces or the projections force the stems into the corresponding recesses. On these places the stems are broken. To cause a maximum of breaking effect the breaking device is fitted with a maximum number of breaking cylinders. The passing carpet layer of stems is forced to follow the outward teeth and space profiles or projections and recesses. When the stems pass through the breaking device they make a wave-like path and are broken at various places in the transversal direction. The disrupted part of the stem falls down as a tow into the room under the breaking device or is exhausted. The stem fibers are step by step separated from the wood and the shell. The bottom cylinders or as the case may be a rack are usually driven by an electric motor over a gearing box. The upper cylinders may be driven in two different manners. In the first case the upper cylinders are not provided with their own driving mechanism while they are driven by rolling over the respective part of the bottom cylinders with the same effect as when using a gearing. In another embodiment the upper cylinder is driven over a system of transmissions by the bottom cylinder. The upper cylinders are secured together with the bottom cylinders to one frame. A devices for processing of fibers before spinning, especially fibers of bast, as described in the Czech

AO 167732 have a swinging upper frame. The axis of the swinging is disposed parallel with the cylinder axes.

To enable maximal release of the long fibers and to break each stem at the greatest number of points the breaking devices have up to 21 cylinder pairs. Such a breaking device occupies much space and the production costs thereof are high.

The cylinders provided by profiles and with the upper cylinder driven by rolling over the bottom cylinders are unequally worn down. The individual cylinders are not usually renovated since such an operation is technically and economically impracticable. Therefore always a pair of cylinders is to be replaced. Since the life-time of the cylinders is about 1 year the costs of replacement are high.

The breaking of stems in transversal direction is associated with damage to the long fibers what may be caused by many circumstances. The yield is thus adversary effected.

Further adversary effect onto the overall yield is caused by forming of fibrous flakes and clusters which fall under the lower cylinders as a waste. In order to prevent such a loss exhausters are installed however on account of increased operational costs.

In some events also earth and mud particles enters together with the stems the breaking device, stick to its parts and increase the wear thereof. The devices provided by teeth and grooves, projections and recesses cannot be fitted with wipers which would engage the cylinder surface or endless belts and remove the aforesaid undesirable admixtures. The admixtures stick to the surface and if the stem is caught by the earth or mud it declines from its regular wave path, wraps onto the cylinder surface or forms clusters which obstruct the space between the cylinders. The cleaning of this space requires a certain breakdown period and further cuts down the effectiveness.

Summary of invention

The above mentioned disadvantages may be to considerable extent overcome by using a method of separation of long fibers from the stems of plant material by which the stems pass through a pair of cylinders wherein a substantial feature of the invention is that the stems arranged so that their axes are parallel or substantially parallel with the cylinder axes are exposed to radial pressure and a force couple applied simultaneously along the full length of the stems. The force couple acts in the planes which are perpendicular to the direction in which the pressure is applied. The pressure exercised in this manner causes the stems to flatten in their cross-section. The shell of stems is disintegrated along the full length of the stem. At the same time by the effect of the applied force couple the stem is rubbed also along its full length. Thus the stem is being opened and the long fibers are released.

A device for performing this method comprises driven cylinders secured to a frame in staggered position to each other. The bearings of the bottom cylinders are fixed to a bottom frame. The bearings of the upper cylinders which are provided by independent pressure generating means are positioned on guides slidably mounted on the upper frame. The upper frame is pivotally mounted on the bottom frame. According to the invention the upper cylinders secured to the upper frame have smooth surface and are provided with independent upper driving mechanism. The lower cylinders secured to the bottom frame have also smooth surface and are provided with independent bottom driving mechanism. The axis of swinging of the upper frame is situated behind the plane in which the rear cylinder faces lies.

The radial pressure exerted together with the force couple accelerate and facilitate the release of fibers. To ensure all necessary functions only nine smooth surface cylinders are necessary. The production costs of the device according to the

invention as well as the space requirements are substantially reduced. The smooth surface cylinders do not damage the long fibers and a higher yield is thus reached. The smooth surface cylinders may be equipped with scrapers to remove the stuck earth and mud and to reduce the creation of wraps. Thus the wear of the cylinders as well as the breakdown period are diminished. The worn out cylinders may be repaired and used again many times what results in the reduction of maintenance costs. The placing of the pivotal axis of displacement of the upper frame beyond the plain of the rear cylinder faces favorable effects the space magnitude available between the cylinders when the upper frame swivels out of its normal position.

Brief description of the drawings

The invention is in more details explained with reference to the accompanied drawings wherein:

Fig.1 illustrates the stem in cross-section before processing;

Fig.2 is the cross-sectional view of the stem after processing;

Fig.3 is a front elevation of the device for releasing of long stems;

Fig.4 is a side elevation of the same device.

Description of the embodiments of invention

A stem of the plant material to be processed such as stem of flax has a circular section (Fig.1). Under the outside shell O a layer V of long fibers having the annual section is placed. The fibers are situated parallel to the stem axis. Under the layer V of the long fibers a fragile annual layer of wood D from which the layer of long fibers V shall be disengaged is located. The center of the stem is formed as a hollow core.

The description of the disengagement and release of the long fibers is based on the following simplified condition: the stem is exposed to a radial pressure T along its entire length on its opposed sides. Simultaneously the stem is exposed to the action of a force couple P1 and P2 which acts in tangent planes perpendicular to the exerted pressure T. Due to the pressure T the original circular section of the stem is deformed to take a shape of a flat oval (Fig.2). The fragile wood D of the stem crashes due to the action of the said deformation forces while local disintegration spots N begin to appear and continue to expand. The disintegration effect appears usually on the spots exposed to the pressure T and on places where the stem is subject to the highest deformation i.e. in the central plane of the stem and perpendicular to the direction of the exerted pressure T. The pressure T is generated by a couple of cylinders while the stem is introduced into the gap between them in the position where the axis of the stem is parallel to the axes of the cylinders or slightly different from such a parallel arrangement. Due to the action of the force couple P1 and P2 the spot of disintegration expand and the stem is under the process of so called opening. In this process the crashed wood D and shell O are being separated from the long fiber layer V. The force couple P1 P2 are generated by the different circumferential velocity of the cylinders constituting one couple of engaging cylinders. If the axis of the stem retains its parallel position with respect to the cylinder axes the stem is exposed along its entire length simultaneously to the pressure T and the action of the force couple P1 and P2. If the axis of the stem is in the position which is slightly different from the said parallel position the stem is exposed to the pressure T along its entire length gradually. This process is repeated with a less or greater intensity what depends on the elected pressure grade. The greater is the stem deformation the larger is the area of disintegration N. The disintegration N occur along the entire

length of the stem parallel or preferably parallel with the long fibers. The simultaneous exertion of the pressure T and the force couple P1 P2 causes disintegration of the shell and the wood of the stem only. No disintegration of long fibers occur.

A device for performing this method comprises a solid bottom frame 1 (Fig.1) and a upper frame 2 adapted to make swinging motion. To a bottom frame 1 in the upper part of its side walls pivots 10 are secured in a manner that their axes are situated beyond the plane ρ of the rear front faces of the cylinders 3 and 4 (Fig.2). The plane ρ is usually situated outside the floor space of the lower part of the bottom frame 1. The upper frame 2 is rotatably mounted on the pivots 10. On the bottom frame 1 five bottom cylinders 3 are mounted. To each of them a sprocket driving wheel 5 driven by a bottom driving mechanism 8 is secured. The bottom driving mechanism is represented by a known chain drive with a bottom idle sprocket wheels 16 and a tension pulley 15. The bottom sprocket driving wheels 5 are fixed to the bottom cylinders 3 and their rear front faces are situated in the plane ρ of the rear front faces of the bottom cylinders 3. Four upper cylinders 4 are secured to the upper frame 2 which upper cylinders are provided outside the upper frame 2 by upper sprocket driving wheels 6 driven by the upper driving mechanism 9. The upper driving mechanism 9 is also represented by a known chain drive with upper tension pulleys 17. The upper sprocket driving wheels are fixed to the upper cylinders 5 and their rear front faces are situated in the plane ρ of the rear front faces of the upper cylinders 4. The bottom cylinders 3 are secured to the solid bottom frame in bearings. The upper cylinders 4 are secured to the swinging upper frame 2 in a known manner in swivel antifriction bearings mounted on resilient guides provided with adjustable pressure means. The cylinders 3 and 4 are made of steel thick-wall rolled tubes having a smooth

surface. A known linear hydraulic motor 11 associated with a hand operated hydraulic generator is mounted for swivel motion on the bottom frame 2. A draw bar 13 of the linear hydraulic motor 11 is connected to the upper frame 2.

The function of the device is as follows. All bottom cylinders are driven through the bottom driving mechanism 8 and the bottom sprocket driving wheels 5. The upper cylinders 4 are driven through the upper driving mechanism 9, which is independent in operation of the bottom driving mechanism 8, and further through the upper sprocket driving wheels 6. On the entrance side of the device between the first rotating cylinder pair 3,4 is introduced a carpet-like layer of a stem material for example of flax. Stems entering the device are situated so that their axes are parallel or substantially parallel to the axes of the cylinders 3 and 4. After passing the first cylinder pair 3 and 4 in which the stems are exposed along their entire length to the pressure T from the cylinders 3 and 4 and simultaneously to the a force couple P1,P2 the stem continue to travel to further processing operation between the first upper cylinder 4 and the second bottom cylinder 3. The pair of the cooperating cylinders 3 and 4 apply pressure T and the force couple P1 and P2 to the stems at the area of their engaging surfaces. The force couple P1 and P2 acts in parallel planes which are perpendicular to the direction in which the pressure is exerted. The stems are pressed due to the pressure T applied to them. The outside stem shell O is gradually disintegrated and the inner wood D is being crashed. The circumferential velocity of the bottom cylinders 3 driven by their own driving mechanism 8 differs from that of the upper cylinders 4 driven also by their own driving mechanism 9. Due to the difference between the circumferential velocity of the upper and the bottom cylinders the couple force P1 and P2 is generated which force causes rubbing of the stems. The outside shell O of the stems is opened and the crashed inner wood falls away and the fibers are released. This process of

simultaneous stem pressing and rubbing along their entire length is effected when the stems pass the nine-cylinder device eight times in series. The crashed wood falls down as a tow into the space under the bottom frame 1.

If the working place is jammed or undesirable material enters the gap between the cylinders 3 and 4 or a wrapping occur the device is stopped and the upper frame 2 with the upper cylinders 4 is lifted by the hand operated hydraulic motor 4. Upon lifting the draw bar 13 of the hydraulic motor 14 gets out and the upper frame 2 together with the upper cylinders swivels about the pivot 10. Between the upper cylinders 4 and the bottom cylinders 3 on the operator's side a V-shaped space is created. When the upper frame 2 swivels into its upper position enough space is available to remove all undesirable objects, wraps clusters etc. With respect to the fact that the axis of the pivot 10 around which the upper frame 1 swivels lies behind the plane ρ of the rear front faces of the cylinders 3 and 4 there is enough space to find to enable cleaning of the space between the cylinders 3 and 4 on the side opposite to the operator. In the lifted position the upper frame is blocked in any position. After cleaning of the space between the cylinders 3 and 4 the upper frame 2 together with the upper cylinders 4 is returned to its basic position by the reverse stroke of the linear hydraulic motor 11 and the device is ready for further operation.

Industrial applicability

The invention may be used with the devices which are designed for separation of plant fibers from the plant materials such as flax etc.

List

of reference characters

1	bottom frame
2	upper frame
3	bottom cylinder
4	upper cylinder
5	upper sprocket driving wheel
6	bottom sprocket driving wheel
7	
8	bottom driving mechanism
9	upper driving mechanism
10	pivot
11	linear hydraulic motor
12	hand-operated hydraulic motor
13	draw bar
15	bottom tension pulley
16	bottom idle pulley
17	upper tension pulley
ρ	plane ρ of the rear front faces of the cylinders 3 and 4
D	wood
J	hollow core
N	disintegration
O	shell
P1,P2	force couple
T	pressure

CLAIMS

1. Method of releasing long fibers from the stems of plant material where the stems pass through a couple of cylinders characterized in that the stems situated with their axes parallel or substantially parallel to the cylinder axes are exposed along their entire length simultaneously to a radial pressure /T/ and to a force couple /P1 P2/ acting in planes which are perpendicular to the direction in which the pressure /T/ is applied, the stem cross-section of the stem being due to the application of the pressure /T/ flattened and the stem shell /O/ and the wood /D/ thus disintegrated along the entire stem length and simultaneously rubbed due to the action of the force couple /P1,P2/ which both results in opening of the stem and releasing the fibers /V/.

2. Device for performing of the method according to claim 1 comprising driven cylinders secured in a staggered position to each other to a frame wherein the bottom cylinder bearings are fixed to the bottom frame and the upper cylinder bearings are provided with independent pressure means and secured to guides which are mounted for sliding motion to the upper frame which is pivotally mounted for swivel motion on the bottom frame characterized in that the upper cylinders /4/ secured to the upper frame /2/ are provided with an independent upper driving mechanism /9/ and the bottom cylinders /3/ secured to the bottom frame are provided with an independent bottom driving mechanism /8/ and the swivel axis of the upper frame /2/ is situated behind the plane /ρ/ in which the rear front faces of the cylinders /3 and 4/ lie.

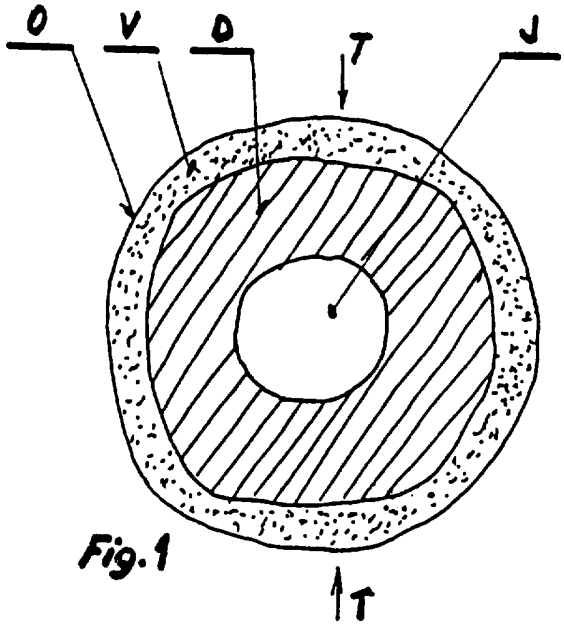

Fig. 1

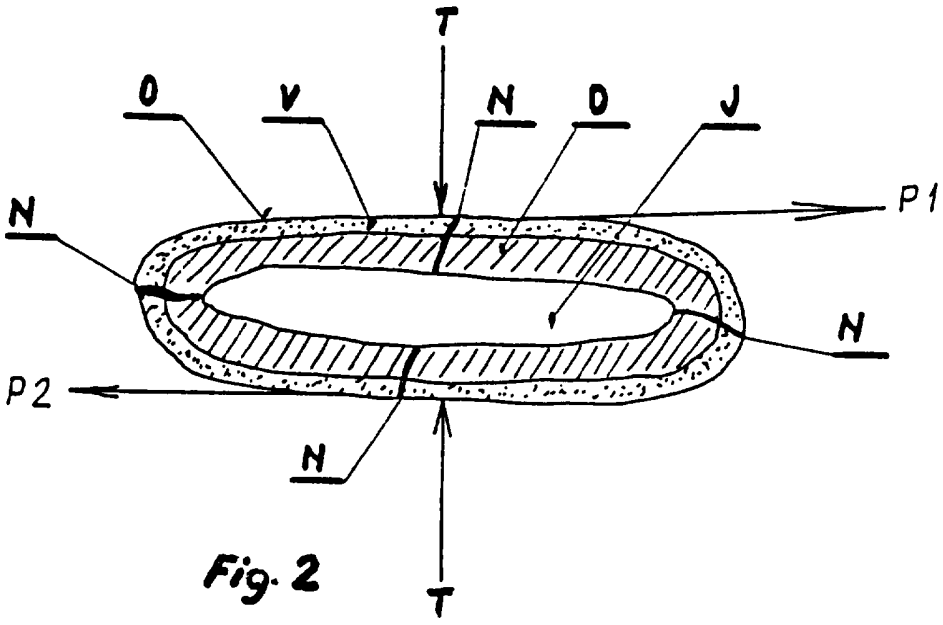

Fig. 2

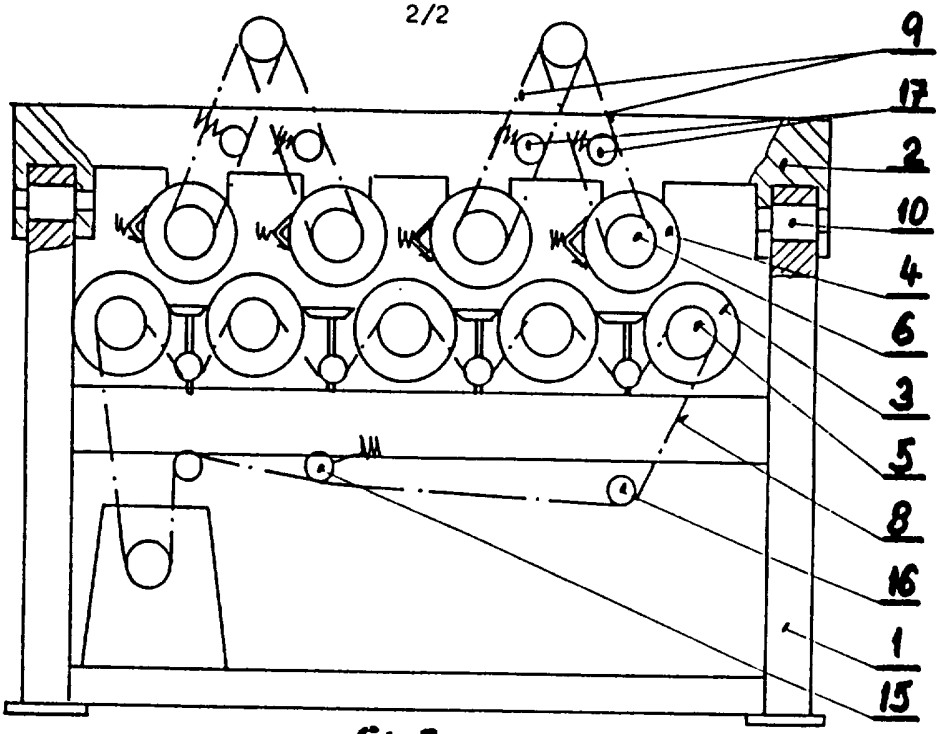

Fig.3

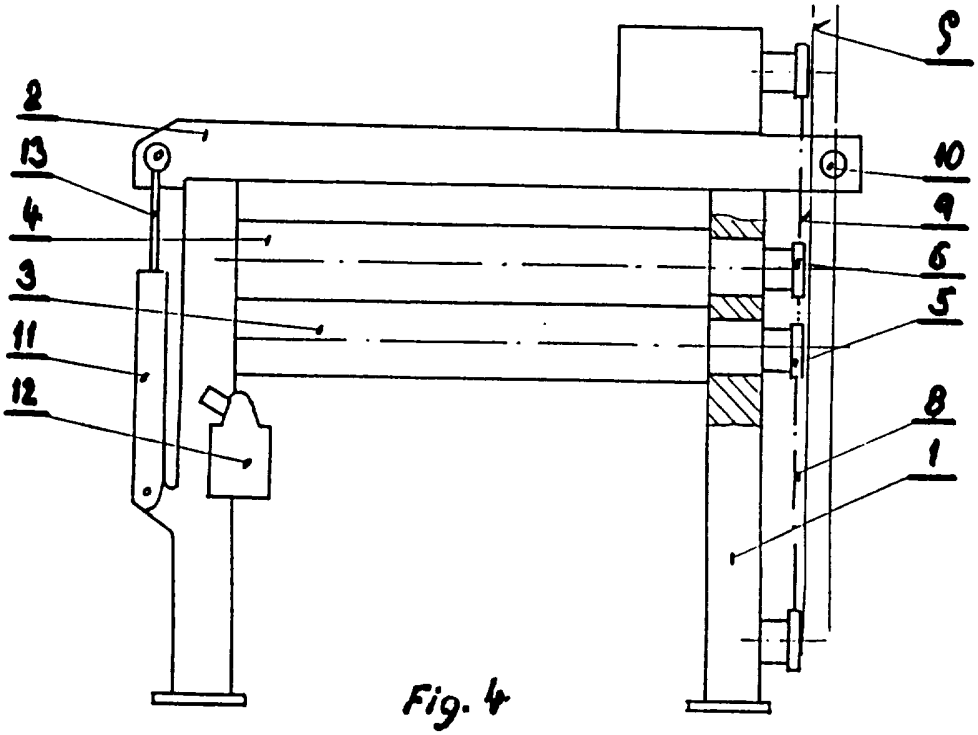

Fig. 4