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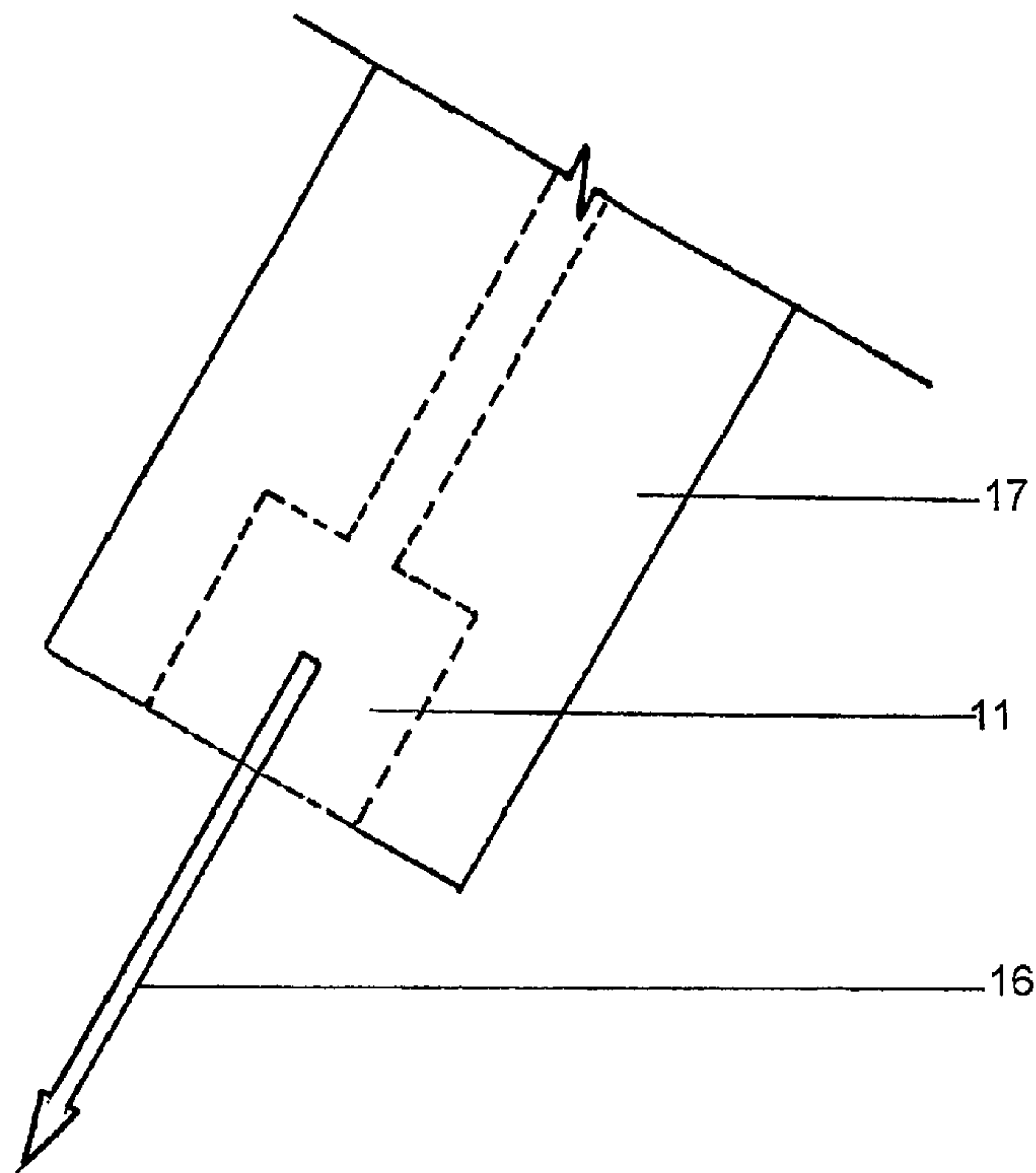
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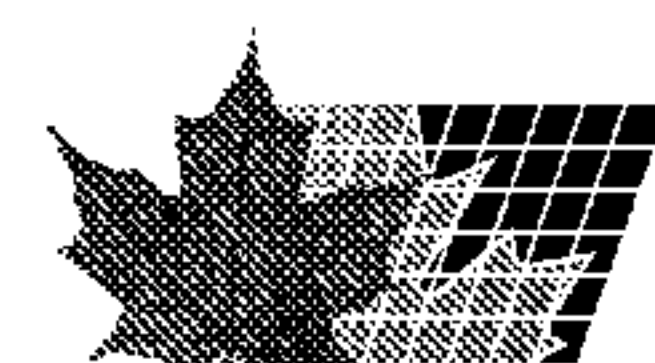
(54) Titre : EQUIPEMENT DE RECOLTE DE SAUMON QUI CAUSE LA MORT CEREbraLE CHEZ LE POISSON, AMELIORE LA PRODUCTION DE FILETS, CET EQUIPEMENT COMPORTANT UN PISTON DE FORME CYLINDRIQUE QUI PERMET D'Y ATTACHER DIVERS TYPES DE POINCONS POINTUS A SON EXTREMITE INFERIEURE QUI AGISSENT SUR LA TETE DU POISSON

(54) Title: SALMON HARVEST EQUIPMENT THAT CAUSES CEREBRAL DEATH IN FISH, IMPROVING FILLET YIELD, SAID EQUIPMENT HAVING A CYLINDER-SHAPED PISTON THAT ALLOWS THE ATTACHMENT OF DIFFERENT TYPES OF SHARP-POINTED PUNCHES AT ITS BOTTOM END ACTING OVER THE HEAD OF THE FISH



(57) Abrégé/Abstract:

The present invention discloses an equipment for the automatic application of "Ike-Jime" technique in salmon harvest processes. The stunning system of known equipment was redesigned by modifying the stunning unit. The equipment of the invention



(57) Abrégé(suite)/Abstract(continued):

produces cerebral death in fish by rapid insertion of a punch into fish brains. The equipment of the present invention has a piston with a bottom cylinder-shaped threaded cavity to attach a punch having a sharp-pointed bottom end similar to an arrowhead. With this modification, the equipment of the present invention penetrates the skull of fish and causing them a cerebral death, lengthening rigor mortis stage and ultimately resulting in a better fillet texture.

SUMMARY

The present invention discloses an equipment for the automatic application of "Ike-Jime" technique in salmon harvest processes. The stunning system of known equipment was redesigned by modifying the stunning unit. The equipment of the invention produces cerebral death in fish by rapid insertion of a punch into fish brains. The equipment of the present invention has a piston with a bottom cylinder-shaped threaded cavity to attach a punch having a sharp-pointed bottom end similar to an arrowhead. With this modification, the equipment of the present invention penetrates the skull of fish and causing them a cerebral death, lengthening *rigor mortis* stage and ultimately resulting in a better fillet texture.

**SALMON HARVEST EQUIPMENT THAT CAUSES CEREBRAL DEATH IN
FISH, IMPROVING FILLET YIELD, SAID EQUIPMENT HAVING A
CYLINDER-SHAPED PISTON THAT ALLOWS THE ATTACHMENT OF
DIFFERENT TYPES OF SHARP-POINTED PUNCHES AT ITS BOTTOM END
ACTING OVER THE HEAD OF THE FISH**

Field of the invention

10 The present invention relates to an equipment to automatically apply an old Japanese technique, the "Ike-Jime", in salmon harvest processes. The application of said harvest equipment causes cerebral death in fish but preserves physiological function, thus improving bleeding and lengthening the establishment of *rigor mortis*. In this way, it allows to improve the yield, due to a higher fish flexibility and adaptation to filleting machines, and also to an improvement in fillet texture quality. Thus, important benefits for salmon factories are generated.

Background of the invention

20 Traditional harvest methods applied in salmon industry are efficient in terms of process rate, but they show deficiencies in the quality of the final product obtained in the plant after fish processing in culture centers. This can be explained because salmon is processed in plant, often when it has already entered *rigor mortis*.

After harvest and fish death, three *post-mortem* stages can be distinguished: pre-*rigor* stage, *rigor mortis* stage and post-*rigor* stage.

Right after death (pre-*rigor* stage), fish musculature is totally relaxed, showing a flexible and elastic texture. pH values in muscles are close to 7.

30 Afterwards, the fish body becomes hard and rigid. This is called *rigor mortis* stage, and its time of establishment and duration varies according to the

species and depends on parameters like the physiological state, size, feeding, capture method and storage temperature of the fish.

Rigor mortis begins in the head region, propagating afterwards toward the tail region and then disappearing in the same direction of propagation. pH values in muscle are around 6.

Finally, muscles begin to soften again, however pre-*rigor* flexibility is not recuperated. This post-*rigor* stage is correlated with the liberation of proteolytic enzymes and the beginning of fish degradation.

- 10 The relevance of *rigor mortis* in fish harvest is explained by its major effects on the mechanized processing of fish, and also on the sensorial characteristics of the final food product.

Fish processing seeks to improve fillet yield. Muscle contraction caused by *rigor mortis* causes connective tissue weakening and subsequent fillet break, therefore resulting in a low fillet yield and demanding careful handling. If fish fillets are separated from fishbone before *rigor mortis*, muscle can contract freely and will shrink when entering *rigor mortis*.

- 20 Food product quality is evaluated by its sensorial characteristics as, for instance, appearance, smell, texture and flavor. The first sensorial changes in post-harvest fish are related to fillet appearance and texture. When fish is cooked before entering *rigor mortis* has a soft and pasty texture, however, when it is cooked during *rigor*, its texture is hard.

In the case of salmon culture, the time period between fish death and *rigor mortis* establishment is approximately 4 to 8 hours, depending on the harvest method used. Accordingly, the time available to process fish before entering *rigor mortis* is reduced to a minimum.

- 30 Traditional methods to sacrifice salmon are varied and depend on the harvested species as follows:

1.- For Atlantic salmon there are two methods:

a) The first method comprises harvesting by manual stunning; fish are stunned by hitting their heads and subsequently bleeding them by cutting their gill arcs. Generally harvest is carried out in the same farm, in a harvest platform installed to perform the operation.

Salmon is transported to the process plant in bins or pans in a solution of water, salt and ice.

b) The second method comprises harvesting by mechanized stunning; fish are stunned by means of an automatic equipment, called "stunner", and subsequently fish are bled by cutting their gill arcs. As in the former case, the operation is performed in the farm and subsequently salmon is transported to the process plant.

Harvest can also be performed by these two methods transporting living fish by means of a wellboat to a suitable prepared harvest center located at a short distance from the process plant.

The time period for salmon to enter *rigor mortis* is approximately 4 hours for the first method and 8 hours for the second method.

2.- For Pacific salmon and sea trout, stunning is generally produced by asphyxia. Asphyxia is caused by CO₂ addition or by oxygen reduction produced by water circulation in the culture unit. Subsequently fish bleeding is performed in the farm and then fish are transported to the process plant. These harvest systems have higher costs due to CO₂ and also cause excessive stress to fish and a deficient bleeding, which results in a low quality final product in the process plant. The time period for salmon to enter *rigor mortis* is approximately 4 hours.

A manual Japanese technique, called "Ike-Jime", carries out fish sacrifice for harvest by producing cerebral death in fish by rapid insertion of a punch in their brain. Subsequently, bleeding is carried out by any traditional method (gill arc cutting).

Due to brain destruction in "Ike-Jime" method, fish stops all movement and no energy is further spent, therefore the energy stock preserves post-harvest

tissue metabolism. This delays *rigor mortis* process and also tissue degradation. In this way, a superior quality meat is obtained in comparison to conventional methods, wherein the energy stock is rapidly consumed after harvest. Said traditional methods can take several minutes to kill the fish, and during this time period the animal exhibits its natural escape behavior, consequently consuming its muscle energy stock.

10 The application of "Ike-Jime" technique produces a quality improvement, which is explained from the standpoint of fish physiology by the lengthening of pre- and post-*rigor mortis* times. With the use of "Ike-Jime", time periods of 24 hours can be achieved before the establishment of *rigor mortis*, which gives a larger time range to process salmon before entering *rigor mortis*, thus generating a higher product quality and texture.

As a consequence of lengthening the time period before entering *rigor mortis*, and besides said quality and texture improvement in fillets, major benefits are obtained in salmon plant processing. One of these benefits is an increased fillet yield, due to a higher flexibility of salmon when is put in the filleting machine and also due to an easier removal process of pin bones from fillets by the operators.
20 These latter two points have a great importance from an economic standpoint for a salmon producing company.

Patent GB N°2,379,375 discloses an equipment to sacrifice fish by stunning. This equipment automatically produces stunning in fish using a cylinder-shaped 50 mm-long piston having a bottom end with curve-convex surface. The difference between said patent and the present invention resides in the replacement of said compact cylinder-shaped piston by a smaller compact cylinder-shaped piston, wherein the piston of the present invention has a punch with a sharp-pointed bottom end inserted in its bottom end by means of a thread.

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Summary of the invention

In the present invention an equipment was designed to automatically apply "Ike-Jime" technique in salmon harvest processes. The "stunner" system of the equipment disclosed in Patent GB N°2,379,375 was redesigned by modifying the stunning unit that hits the salmon head, which is an air-driven cylinder, when said fish is put in the equipment during the harvest operation. In this way, the stunning principle of the original equipment changes to a principle based in causing cerebral death to a fish by rapid insertion of a punch in the brain.

10 Accordingly, if the original piston comprises a compact 50 mm-long cylinder having a bottom end with curve-convex surface for the stunning of fish, with the new principle there is no requirement of such a big weight and the length of the cylinder is reduced to 25 mm, and the second modification resides in giving the new piston a cylinder-shaped bottom cavity having a thread within to attach a punch with a sharp-pointed bottom end, similar to an arrowhead. With this modification, the equipment of the present invention penetrates fish skulls, causing cerebral death and lengthening *rigor mortis* stage, which finally leads to a better fillet texture.

20 Brief Description of the Drawings

Figure 1: Shows a perspective view of the equipment.

Figure 2: Shows a side elevation view of the equipment.

Figure 3: Shows a side elevation view of the original piston design. The cylinder is made of stainless steel and has 50 mm in length and 25 mm in diameter, and has a threaded opening (a) located at its top end to connect the piston to the air-driven shaft.

30 Figure 4: Shows a side elevation view of the modifications made to the original piston. The new cylinder preserves the same diameter dimensions, but varies the length, having a final length dimension of 25 mm, and has an internal threaded cylinder-shaped cavity to attach different types of punches.

Figures 5a to 5e: Show the different types of punches

Figure 6: Shows a plot with pH variation in salmon fillets at different post-harvest times.

Figure 7: Shows a photograph with pH measurement of an Atlantic salmon fillet.

Figure 8: Shows a photograph depicting the measurement method for *rigor mortis*. The angle formed by the caudal fin is measured at different intervals from harvest time.

The method comprises disposing the salmon over a table, supporting only part of the fish body and freely hanging the remaining part of the body. The angle described by the tail, which is measured using a graduated scale supported on the table, is the *rigor mortis* measurement value.

Figure 9: Shows a plot with the average *rigor mortis* measurement of a 5 salmon sample using the angle described by the fish tail, according to fish *post-mortem* stage.

Figure 10: Shows a plot of the variation of the Fracturability texture parameter with time in refrigerated salmon fillets, measured at point A, comparing killing methods 1 and 2.

Figure 11: Shows a plot of the variation of the Fracturability texture parameter with time in refrigerated salmon fillets, measured at point B, comparing killing methods 1 and 2.

Figure 12: Shows a plot of the variation of the Hardness texture parameter with time in refrigerated salmon fillets, measured at point A, comparing killing methods 1 and 2.

Figure 13: Shows a plot of the variation of the Hardness texture parameter with time in refrigerated salmon fillets, measured at point B, comparing killing methods 1 and 2.

Figure 14: Shows a plot of the variation of the Adhesivity texture parameter with time in refrigerated salmon fillets, measured at point A, comparing killing methods 1 and 2.

Figure 15: Shows a plot of the variation of the Adhesivity texture parameter with time in refrigerated salmon fillets, measured at point B, comparing killing methods 1 and 2.

Detailed description of the invention

In Figures 1 and 2, equipment (1) is shown to be essentially formed by a piston unit (2) and a support unit (3). Support unit (3) comprises a base (4), two side walls (5) and (6) joined in their top ends by a support member (7), and two side guides (8) and (9), attached to said lateral walls (5) and (6) respectively by a perpendicular shaft (10) located close to the front end of both walls, said shaft being provided with a thread to adjust the distance between said side guides, and a bottom guide (12) located just above said base (4) to allow a suitable location of the fish head in the equipment. Besides, the piston unit (2) substantially forms a cylinder (17) (Fig. 2) obliquely inclined backwards, having a top Standard pneumatic cannon (20) (Fig. 2) at its top end, and an internal cylinder-shaped cavity with a cylinder-shaped piston (11) (not shown in these figures) moving therethrough, as shown in Fig. 4, said cylinder having a superior guide (21) mounted at its bottom end with a suitably formed opening to allow piston (11) to pass therethrough, said piston unit (2) being also pivotable through a perpendicular shaft (13) located in the back end between side walls (5) and (6), with two rails (14) (Fig. 2) located at both sides of the unit, said cylinder (17) allowing also a small height variation by means of an adjustment screw (15) located on the support member (7), which allows the adjustment of the distance between said top guide (21) and said bottom guide (12) to compensate for fish size differences, and the distance between the cylinder's bottom end (17), having said piston (11) of the unit extending therethrough, and said bottom guide (12) is determined by an adjustment screw (18), which also contacts a tongue (19) projecting inwardly from said side wall (6). The bottom end of piston (11) extending from cylinder (17) has an internal small-diameter cylinder-shaped cavity having a thread to attach a punch (Fig. 5) with sharp-pointed bottom end, with a possible configuration that encompasses five different variations: a stylized cylinder having a bottom end slightly enlarged to form an inverted cone (5a), a stylized inverted cone spanning almost the entire height of the punch (5b), a cylinder having a bottom end slightly enlarged to form an inverted quadrangular-based pyramid (5c), a cylinder having a bottom

end enlarged only at one side that forms an inverted trunk-conical body with a sharp-pointed top end (5d), and a cylinder having an enlarged bottom end forming an inverted trunk-conical body with a sharp-pointed top end (5e).

When the fish is introduced in the equipment (1), said fish is located between side guides (8) and (9) and between top guide (21) and bottom guide (12), and the fish head (27) touches a contact plane (22) located at the further end, which ascends and activates a trigger button (25) by means of a pushing bar (24), then extending piston (11) from cylinder (17) over 30 mm, thus contacting the fish head (27). The location of the contact plane (22) is adjustable by means of a pivot (23) that fixes approximately three position angles. In order to prevent multiple cannon firing (which could be very damaging to the fish), said pushing bar (24) is stopped by an end button (31), thus allowing an immediate piston retraction, and said contact plane (22) together with said pushing bar (24) return to their initial positions by the action of springs (29) and (32), respectively. Afterwards, the equipment is ready for the repetition of the procedure. The components of said support unit (3) are preferentially made of corrosion-resistant metals, like stainless steel. The pneumatic cannon (20) of said piston unit uses air at 4.0 to 7.0 bar, but generally operates with 4.0 bar.

The main equipment features are:

1. Height 350 mm
2. Width 195 mm
3. Length 440 mm
4. Weight 16 kilograms

The economic impact of the salmon harvest equipment of the present invention resides in the improvement of meat quality that arrives to the process plant, given by the higher yield achieved in filleting machines, as fish is more ductile and easier to handle, and also by the higher efficiency of the operators in charge of fillet processing, i.e. operators that remove pin bones.

In the performed assays it has been shown that the yield of processed Atlantic salmon fillets increases in 0.5% by using the equipment. Year 2003 statistics

show 129,178 exported tons of Atlantic salmon fillets and fillet derivatives from Chile, producing an income of USD 603,334,000 to the country. If the net effect of applying the equipment of the present invention was considered in said total Atlantic salmon harvest, the exportations would have increased by 646 tons and the income would have increased by USD 3,017,000. In the other hand, if the equipment of the present invention is used for the harvest of all salmon types, including Atlantic salmon, Pacific salmon, trout and king salmon, with exports of fillets and fillet derivatives of 155,868 tons and an income of USD 730,408,000, the benefit to producers would increase by USD 3,652,000. The benefit for the increase in efficiency of operators is more complex to quantify and have a large variation between different plants.

The invention is further described by selected or particular examples. The use of said examples is merely illustrative and does not limit in any way the scope and spirit of the invention or any of the exemplified terms. In the same way, the invention is not limited to any of the preferred embodiments described in the present invention. On the contrary, many modifications and variants of the invention will be evident for one skilled in the art when reading this specification, which could be made without departing from the spirit and scope of this invention.

EXAMPLE 1: Brain size

To determine the exact location of salmon brain, specifically in Atlantic salmon, salmon head dissections were performed in salmon heads with different sizes or calibers, in order to establish a size or measure that would allow the effective application of the equipment of the present invention, i.e. using the obtained parameters the cylinder and punch system was modified and designed.

The applied methodology is described in the following steps:

Firstly, received head samples from Atlantic salmon species were classified and divided in most common harvest grades as follows:

- Grade 3-4 (Kg)

- Grade 3-4 (Kg)
- Grade 4-5 (Kg)
- Grade 5-6 (Kg)
- Grade 6-7 (Kg)
- Grade over 7 (Kg)

According to reviewed bibliography, brain is located in salmon 2 cm behind the eyes. Following indications about brain location, a transversal cut was performed in salmon heads to verify that information. Observing the cranial zone morphology in salmon, bibliographic information was practically confirmed; nevertheless, measurement referring to eyes location is not practical in order to size and operate high throughput equipment, therefore measurements referred to brain location and main size were carried out, registering data in Table 1.

Table 1: Location coordinates of Atlantic salmon brain

Size in mm	Grade 3-4	Grade 4-5	Grade 5-6	Grade 6-7	Grade over 7
Depth from skin to brain base	19	18.75	20.3	21.5	22.25
Mouth-brain distance	64	65.25	69.0	73.0	77.5
Preopercule-brain distance	17.5	20.25	22.0	20.3	21.25
Transversal brain diameter	15	14.75	15.0	15.3	15.5
Brain length	33.5	33.25	34.3	34.8	37.25
Brain depth location	5	6.25	7.3	7.5	8
Width (brain location)	45	46.75	50.0	51.8	57.75

With these data obtained from practical measurements, the design and adaptations of the equipment of the present invention could be determined.

EXAMPLE 2: Yield comparison according to harvest type

To compare yields of the method of the present invention and the traditional method, 6 salmon batches were analyzed.

Salmon in the study corresponds to Atlantic salmon species (*Salmo salar*), harvested fish belonged to the same cage-raft, having an average weight of 4-5 Kg. Fish were harvested using the equipment of the present invention or using conventional stunners.

Once harvested, fish was processed in plant to different final products. Salmon filleting is performed in an automatic Baader 200 machine, subsequently entering the process line for manual portioning according to fillet type, principally Trim C and Trim E.

In Trim C fillet has no dorsal and ventral fishbone, and no dorsal and ventral fins; no ventral zone fat and no pin bones.

Trim E fillet has the same features as Trim C fillet, but ventral cavity fat is also removed, a straight cut is made at the tail and has no skin.

"Striped" denomination is achieved by means of a lower cut made in the ventral fillet zone, exposing some grain of the meat.

Table 2

Harvest method	Salmon number	Kg of raw material		Kg of products		Yield %	
		Destined to Frozen Striped Trim C	Destined to Frozen Trim E	Frozen Striped Trim C	Frozen Trim E	Frozen Striped Trim C	Frozen Trim E
Traditional stunner	3,271	5,613	985.09	3427.36	484.19	61.06	49.15
Traditional stunner	6,108	15,005.6	2,185.39	9,261.67	1,082.57	61.72	49.54
Traditional stunner	6,064	3,741.4	2,584.92	2,333.97	1,300.25	62.38	50.30
Total for traditional stunner	15,443	24,360	5,755.4	15,023.00	2,867.01	61.67	49.81

Equipment of the present invention	3,253	2,999	3,017.6	1,849.87	1,495.27	61.68	49.55
Equipment of the present invention	6,048	3,862.8	2,463.18	2,401.83	1,235.59	62.18	50.16
Equipment of the present invention	6,108	9,689.8	1,296.23	6,060.52	657.93	62.55	50.76
Total for the equipment of the present invention	15,409	16,551.6	6,777.01	10,312.22	10,312.79	62.3	50.0

Comparing total values, the use of the equipment of the present invention in both products produces a higher yield when compared to the stunner method. In the case of Frozen Striped Trim C, the difference in yield is 0.63%, and in the case of Frozen Trim E, the difference is 0.19%.

Salmon coming from harvest is processed in two shifts in the process plant, the first shift entering the process 6 to 8 hours after salmon harvest, and the second shift having an elapsed time of 10 to 12 hours after harvest before entering the process, thus the respective *rigor mortis* stages are different at the moment of entering the plant for processing.

In the first shift, half of the harvested salmons enters the plant, and 40% of them is beginning *rigor mortis* stage while processed in plant, whereas the remaining is in pre-*rigor* stage, considering the traditional harvest method. On the other hand, for the method of the present invention, salmon is still in pre-*rigor* stage.

For the second processing shift, 100% of salmon harvested with the traditional method is in *rigor mortis* stage, whereas salmon harvested with the method of the present invention are in pre-*rigor* stage.

The corresponding income or economic relevance has been previously discussed.

In conclusion, Table 2 shows the higher yield obtained in plant fillet processing when using the equipment of the present invention compared with the traditional stunner.

EXAMPLE 3: Fillet yield comparing the easiness of fishbone removal

A control experiment was carried out in the process plant to assess the efficiency of workwomen removing pin bones from fillets. A group of workwomen was measured taking into account their pin bone removal efficiency (processing rate and number of remaining pin bones in the fillets).

Table 3 shows the higher yield of workwomen to remove pin bones from fillets obtained when using the equipment of the present invention compared with the traditional stunner.

At the moment of filleting, salmon has passed 6 to 8 hours from harvest in the first filleting shift and 10 to 12 hours from harvest in the second filleting shift.

Table 3:

Experiments	Yield of pin bone removal using the equipment of the present invention	Yield of pin bone removal using the traditional stunner
1	87.5%	82.5%
2	86.09%	78.17%

The higher yield is due to the fact that fillets harvested with the equipment of the present invention are more flexible and soft, because *rigor* is less intense than in fish harvested using the traditional stunner, therefore making pin bone extraction easier.

EXAMPLE 4: pH variation in salmon fillets

pH variation is a good indicator to measure stress fish was subjected to during harvest, a value close to 7 indicates that harvested salmon did not suffer

harvest stress, whereas a lower value indicates stress problems during harvest, which causes an earlier and more intense *rigor mortis* stage.

A total of 10 salmon fillets were analyzed with the same characteristics as discussed above for example 2, having been harvested using the equipment of the present invention and the traditional stunner, pH being measured with a pH-meter (Hanna Instruments, model HI 98150) by inserting the electrode into the fillet (see Figure 7) and discarding the measured fillet portion, and repeating this operation in the same fillet at 8, 12, 16, 26, 33 and 55 hours after salmon harvest. The measured fillets had no skin and fishbone and were stored at 0°C during *rigor mortis* measurements.

In average, values shown in Figure 6 were obtained. From said plot the following can be concluded:

- Pre-*rigor* is less intense for fish harvested with the equipment of the present invention, as the initial value was 6.9 instead of 6.6 for the traditional stunner.
- *Rigor* period in fish starts at 26 hours for fish harvested with the equipment of the present invention, where a value of 6.37 or less is registered, whereas the traditional stunner registers its lowest value of 6.4 at 12 hours.

EXAMPLE 5: *Rigor mortis* measurements

The variable *rigor mortis* is a relevant indicator to determine the stress level of fish during harvest, which is directly related to the harvest method, i.e. the earlier and more intense the *rigor mortis*, the worse is the harvest method, because fish were subjected to a higher stress level.

The methodology used to measure *rigor mortis* is based in the measurement of the angle formed by salmon tail (caudal fin) with time elapsed since harvest.

The method comprises disposing the salmon over a table, supporting only part of the fish body and freely hanging the remaining part of the body. The angle described by the tail, measured using a graduated scale supported on the table,

is the *rigor mortis* measurement value (see Figure 8). The interpretation of *rigor mortis* measurement is as follows: when the angle approaches to 90°, *rigor* is less intense, and when the angle decreases (tends to 0°), *rigor mortis* is more intense.

Complete eviscerated fish bodies were used and were stored at 0°C during *rigor mortis* measurements. In the process plant, a salmon sample was measured over a 50 hour period from harvest at different time intervals (8, 12, 16, 26, 33 and 50 hours).

10 Figure 9 shows the average value of the measurements. The following can be concluded therefrom:

- Pre-*rigor* is less intense with the equipment of the present invention, as the initial value was 35,6° instead of 22,2° for the traditional stunner.
- *Rigor* period starts at 33 hours for fish harvested with the equipment of the present invention, where a value of 17° or less is registered, whereas the traditional stunner registers its lowest angle of 12° at 12 hours.
- Post-*rigor* period has not yet started at 50 hours for the equipment of the present invention, whereas for the traditional stunner it begins at 33 hours.

20

EXAMPLE 6: Texture measurements

1.1 EXPERIENCE 1

30 Texture was measured in two representative samples, each comprising 8 salmon fillets, where measurements were taken at days 0 and 5 of storage at 4°C. This was made to compare the texture between both types of harvest, using the equipment of the invention (method 1) and using a traditional

equipment (method 2), and compare texture variation over time. Texture measurement at reception of the fillets was considered day 0. Measurement was taken in two measurement points (A and B). Fish were stored at 4°C during the study, which is a relevant parameter to be considered as texture final results are affected by temperature changes.

The method used for texture measurement was an objective method, using a Texturometer TA-XT2 instrument, which gives textural parameters by means of a Texture Profile Analysis (TPA), comprising the following for salmon:

- a) Fracturability: It is defined as the force at the first significant rupture in the curve during the first compression cycle. The equipment will calculate this parameter as Force 1.
- b) Hardness: It is the force obtained after sample break during the first compression cycle. In the plot, it is the highest force during the first compression cycle. The equipment will calculate this parameter as Force 2.
- c) Adhesivity: It is defined as the negative force area for the first penetration and represent the work required to surpass attracting forces between the surface of a food material and the surface of other contacting material, and is the total force required to remove the compression piston out of the sample. The equipment will calculate this parameter and show the value as negative area.

Tables 4 and 5 show the measurement results (averages) for textural parameters in both measurement points A and B for harvest methods 1 and 2.

Method 1

Table 4

Day	Fracturability (N)		Hardness (N)		Adhesivity (N*S)	
	A	B	A	B	A	B
	Average		Average		Average	
0	6.85	6.88	6.70	6.72	0.49	0.20
5	6.31	6.01	6.11	5.57	0.26	0.38

Method 2Table 5

Day	Fracturability (N)		Hardness (N)		Adhesivity (N*S)	
	A	B	A	B	A	B
	Average		Average		Average	
0	6.24	6.01	5.67	5.79	0.47	0.50
5	5.50	5.14	5.19	4.81	0.29	0.46

a) Fracturability

When observing the results of fracturability measurements and comparing results at measurement point A between methods 1 and 2, it is possible to observe higher fracturability values for method 1 at day 0 (Fig. 10). This means that for method 1 a higher force is required to break salmon structure (6.85 N in average) in comparison with method 2, which required 6.24 N in average.

When comparing the variation of fracturability over time between both methods, it is possible to observe that fracturability values significantly decreases for both methods, nevertheless higher fracturability values were observed for method 1, decreasing from 6.85 N at day 0 to 6.31 N at day 5, whereas for method 2 fracturability decreased from 6.23 N at day 0 to 5.50 N at day 5.

For the case of fracturability measurements at point B for methods 1 and 2, it is possible to observe that average fracturability values in method 1 are higher (6.87 N in average) for method 1 when compared to average fracturability values for method 2 (6.01 N in average, Fig. 11).

When analyzing the variation of fracturability over time at point B, a decrease is observed for both methods, nevertheless a higher difference was observed for method 2 between day 0 (6.1 N) and day 5 (5.14 N),

whereas for method 1, although it decreased, the variation thereof is not as high, having average values of 6.87 N at day 0 when compared to 6.07 N at day 5.

Finally, it is possible to observe that fracturability forces were higher for method 1, which means that the force required to produce salmon break was higher for method 1 at both measurement points (A and B).

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When analyzing the statistical results, significant differences exist between both methods at a significance level of 1% for this parameter, being better method 1 than method 2 as it gives higher fracturability values. As for time factor, there are also differences at a significance level of 1%, which means that fracturability decreases over time for both methods. (See Figures 10 and 11)

b) Hardness

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When analyzing the results, it can be observed that at day 0 hardness at point A was higher for method 1, with values of 6.70 N, compared to the same day for method 2, with values of 5.67 N (Fig. 12). For harvest method 1 a higher force is required to deform salmon, which also means that texture is more desirable with harvest method 1 than with harvest method 2.

When comparing the variation of hardness over time measured at the same point, it is possible to observe that values significantly decrease for both methods, nevertheless higher hardness values were observed for method 1, decreasing from 6.70 N at day 0 to 6.11 N at day 5, whereas for method 2 hardness decreased from 5.67 N at day 0 to 5.19 N at day 5.

When analyzing the behavior of hardness at point B, average values were also higher for method 1, with a hardness value at day 0 of 6.72 N in comparison with method 2, having average values of 5.67 N.

When comparing the variation of hardness over time measured at point B, it is possible to observe that values significantly decrease for both methods, nevertheless higher hardness values were observed for method 1, decreasing from 6.72 N at day 0 to 5.57 N at day 5, whereas for method 2 hardness decreased from 5.79 N to 4.81 N.

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Finally, it is possible to observe that hardness forces were higher for method 1, which means that the force required to produce salmon deformation was higher for method 1 at both measurement points (A and B).

When analyzing the statistical results, significant differences exist between both methods at a significance level of 1% for this parameter, being better method 1 than method 2 as it gives higher hardness values that are more desirable for resulting in a better texture. As for time factor, there are also differences at a significance level of 1%, which means that hardness decreases over time for both methods. (See Figures 12 and 13)

20

c) Adhesivity

Adhesivity is the total force required to remove the compression piston out of the sample. Salmon becomes more adhesive over time, thus requiring more work to surpass attracting forces between salmon surface and the compression piston. Adhesivity increases as fish deteriorates and concomitantly loses freshness.

30

When analyzing the results it is possible to observe that adhesivity at point A was similar for both methods at day 0, with values of 0.49 N*S for

method 1 and 0.47 N*S for method 2 (Fig. 14), which means that it is not possible to compare both methods taking into account this parameter.

When analyzing the behavior of adhesivity over time for both methods, it is possible to observe that the expected results were not obtained, as adhesivity decreased instead of increasing, which was the expected behavior because salmon deteriorates and loses freshness over time.

10 When analyzing adhesivity at point B, adhesivity was higher at day 0 for method 2, with a value of 0.5 N*S, when compared to the adhesivity of method 1, with a value of 0.2 N*S (Fig. 15). This means that method 2 causes the salmon to have a higher adhesivity, i.e. it looks stickier.

When analyzing adhesivity over time, it is possible to conclude that only for method 1 expected results were obtained, as adhesivity increased between day 0 and day 5, from values of 0.20 N*S to 0.38 N*S, respectively, whereas for method 2 adhesivity decreased, which was an unexpected result.

20 When performing an statistical analysis and observing the results, it is possible to state that there are significant differences between both methods, only reflecting differences between days at a significance level of 5%, however adhesivity increased only for method 1 at point B. See Figures 14 and 15.

CONCLUSION

- 30 • From a statistical point of view, fracturability and hardness parameters showed significant differences between both methods (at a significance level of 1%), with method 1 having higher fracturability and hardness values. Adhesivity parameter did not show any significant difference between both methods. Time factor for the three parameters showed

differences at a significance level of 5%, which means that these parameters decreased over storage time.

- Harvest method 1, i.e. using the equipment of the present invention, gives much higher fracturability and hardness values than method 2 (traditional method). Therefore, for this experience it can be stated that harvest method 1 is better than method 2 as fracturability and hardness parameters result in a better salmon texture.

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- For both harvest types, fracturability and hardness significantly decreased over time, however method 1 gave higher values for the forces.

What is claimed is:

1.- An equipment for salmon harvest that causes cerebral death in fish, improving filleting yield, wherein said equipment (1) is formed by a piston unit (2) and a support unit (3), said support unit (3) comprising a base (4), two side walls (5) and (6) joined in their top ends by a support member (7), and two side guides (8) and (9), attached to said lateral walls (5) and (6) respectively by a perpendicular shaft (10) located close to the front end of both walls, said shaft being provided with a thread, and a bottom guide (12) located just above said base (4), and the piston unit (2) substantially forming a cylinder (17) obliquely inclined backwards, having a top standard pneumatic cannon (20) at its top end, and a superior guide (21) mounted at its bottom end with a suitably formed opening to allow cylinder-shaped piston (11) to pass therethrough, said piston unit (2) being also pivotable through a perpendicular shaft (13) located in the back end between side walls (5) and (6), with two rails (14) located at both sides of the unit, said cylinder (17) allowing also a small height variation by means of an adjustment screw (15) located on the support member (7), and to allow compensating for fish size differences, the distance between the cylinder's bottom end (17), having said piston (11) of the unit extending therethrough, and said bottom guide (12) is determined by an adjustment screw (18), which also contacts a tongue (19) projecting inwardly from said side wall (6), in such a way that when the fish is introduced in the equipment (1), said fish is located between side guides (8) and (9) and between top guide (21) and bottom guide (12), and the fish head (27) touches a contact plane (22) located at the farther end, which ascends and activates a trigger button (25) by means of a pushing bar (24), location of said contact plane (22) being adjustable by means of a pivot (23) that fixes approximately three position angles, and in order to prevent multiple cannon firing said pushing bar (24) is stopped by an end button (31), thus allowing an immediate piston (11) retraction, and said contact plane (22) together with said pushing bar (24) return to their initial positions by the action of springs (29) and (32), respectively, characterized by cylinder-shaped piston

(11) having a cylinder-shaped cavity that allows the attachment of different types of punches, all having sharp-pointed bottom ends.

2.- An equipment for salmon harvest according to claim 1, wherein said different types of punches comprise a stylized cylinder having a bottom end slightly enlarged to form an inverted cone (5a), a stylized inverted cone spanning almost the entire height of the punch (5b), a cylinder having a bottom end slightly enlarged to form an inverted quadrangular-based pyramid (5c), a cylinder having a bottom end enlarged only at one side that forms an inverted trunk-conical body with a sharp-pointed top end (5d), and a cylinder having an enlarged bottom end forming an inverted trunk-conical body with a sharp-pointed top end (5e).

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Figures: 7-8

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Figure 1

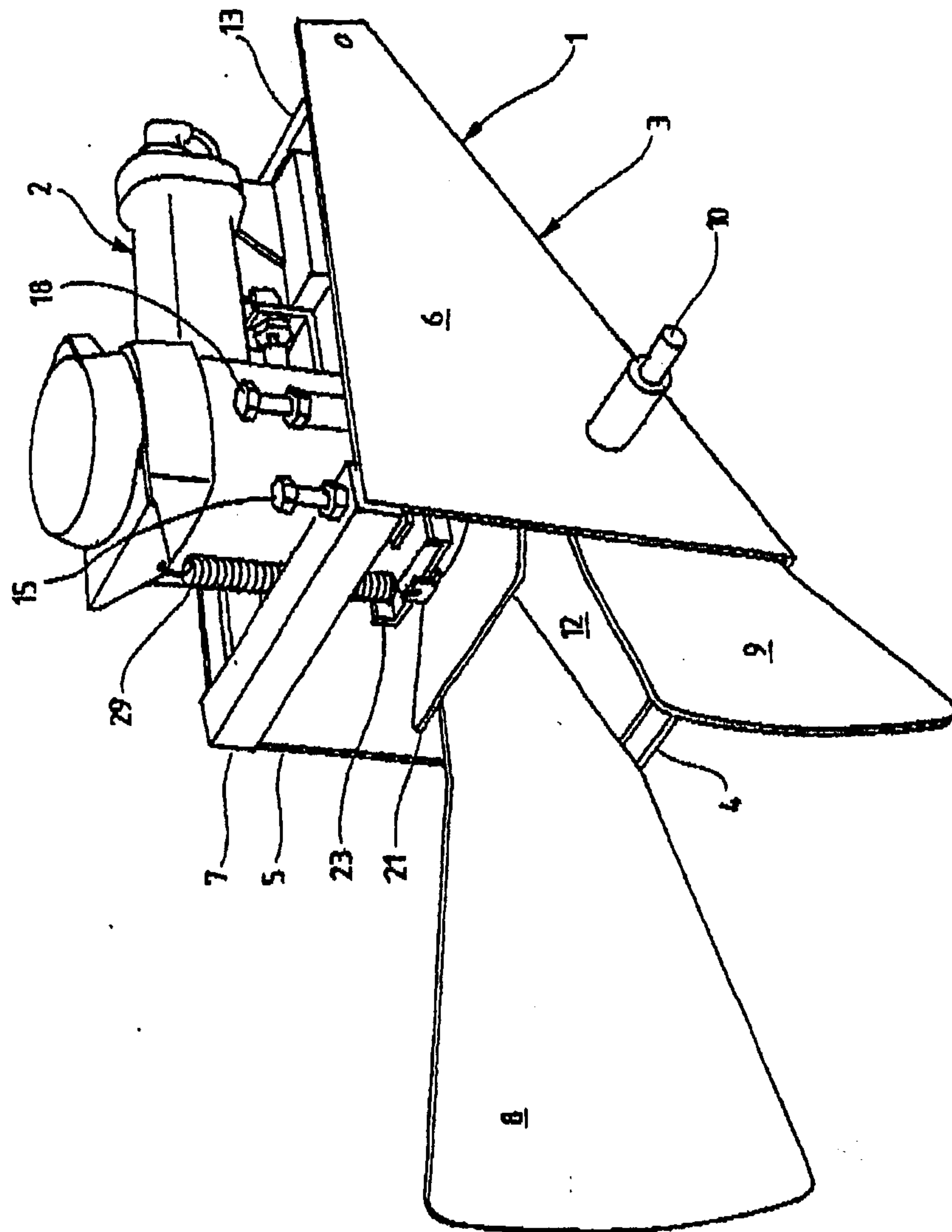


Figure 2

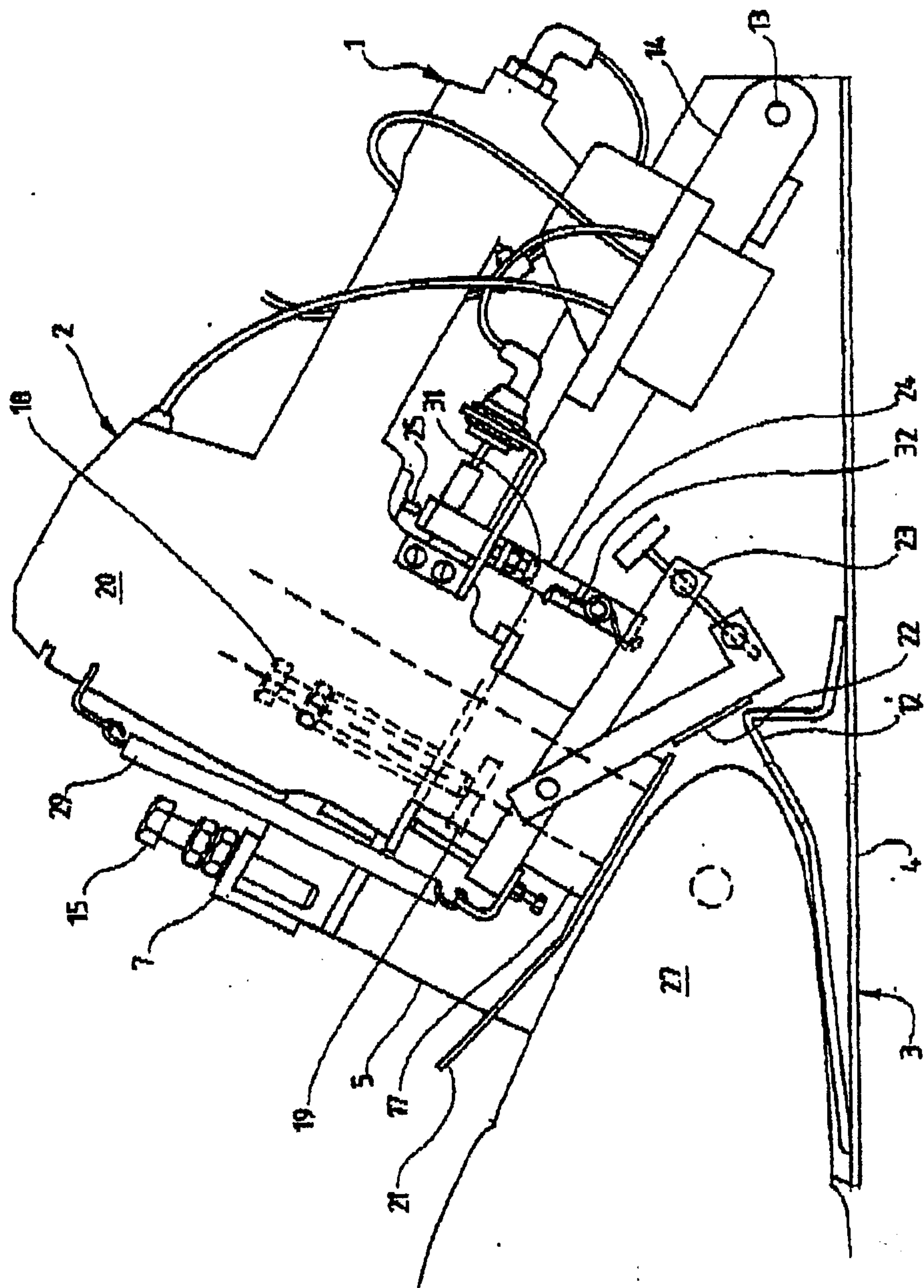


Figure 3

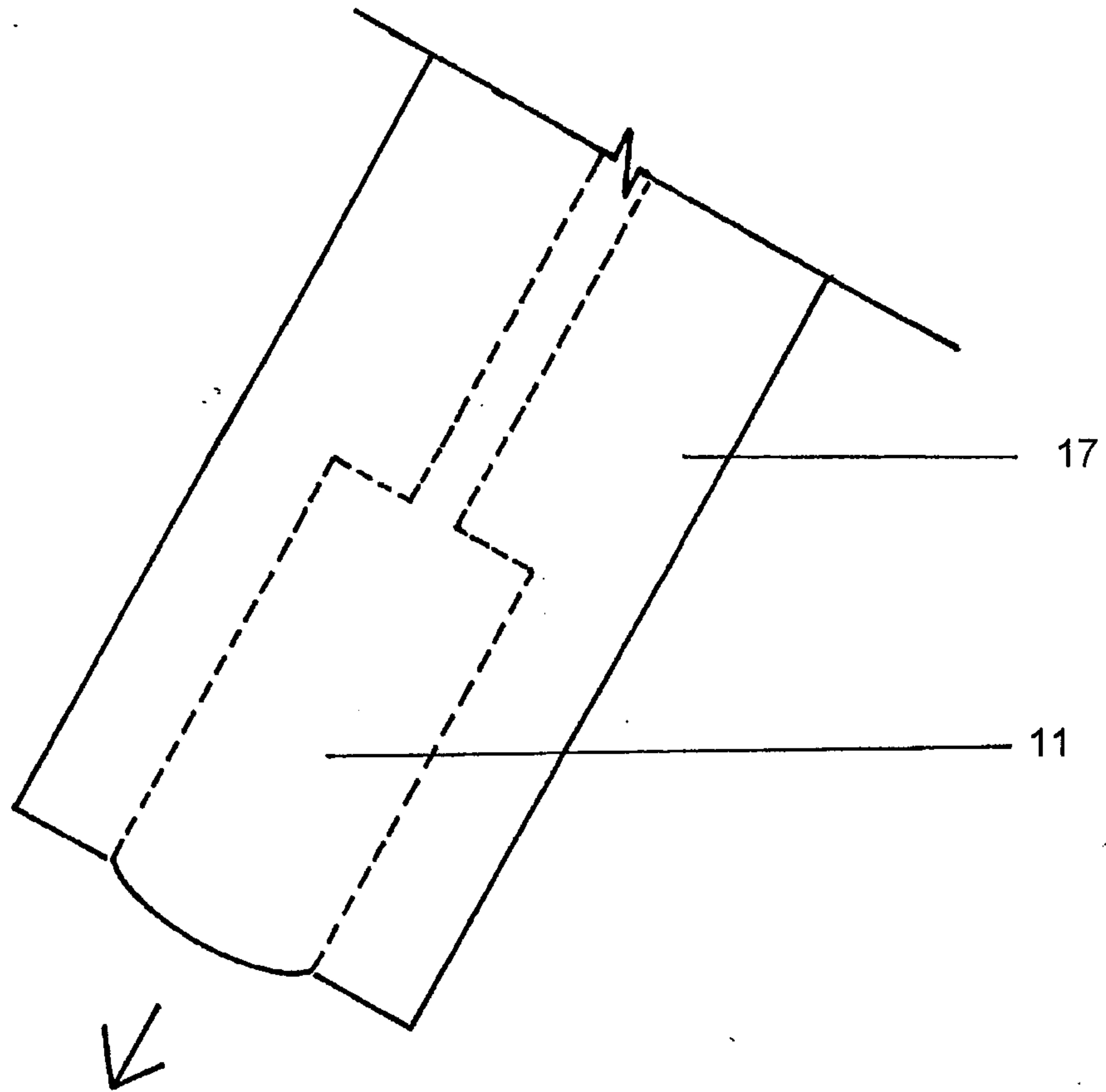


Figure 4

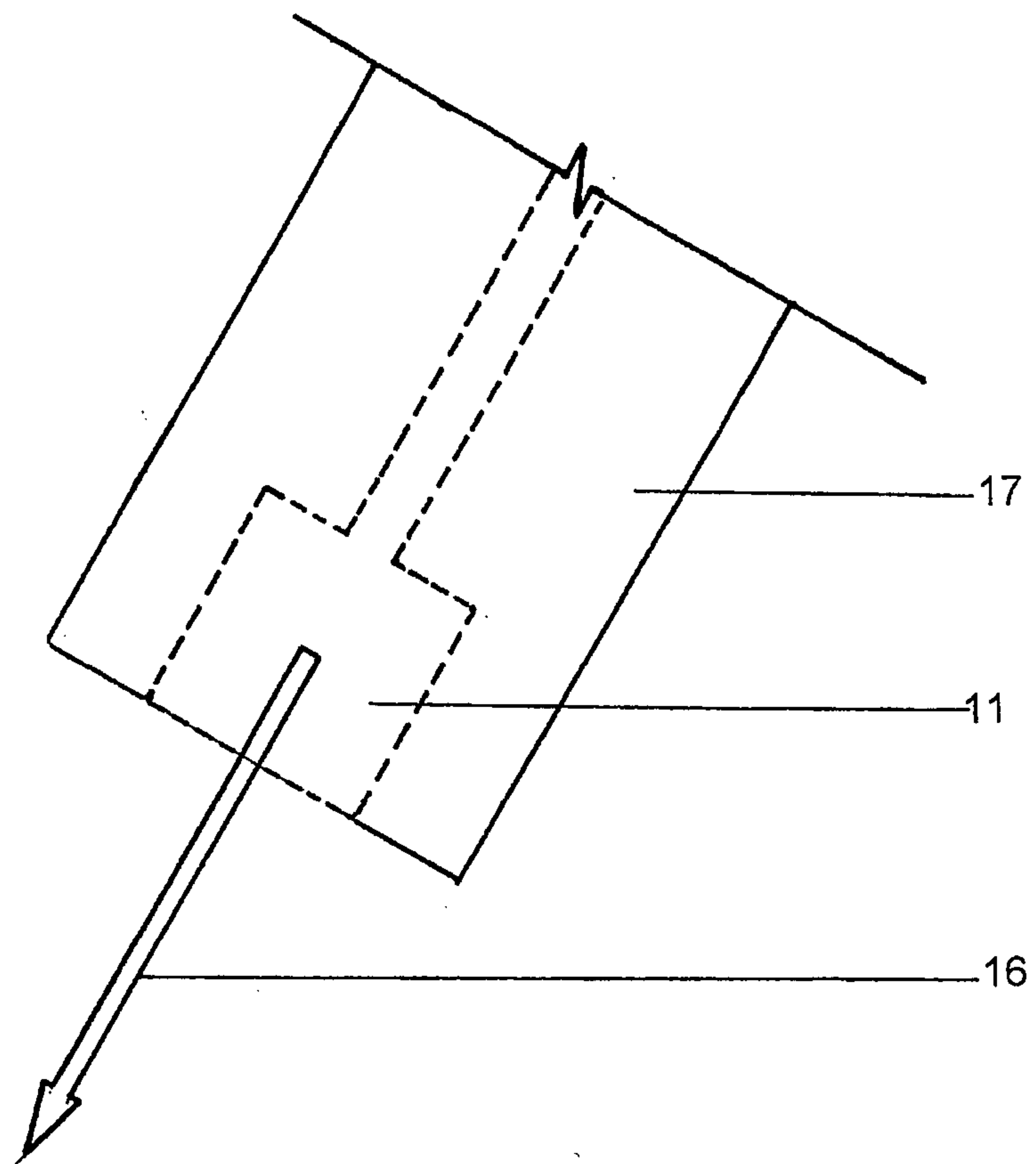


Figure 5

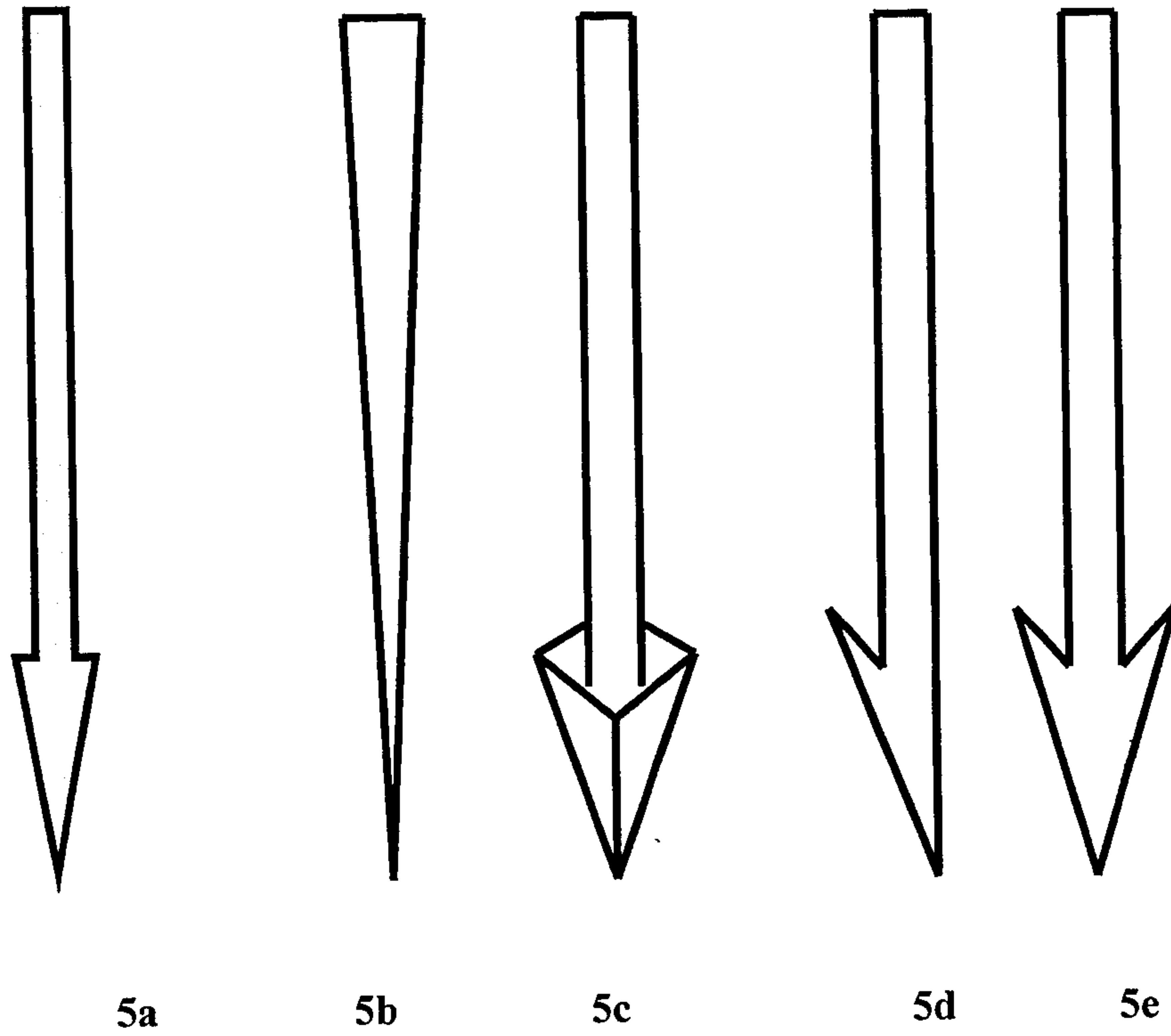


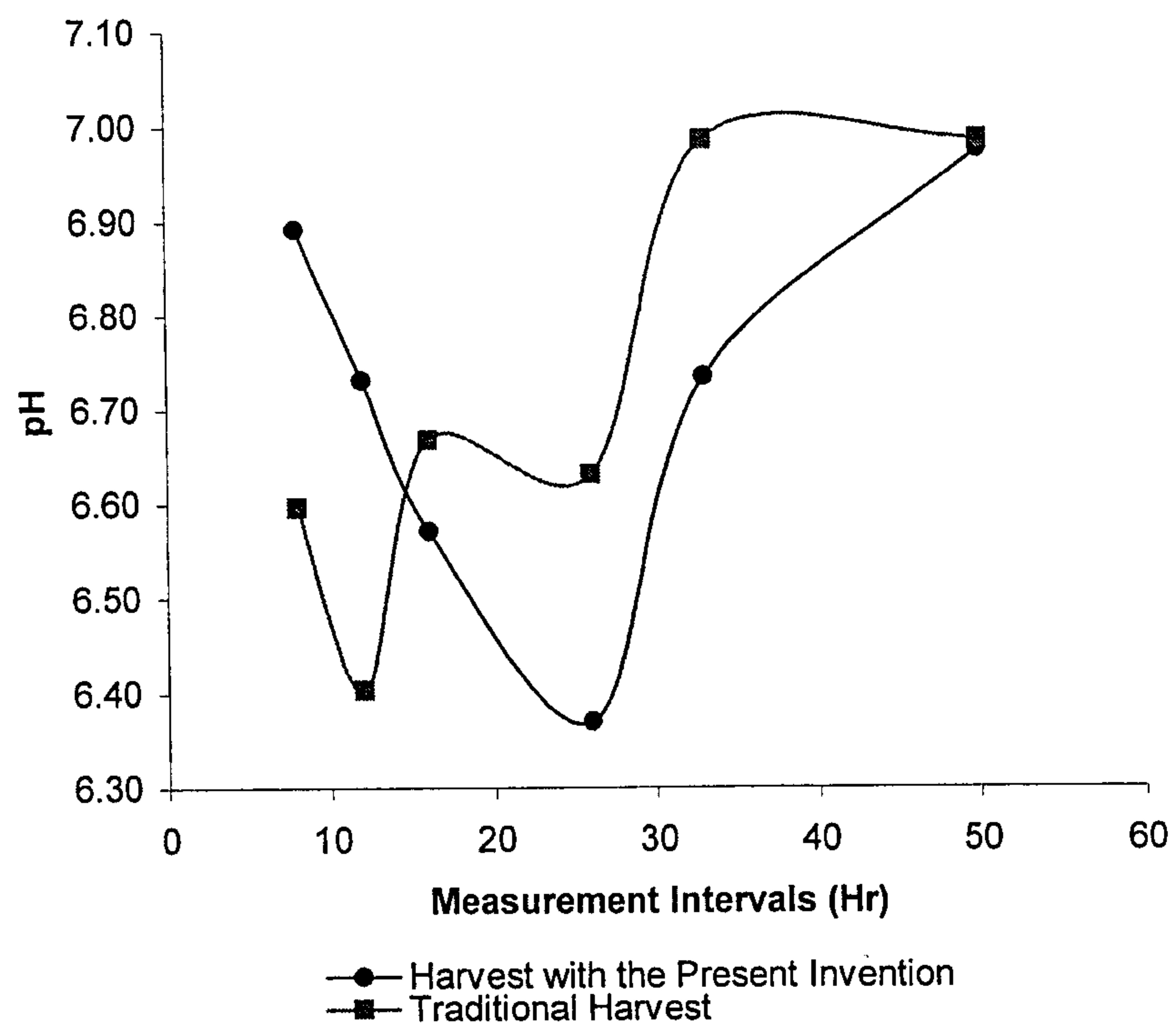
Figure 6

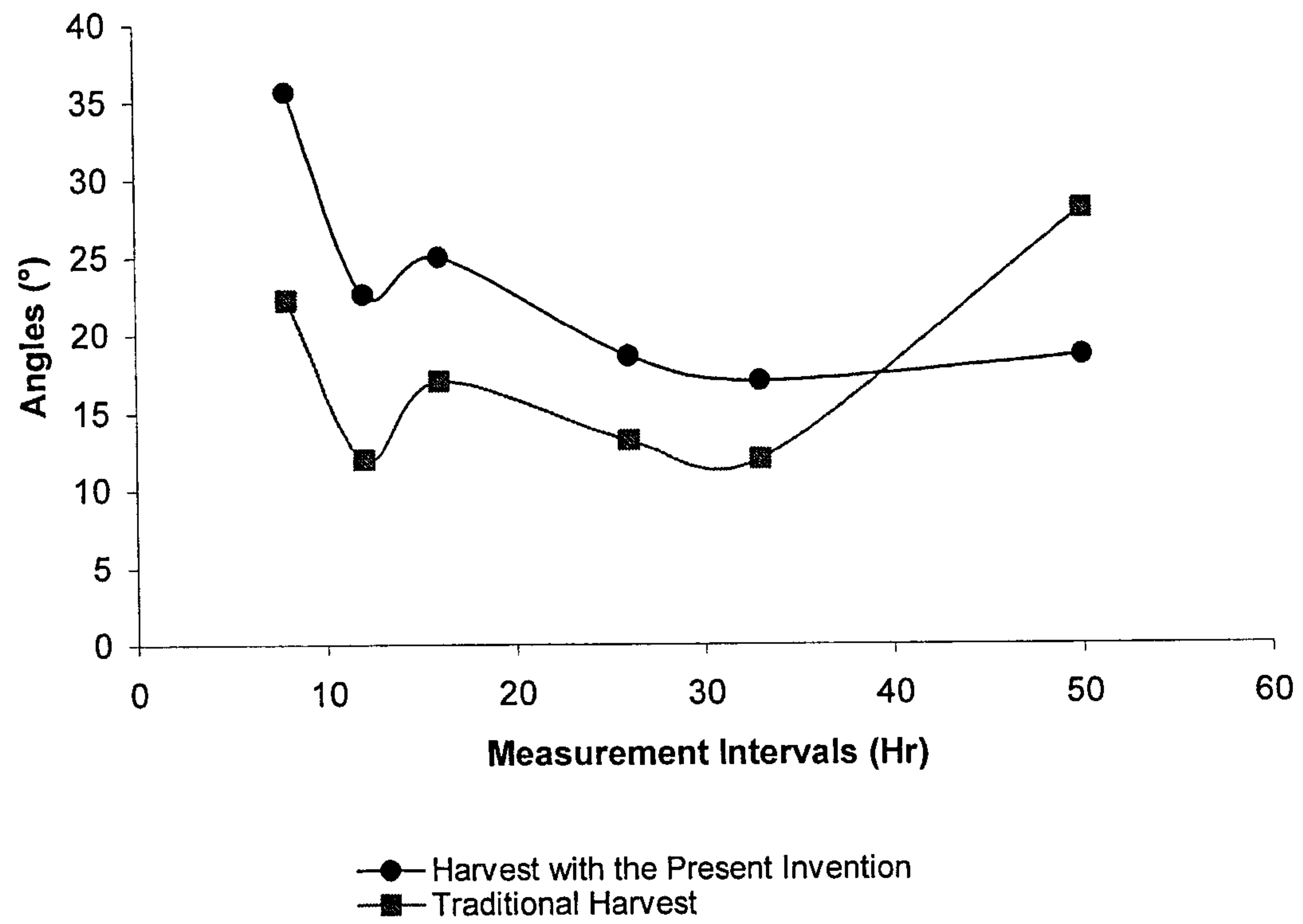
Figure 9

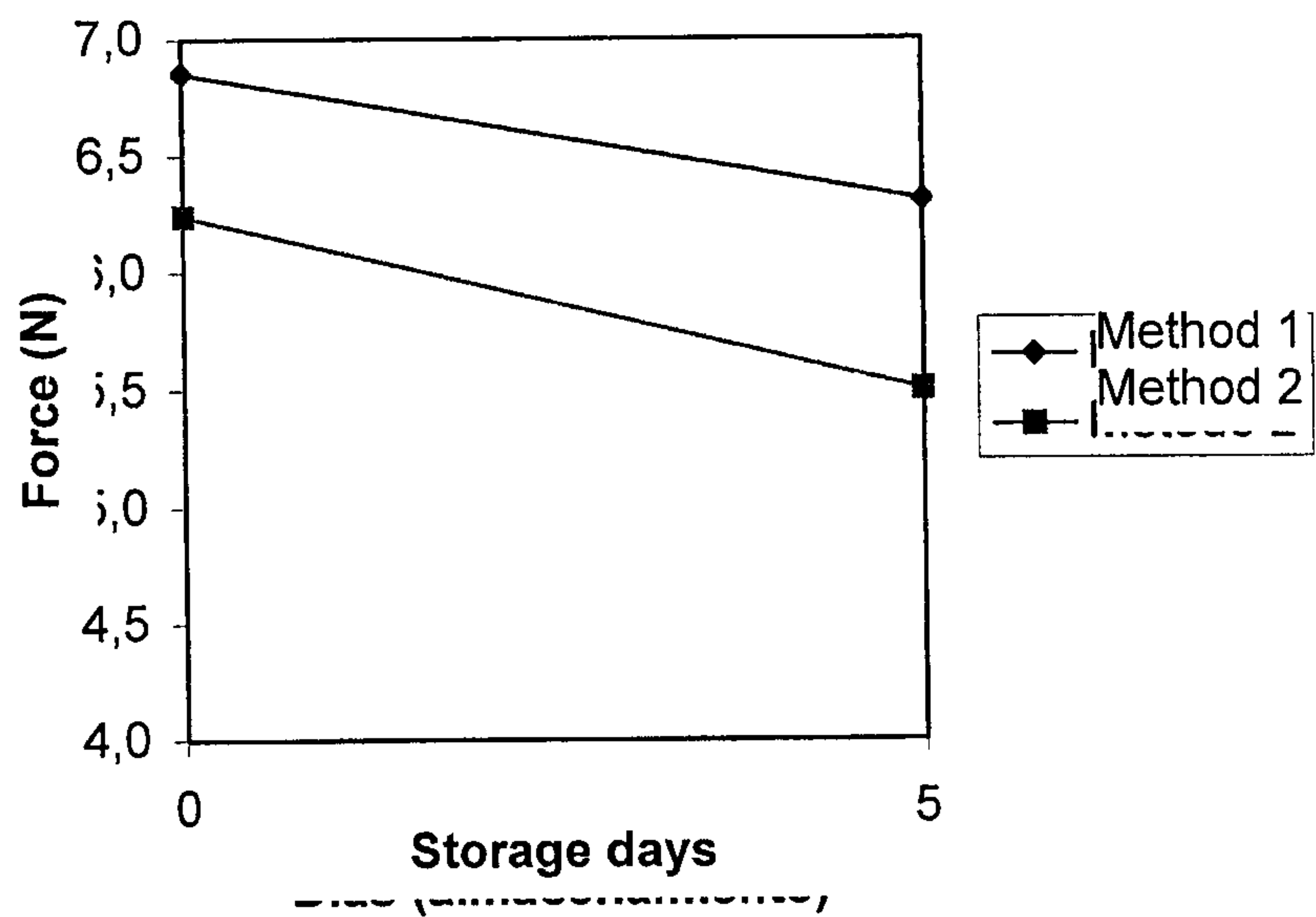
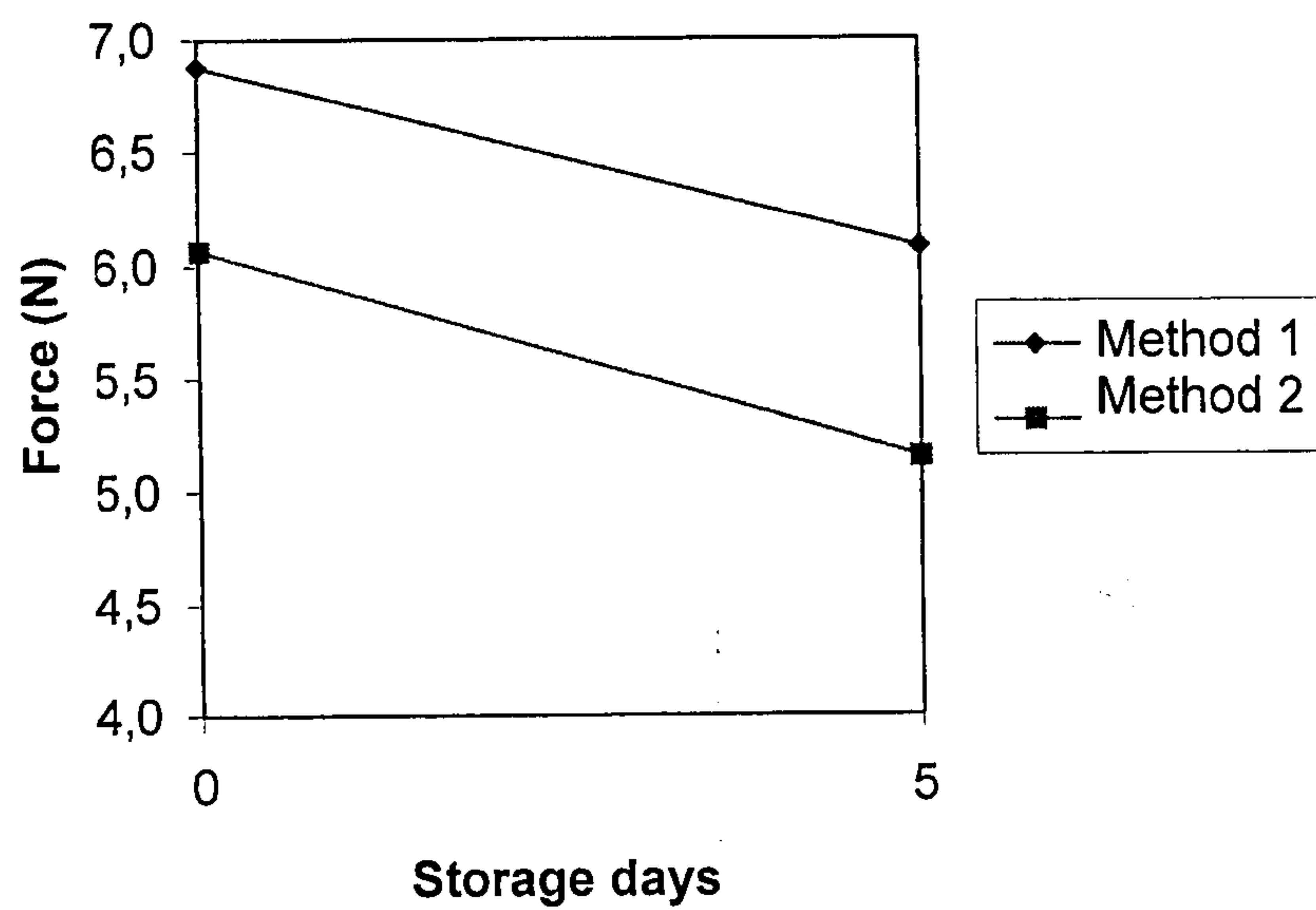
Figure 10 Pt. AFigure 11 Pt. B

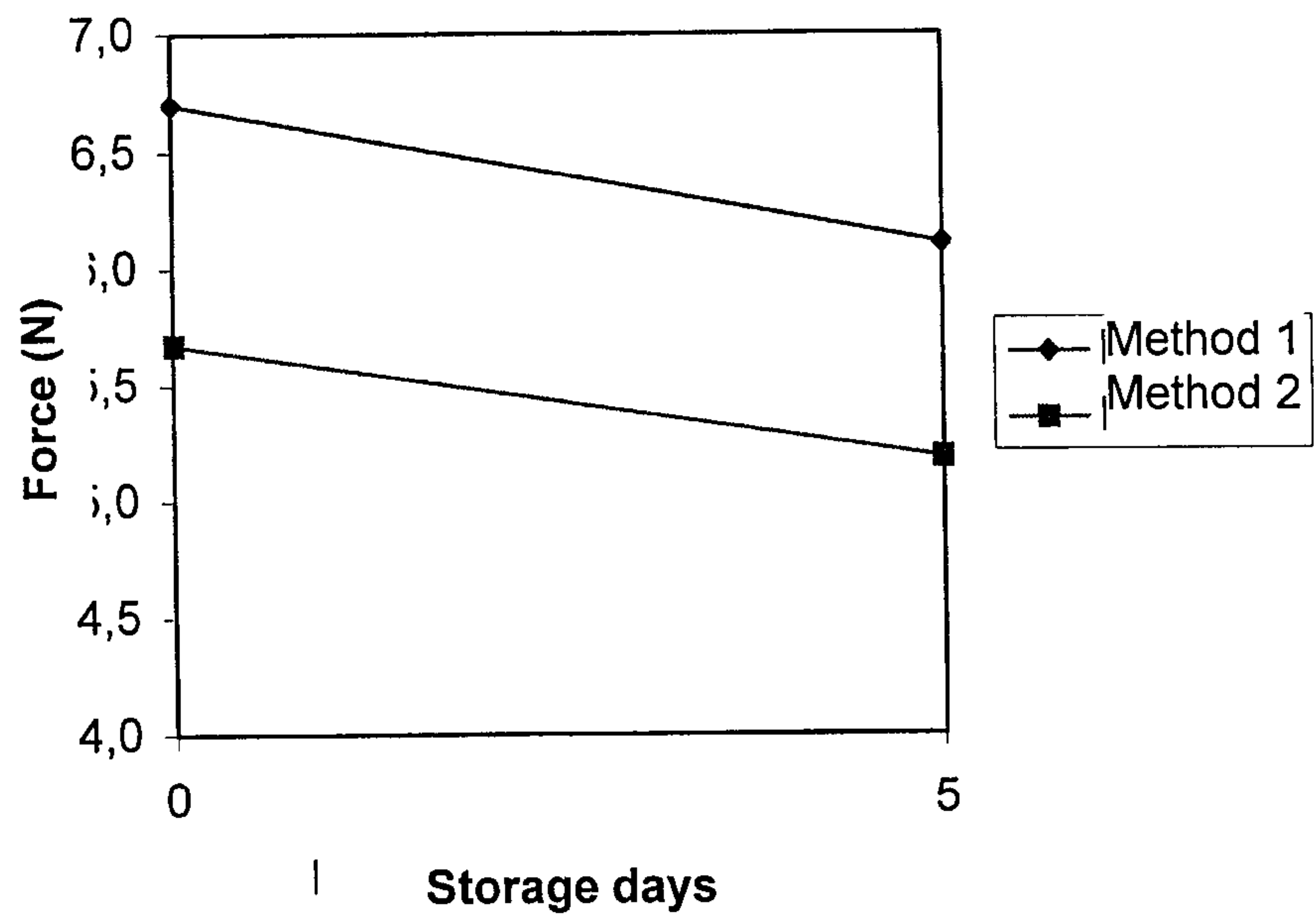
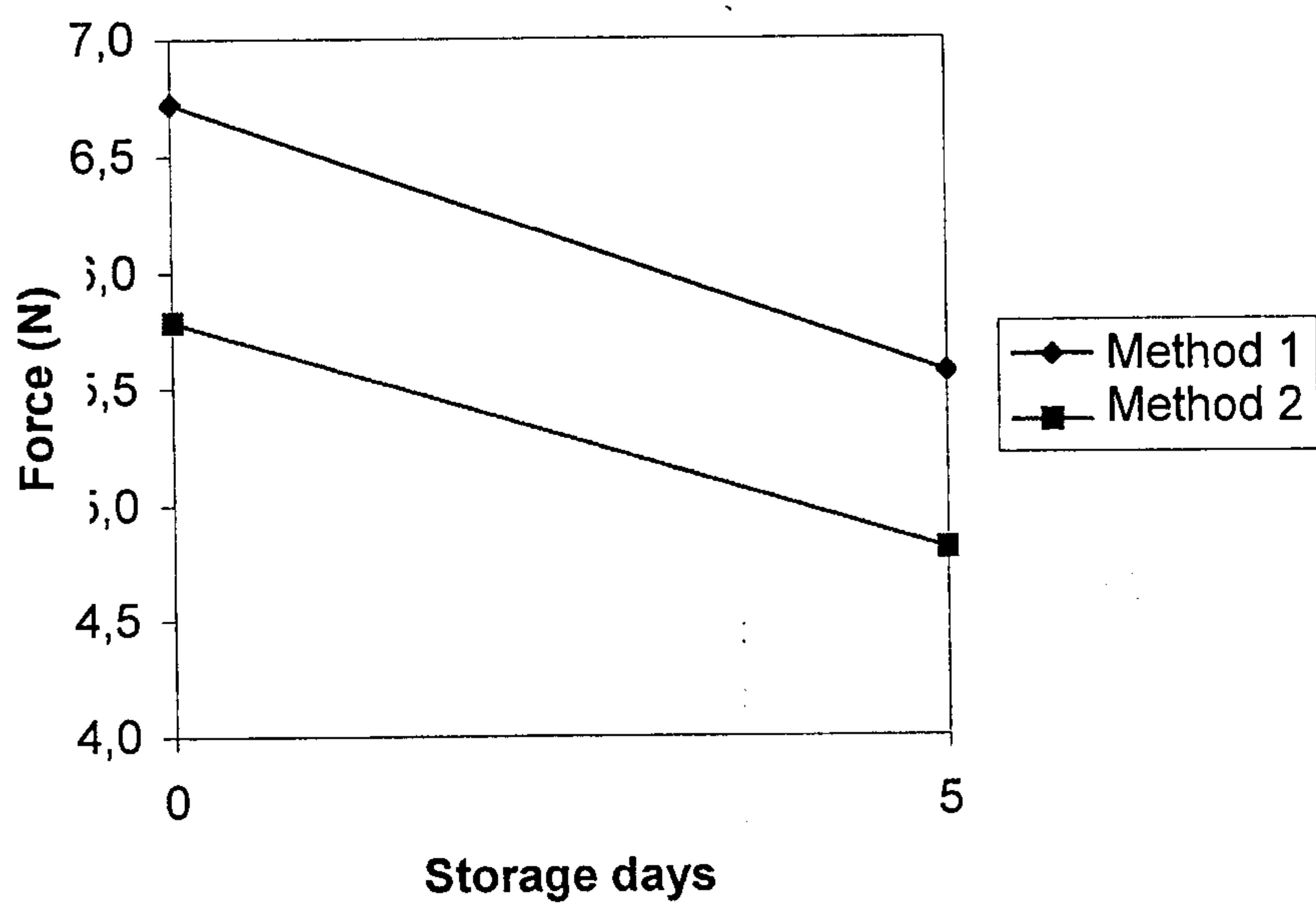
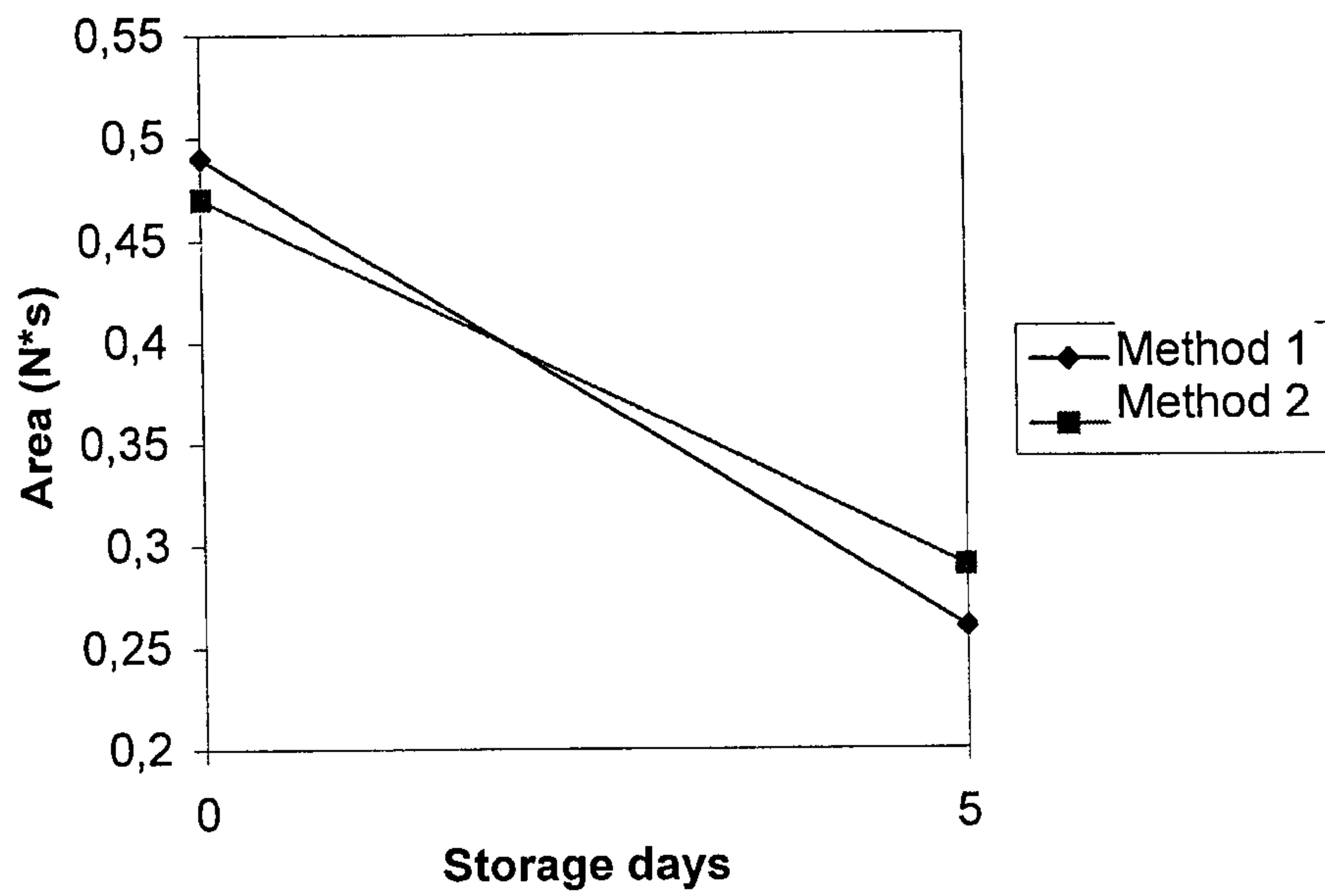
Figure 12 Pt. AFigure 13 Pt. B

Figure 14 Pt. AFigure 15 Pt. B