(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 707 078 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.04.1996 Bulletin 1996/16

(51) Int. Cl.[6]: **C13D 1/02**, C13D 1/04

(21) Application number: 94402832.3

(22) Date of filing: 09.12.1994

(84) Designated Contracting States:
BE DE DK FR GB

(30) Priority: 26.09.1994 AU 74195/94

(71) Applicant: Rivière, Maxime
97441 Sainte Suzanne (RE)

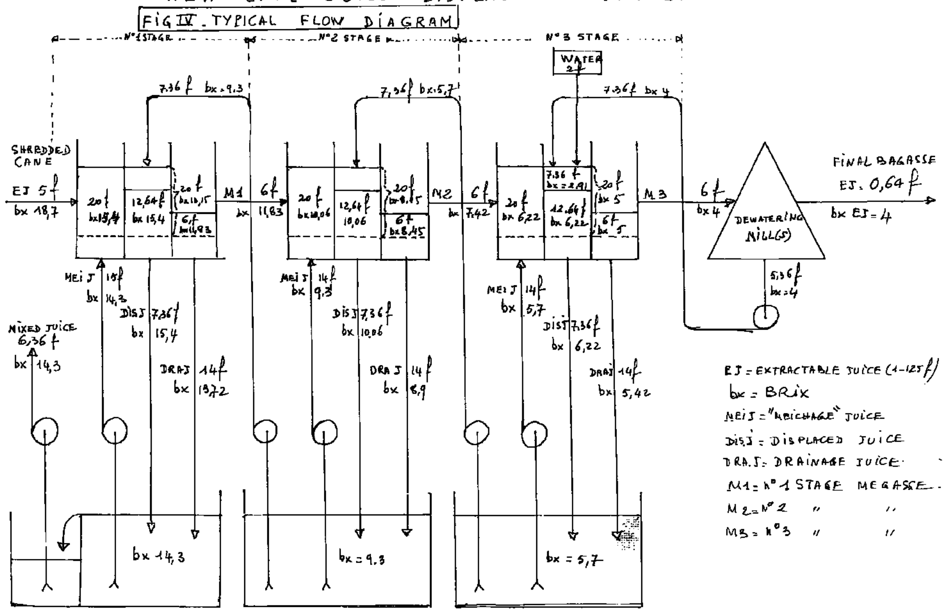
(72) Inventor: Rivière, Maxime
97441 Sainte Suzanne (RE)

(54) New canejuice displacement process

(57) 1 - Industry concerned : Cane Sugar Manufacture
2 - Part of the process to which the invention pertains : Extraction of the sugar cane juice.
3 - In the prepared raw material (shredded cane) up to 94 % of the juice containing cells are open.
If has a low bulk density and high void volume (filled with air)
The gist of the invention is to take advantage of this specific structure to improve the efficiency of the extraction process by :

- Avoiding compaction to maintain high percolation rate
- Filling the voids with recirculated juice thus turning the solid mass of shredded cane into a free flowing mixture of cane and juice.
- Replacing,in three stages,the thick juice of cane by thinner juices and finally by water,in a true plug flow displacement process.
- Improving the efficiency the solid/liquid separation between stages by increasing hydrostatic head between the liquid mass in the extractor and the discharge tank.

NEW CANE JUICE DISPLACEMENT PROCESS
FIG IV. TYPICAL FLOW DIAGRAM



EP 0 707 078 A1

Printed by Rank Xerox (UK) Business Services
2.11.2/3.4

Description

1 - STATE OF THE ART OF JUICE EXTRACTION FROM SUGAR CANE

1.1 - Preparation

The first step is to open the juice containing cells so that the extractable juice of cane be readily available for leaching or displacement.

In modern sugar factories the use of heavy duty shredders can open up to 94 % of the cells

1.2 - Juice extraction by dry pressure

80 to 84 % of the extractable juice % cane [(1)] can be extracted by dry pressure in a mill. Sugar (Pol) extraction is from 60 to 80 %. For higher extraction, imbibition have to be resorted to. The aim of imbibition is to dilute the extractable juice of cane before the final juice extraction by pressure.

1.3 - Juice extraction by the leaching process in milling

In conventional milling, n° 1 mill bagasse is processed in a counter-current multistage dilution process. In each stage, two separate operations take place :

- The extractable juice in bagasse is diluted in a leaching process by thinner juice coming from the down stream stage and finally by imbibition water.
- Then the mixed juice is separated from the fiber by pressure in a mill - the solid/liquid separation is quite efficient as we have seen in dry crushing. But as 4 to 7 mills are needed, to achieve the desired extraction rate (95 to 98 %) , using 3 to 6 imbibition stages, the process of extraction by milling has the following disadvantages : high investement and maintenance costs, high energy consumption.

Further more, the stage efficiency (as measured by the Murphree criterion [(2)] is surprisingly low for an industrial process (25 to 35 %)

For all these reasons the use of mills for the extraction of juice has been denounced many times by the most famous authors. For instance in 1929, Francis Maxwell [(3)] (the author of the famous handbook "Modern milling of sugar cane") wrote : Mills in action "are somewhat reminiscent of the cave age ; sheer brute force, huge wearing masses of metal, vast amount of power and enormous pressure".

In his famous "Handbook of cane sugar technology" Emile Hugot says : "milling is a barbaric system of extraction".

All attempts to improve stage efficiency, in order to reduced the number of mills used, never achieved commercial success.[(1)]

1.4 - Juice extraction by the leaching process in cane "Diffusers"

Since the 1970's there has been in some countries (mainly in South Africa) a conversion from milling to diffusion. But cane diffusers were developped empirically from beet diffusers or from countercurrent extractors used in other industries. It was not the resullt of a scientific approach as recommended by F. Maxwell in 1929 : "Scientific examination of the factors in question... should give way to more rational means, to induce the juice to leave its cellular abode".

Commercial diffusers now in use are cheaper and less energy consuming than mills but the stage efficiency in diffusion is not any better than in milling. The number of stages used which should be between 4 and 7 (depending on the imbibition rate) assuming 100 % efficient mixing, is between 15 to 18 (so that the stage efficiency is between 4/15 (26.7 %) to 7/18 (38.9 %)

[(1)] Extractable juice % cane = 100-1.25 F If fiber % cane (F) is 16 then extractable juice % cane is 80 %

[(2)]

$$\text{Stage efficiency} = \frac{\text{achieved drop of brix through stage}}{\text{achievable drop of brix, (assuming 100 \% efficient mixing)}}$$

[(3)] "A comparative survey of milling in Cuba, Hawaii and Java" (Proceedings ISSCT 3rd Congress).

[(1)] Even when they proved to be efficient (95 %) as was the case for the patented process of imbibition under vacuum 1975 (FCB and Maxime Rivière).

2 - THE DISPLACEMENT PROCESS : A DEPARTURE FROM THE LEACHING PROCESS

2.1 - According to Noel Deer (Cane sugar handbook" 1921) the concept of "Substitution or displacement extraction" (as opposed to the mixing/separation process still used now-a-days) was patented by Matthey in 1889. [2]

In 1962, John Payne [3] pointed out the advantages of the displacement process.

In 1968, the same author reported [4] the implementation, in Hawaii, of the displacement process both on pilot plant and in a commercial diffuser.

The advantage of displacemennt on mixing/separation can best be demonstrated by the Ponchon-Savarit diagram :

- Fig.I is the Diagram of a conventional 5 mill tandem [5] It shows that the brix of the extractable juice in bagasse leaving a given stage is much higher (5 to 7 points) than the juice separated from the same stage.

- Fig.II is what the diagram should be (n° 2 mill bagasse should have the same brix of extractable juice as the juice (J2) coming out of the first stage : 100 % mixing efficiency).

- Fig.III is the Ponchon-Savarit diagram, applied to a fully efficient displacement process : the brix of the juice displaced in a given stage is always higher by at least 2 points [6] than the brix of the extractable juice of the bagasse leaving the same stage.

If displacement were really taking place in a diffuser, 3 stages only would be enough to achieve 98 % extraction, using an imbibition rate of 200 % on fiber.

In the Silver diffuser exemplified by John Payne in his book (Unit operations of cane sugar production) the number of stages used is 18. In fact, as John Payne himself has to admit, some mixing is taking place and the process is still far from the desired "plug flow displacement process".

3 - THE NEW CANE JUICE DISPLACEMENT PROCESS

In a scientific approach in the design of an extraction plant based on the displacement principle, the structure and the volumetric composition of the raw material should have been taken into consideration.

Bulk density of shredded cane depends on preparation and compaction.

On a horizontal conveyor, if the bed of cane does not exceeds 0.5 meter, the bulk density may vary from 250 to 350 Kg/cubic meter.

It means that one ton of cane, in this condition, with little compaction, will occupy an apparent volume of between 2.8 to 4 cubic meters.

The no void volume of cane being 0.89 cubic meter per ton, the void volume in a bed of shredded cane of less than 0.5 meter is between 2.8 - 0.89 = 1.91 cubic meter/ton of cane and 4 - 0.89 = 3.11 cubic meters per ton of cane.

Assuming a fiber content of 150 Kg per ton of cane (F = 15), the amount of juice (of say 1.05 density) necessary to fill the voids is between 1.91 x 1.05 = 2 tons and 3.11 x 1.05 = 3.29 tons or 2000/150 = 13.33 F and 3260/150 = 21 F.

In the experimentation on a pilot plant, on which this patent is based, the amount of juice to fill the voids was between 15 F to 20 F.

What is the volumetric composition of the material (shredded cane + added juice, called "megasse") in a commercial diffuser?

The upper layer of shredded cane (0.5 meter) probably has the same composition as measured in the above experiments. But, due to compaction, specially in the bottom layer of shredded cane, the bulk density is probably two to three times higher.

According to E. Hugot, the average bulk density (counted on cane only) is between 500 to 600 Kg cubic meter. Which means that the average apparent volume occupied by one ton of cane must be between 1.67 to 2 cubic meters. Deducting the no void volume of cane, this leaves a void volume of between 0.78 to 1.11 cubic meter. The filling of this void volume of with 1.05 density juice will require 819 Kg to 1.655 Kg of juice.

What is the amount a displacement juice added to the shredded cane in a commercial diffuser?

According to the operation results published [1] for a Silver diffuser in Hawaii, the maximum amount of juice that can be

[2] English patent n° 21021

[3] "The processing of sugar cane into juice and fiber "Proceedings ISSCT 1962

[4] "Cane diffusion : the displacement process in principle and practice" Proceedings ISSCT 1968"

[5] Maxime Rivière "Must we abandon mills" Revue agricole et sucrière de l'Ile Maurice Vol 55 n° 1 and 2, p.79 (1976)

[6] According to the experimentation on pilot plant on which the present patent application is based.

[1] John Payne - Diffusion : the displacement process in principle and practice proceeding ISSCT 1968.

used without flooding was 5.6 F. The average fiber content of cane in Hawaii being 13.5, the weight of juice added per ton of cane was 5.6 x 135 = 756 Kg.

The corresponding volume of juice added was 0.720 m3/ton which leaves, on average, a volume of air in the mat of cane of between 0.78 - 0.72 = 0.06 to 1.11 - 0.72 = 0.39 cubic meter of air per ton of cane. (But, as we have seen, in the upper layer of the bed, the volume of air is between 2 and 3 cubic meters per ton of cane).

This may be one of the reasons of the low stage efficiency of commercial diffusers, the presence of air impairing the mixing efficiency (or the displacement efficiency).

But the main disadvantage of the operation of a leaching or displacement process through a bed of cane of 1.5 to 2 meters thick, as is the case of most commercial diffusers, is the low percolation rate (0.1 meter/minute) due mainly to compaction. Stage efficiency is low because of the by passing of the stages : Percolating angles ranging from 57 degrees from the horizontal in the first stage to 14.5 degrees in the third stage have been reported.

This does not happen in the process presented in this patent application :

- using cane beds of between 0.3 to 0.5 meter
- with complete removal of air between the cane shreds, and
- increased hydrostatic head, giving a percolation rate of 0.1 meter per second.

MEICHAGE

Removal of air was considered fundamental for efficient batch diffusion in the beet sugar industry. It is called by the ancient name "meichage" in the North of France.

Meichage was used In Egypt in the early 1930's in the Naudet process of bagasse batch diffusion.

F. Maxwell [(1)] had the opportunity of observing the operation of this process. This is how he describes it : "Meichage" : After filling the first cell of the diffuser with bagasse... "the cell having been closed, juice is allowed to gravitate... into the bottom of the cell, and to rise through the column of bagasse until it emerges from a cock on the lid of the cell, when it is turned off. By this operation, the air contained in the bagasse is removed".

This was performed in a 3000 TCD factory. An extraction rate of 98 % and higher purity juice was reported [(2)]

The object of the present patent is to make the cane juice displacement process efficient by resorting to "meichage" in a continuous cane juice extraction equipment.

The validity of the process has been proved in a pilot plant simulating the displacement, in three stages, of the extractable juice in cane, achieving an extraction rate of 98 %, after dewatering in a hydraulic press to a moisture content similar to what can be achieved by a conventional last mill.

4 - DESCRIPTION OF THE PROCESS

4.1 - Ponchon-Savarit diagram

From the results of the pilot plant experimentation, the number of stages to be used was determined by the Ponchon-Savarit diagram (Fig.III), assuming the following operational conditions :

- a typical composition of the raw material : shredded cane :
  - preparation index 90 %
  - fiber 16 %
  - extractable juice content 80 % (: 5 F)
  - brix of extractable juice 18.7
- an imbibition rate of 200 % on fiber (2 F)
- a final "megasse" with an extractable juice content equal to 6 F
- a brix of the extractablle juice in the megasse, leaving a given stage, 2 points lower than the brix of the juice coming out of the same stage.

The target of 4 brix of juice in the final megasse (corresponding to a Pol extraction rate of 98 %, assuming a final dewatering giving a juice content of the bagasse of 0.64 F) is reached in three stages.

(1) "Modern milling of sugar cane" 1932

(2) Spencer and Meade : "Cane sugar Handbook" eight edition,p.55

4.2 - Flow diagram

With the above operational conditions, the flow diagram (Fig.IV) can be drawn. In each stage, for a 100 % efficient displacement process to take place, 3 operations have to be implemented.

A - FIRST STAGE

1 - Meichage
Given an average typical shredded cane bulk density, the amount of "meichage" juice needed to completely fill the voids between the cane shred is 15 F, giving an initial total juice content of the megasse in the first stage of 20 F at 15.4 brix, using as meichage juice 15 F at the same brix (14.3) as in mixed juice leaving the 1rst stage.

2 - Displacement is performed using the juice (7.36 F, brix 9.3) coming out of the second stage to replace the same amount (7.36 F) of juice at 15.4 brix contained in the megasse, which is thus extracted by displacement.

3. Drainage
Before leaving the first stage the juice content of the megasse (after displacement,it contains 20 F of juice at an average brix of 13.15) is drained by gravity in a receiver tank, down to a juice content of 6 F in the megasse leaving the first stage.
The amount of drainage juice, according to the experimentation, would be 14 F at a brix of 13.72. This juice has to be recirculated as "meichage" juice together with 1 F of the displaced juice (7.36) with a mixed brix of 14.3, leaving 6.36 F at 14.3 brix as juice extracted from the first stage to match the overall balance :

- juice in : 5 F from the cane + 2 F as imbibition water = 7 F

- juice out : extracted juice (mixed juice) 6.36 F + 0.64 F as extractable juice in the final bagasse = 7 F

B - SECOND STAGE

- Meichage As the megasse will have the same juice content (6 F), in and out of the stage, the meichage juice will be 14 F in this case (instead of 15 F in the first stage).

- Displacement juice (7.36 F) coming from the 3rd stage at a brix of 5.7 will displace the same amount (7.36) of juice at 10.06 brix.

- Drainage of 14 F at 8.9 brix will leave 6 F as juice content of the megasse feeding the 3rd stage.

C - THIRD STAGE

- "Meichage" :

As in the 2d stage the meichage juice (14 F) will be supplied by the drainage juice with a mixed brix of 5.7

- Displacement :

The dewatering mill juice (5.36 F) will be used as displacement juice, followed by imbibition water 2 F
The brix of the displaced juice (7.36 F) will be 6.22

- Drainage :

14 F of juice at 5,42 brix will be drained from the 3rd and last stage, giving:

- a juice content a 6 F in the final megasse a the target brix of 4
- a mixed juice (displaced + drain juice) of 21.36 F at 5.7 brix matching the meichage juice (14 F) and the displacement juice for the 2d stage (7.36 F).

5 - DESCRIPTION OF AN INDUSTRIAL CONVEYOR FOR THE IMPLEMENTATION OF A CONTINUOUS THREE " STAGES DISPLACEMENT PROCESS (FIG.V)

5.1 - Displacement

A conventional horizontal drag type conveyor can be used to move the prepared cane delivered by the shredder to the dewatering mill.

The speed of the conveyor (approximately 20 meter/minute) is set according to the cane flow so that a layer of about 0,3 meter is moved along, over the perforated bottom **(1)** of the conveyor.

The conveyor has a closed double bottom **(2)** with compartments and piping to comply with the flow diagram in each of the 3 stages.

In each stage : 3 sections are provided

a) "Meichage" section :
"Meichage" juice is supplied from tank 8 by a variable speed pump **(3)** at a rate of 15 or 14 F (as required in each stage) at a controlled pressure, monitored by the level of juice that will just cover the surface of the mat of cane leaving the meichage part of the conveyor.

b) Displacement section :
To prevent mixing the section of the conveyor devoted to displacement is fed in a rain tray **(4)** pattern. This is obtained by using the upper deck of the conveyor and the return drag chain as a distributor of the juice over-flowing from the displacement juice trough **(5)**
The discharge pipe of the displacement section of the double bottom is controlled by an automatic valve **(6)** to keep the level of juice just above the surface of the cane bed. The displaced juice is discharged in tank **(8)**

c) The drainage section
The double bottom of the drainage section, in each stage, is connected to the discharge tank **(8)** through pipe **(7),** fitted at the bottom with automatic valve **(6)**. This valve is monitored by the level of juice in the cane mat, so that the draining pipe is always kept full of juice.
This description is common to the three stages (see Fig. V).

5.2 - Dewatering

The megasse is discharged from the last section of the displacement conveyor into the chute **(9)** feeding the pre-extractor (PE)
The preextractor consists in conventional 4 roller mill from which the trash plate and the delivery roll have been removed. It is a tilted 3 roller mill set to remove half of the juice content (6 F) of the megasse.

The bagasse coming out of the preextractor is conveyed by a closed chute (Meinecke chute) (C) to the bottom of the conventional bagasse elevator (E) feeding the (Donelly) chute of the final dewatering mill (DWM) which is a conventional 4 roller mill receiving the usual juice content (3 F) consisting, in a conventional milling tandem of the juice content (IF) of the second last mill bagasse and of the imbibition water (2 F) added in front of the last mill.

5.3 - Juice circulation between stages

The dewatering juice coming from the preextractor (3 F) and the final dewatering mill (2.36 F) are pumped at the rate of 5.36 F to the displacement juice trough (5) of the third stage by pump (10).

Similarly displacement juice from the third stage is pumped from tank 8 by pump (10) to the displacement juice trough (5) of the second stage.

Displacement juice for n° 1 stage is pumped from 2nd stage tank (8) by pump (10) to N° 1 stage displacement juice trough.

5.4 - Mixed juice from the displacement extraction plant

The juice extracted from the plant overflows from receiving tank (8) of the first stage into a pump feed tank (11) from which it is pumped at the rate of 6.36 F as mixed juice to the process.

5.5 - Important

To ensure sufficient hydrostatic head for the plug flow displacement process and for quick drainage of the megasse leaving each stage, the level of juice in the receiving tank **(8)** in each stage must be at least 2 meters, and preferably between 3 to 4 meters lower than the level of juice in the conveyor (top of the cane bed).

6 - DESCRIPTION OF AN ALTERNATIVE TYPE OF EQUIPMENT FOR THE IMPLEMENTATION OF CANE JUICE DISPLACEMENT PROCESS.

The conventional drag type conveyor can be used for juice extraction by the displacement process, only up to a capacity of 5/6000 tons of cane per day, because of the following limitations :

- The width of the conveyor trough is limited to that of the dewatering mill to be fed by the conveyor (mill roller length 2.1 meters).
- The thickness of the bed of cane that can be moved along by this type of conveyor is limited to some 300 m/m
- The speed of the conveyor is limited to some 25 meters per minute.

For higher capacities, another type of equipment have to be used : The cross flow displacement system FIG. VI

6.1 - The cross flow displacement system (FIG.VI)

As explained previously, the displacement process can only be performed efficiently when the juice content of the megasse is at least 20 times the fiber content of the cane - which means that the fiber content of the megasse must be less than 1/20 or 5 %.

In this condition, megasse has the hydrodynamic characteristics of a liquid.

In fact, up to 7 % fiber content, such a slurry can be pumped. With a juice content of 20 F, megasse will flow freely, by gravity in an open trough.

So mechanical handling in a displacement process is not needed during meichage and displacement. Only when drainage is taking place, the drier material will need mechanical handling.

The "cross flow displacement process" described in this patent application is based on the above considerations.

6.1.1. - Turning shredded cane (or drained megasse) into a free flowing slurry FIG. VI)

Part of the meichage juice (10 F) is incorporated into the solid feed, while it is thinned out by a macerotor **(1)** (Spiked drum as shown on Fig. VI, rotating at 300 RPM).The slurry (juice content 15 F) is thrown down a curved plate **(2)**

6.1.2. - Meichage

Additional meichage juice (5 F) is applied through double bottom and perforated plate **(3)** of the open trough in which the slurry (juice content increasing from 15 F to 20 F) will flow by gravity towards the displacement section.

6.1.3. - Cross flow displacement and drainage

When displacement is taking place, the juice content of the megasse remains 20 F, the displaced thick juice at the bottom being replaced on top by an equal amount of thin displacement juice (or water). So, in the displacement section, the megasse is still flowing freely by gravity.

But this time, as the juice is flowing down through the perforated bottom, the latter has to be scraped to prevent clogging. This is achieved by a perforated drum **(4)** fitted above a curved perforated bottom.

This drum serves two purposes :

- it scrapes the perforated bottom in the displacement section
- it moves along the megasse in the drainage section when the megasse becomes solid again.

The last function is performed by spikes (0.3 to 0.5 meter long) **(5)** welded on a perforated drum (2 to 3 meters in diameter) along 12 generating lines. Each row (with spikes 50 m/m apart) will act as a fork to move the megasse towards the discharge section while allowing the juice to drip through, to achieve drainage.

The diameter of the drum, length of the spikes and speed (1 to 2 RPM) are chosen to suit the desired escribed volume.

The scraping action is performed by a scraper plate **(6)** welded on the tip of the spikes along each row.

The perforated bottom being kept clean, the displacement juice can move down accross the flow of megasse.

Displacement juice is admitted inside the perforated drum, above the displacement section.
For that purpose the perforated drum is open at each end. A thick steel disk is welded inside the perforated drum, half way between the ends. This disc is welded to a hub, wedged to the shaft. The drum is driven by a hydraulic or electric variable speed motor, at a speed of 1 to 2 RPM.
Displacement juice can be admitted inside the perforated drum (in a distribution box **(7)** from each end, through the flanges from an outside box in which the level of juice can be controlled so that no air is admitted. In this way, displacement juice, uniformly distributed over the megasse in the displacement section, can flow across and collect into the double bottom, from which it drains to the receiving tank below. The flow of displaced juice is controlled by an automatic valve on the discharge pipe monitored by the level in juice box **(8)**

Drainage

Drainage takes place when displacement has been achieved. In the drainage section, air being admitted on top of the bed, the remaining juice is pulled down by the hydrostatic head (2 to 4 meters) between the top of the bed of cane and the level of juice in the receiving tank below, through pipe **(9)**

6.1.4. - Discharge

Drained megasse is discharged by gravity at an angle of 60 degrees, to the feed side of the next stage.
To clear the perforated plate and spikes and to help the discharge of the megasse to the next stage, meichage juice from the next stage is admitted into distribution box **(10)**, through the flanges on each side.
From there starts the next stage in which the same operations are performed in the same sequence.

1- Thinning out and wetting the megasse to a juice content of 15 F using a macerotor
2- Meichage through double bottom and perforated plate
3- Displacement
4- Drainage

Three stages are used, as for the drag type displacement conveyor.
The flow diagram is as shown for the drag type conveyor system (FIG V)

Claims

The cane juice extraction process, for which a patent is applied for, is a complete departure from the existing commercial extraction processes : Milling and Diffusion.

The proposed new cane juice extraction process is the first continuous juice extractor, achieving the replacement of the extractable juice in cane by thinner juice and ultimately by water, in three stages only, using, in each stage, 100 % efficiency plug flow displacement process.

1. In diffusion as in milling the material from which juice is extracted, is in a solid state and has to be moved along by conveyors.
In the proposed new process juice extraction takes place while the juice containing material is in a free flowing liquid state.

2. In milling and diffusion, the leaching process used for juice extraction is impaired by the presence of air (up to 60 % of the apparent volume in the top layer of shredded cane in a diffuser and up to 80 % in mill bagasse.
In the proposed new process all air is removed from the juice containing material, prior to extraction by displacement. The displacement juice acts as a liquid piston pushing down the cane juice across the main flow of the cane slurry and through the bottom perforated plate.

3. Diffusion was designed for extraction of sugar from beet by osmosis from inside the unbroken sugar beet cells, (in shredded cane, up to 94 % of the cells are opened prior to juice extraction). Osmosis being a time consuming process, residence time in the diffuser has to be increased by slowing down the conveying speed of the material so that throughput can only be maintened by increasing the thickness of the bed of material in the diffuser. When used in the sugar industry such diffusers using deep bed of cane induces compaction of the shredded cane in the bottom layer, thus reducing the percolation rate.
In the proposed new cane juice extractor, a much thinner bed of shredded cane is used thus avoiding compaction and retaining good permeability.

4. In diffusers, the driving force for the liquid percolating through, that is to say hydrostatic head is limited to some 1.5 meter of a mixture of juice and air.
In the proposed new extraction process, hydrostatic head can be increased up to 4 meters of fully liquid column (no

air) thus ensuring a percolation rate which, in the experimentation on pilot plant, was 60 times higher than measured in existing commercial diffusers.

5. Finally 98 % Pol extraction can be obtained by the new process, using only a small fraction of the investment and maintenance costs of milling or diffusion and saving 50 to 70 % of the energy used in the existing commercial cane juice extractors.

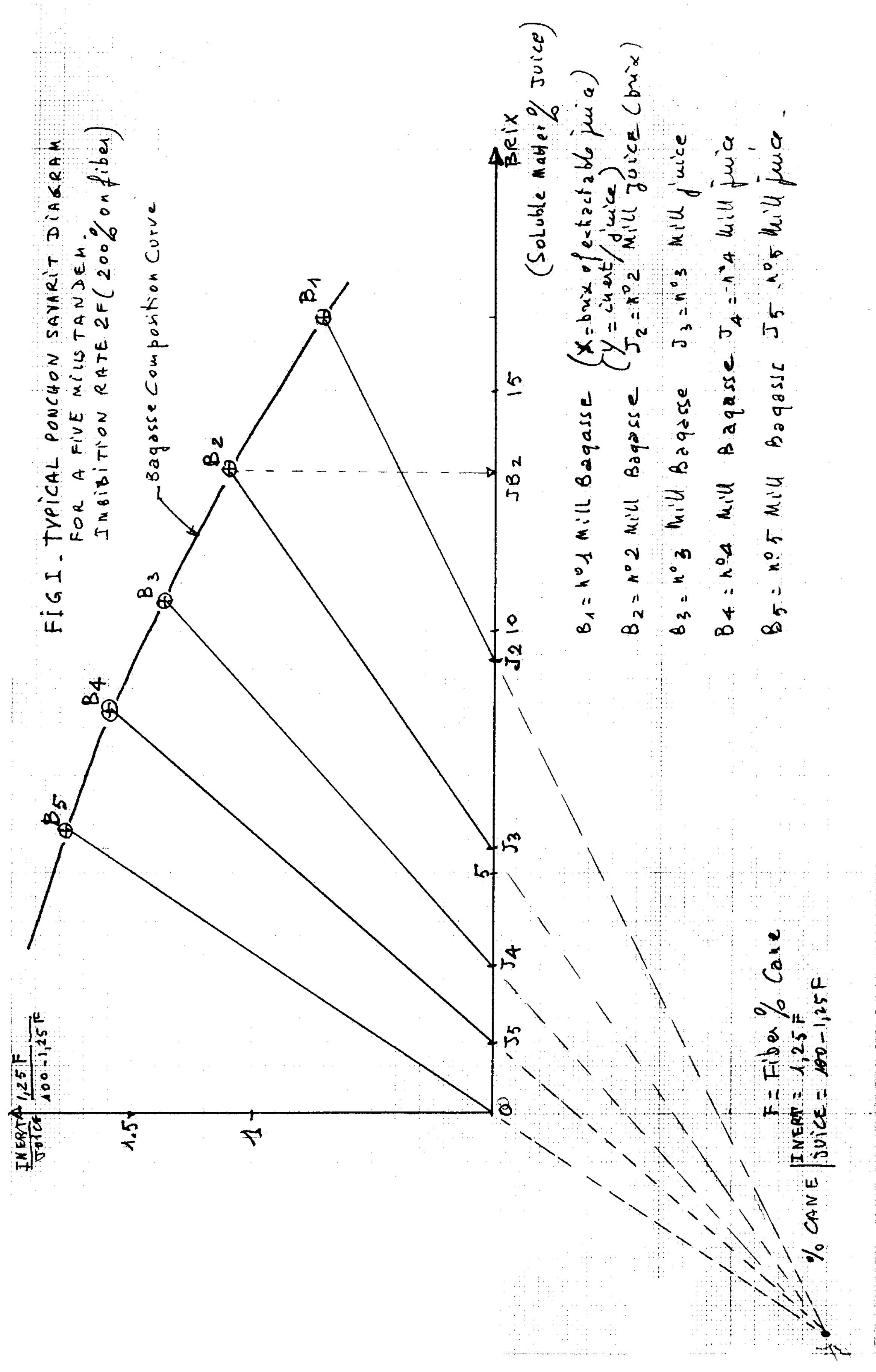


FIG I. TYPICAL PONCHON SAVARIT DIAGRAM
FOR A FIVE MILLS TANDEM.
IMBIBITION RATE 2F (200% on fiber)
Bagasse Composition Curve
BRIX
(Soluble matter % Juice)
INERT/JUICE 1,25 F / 100-1,25 F
1,5
1
0
5
10
15
J5
J4
J3
J2
JB2
B1
B2
B3
B4
B5
F
B1 = n°1 Mill Bagasse (X = brix of extractable juice) (Y = inert/juice)
B2 = n°2 Mill Bagasse J2 = n°2 Mill Juice (brix)
B3 = n°3 Mill Bagasse J3 = n°3 Mill juice
B4 = n°4 Mill Bagasse J4 = n°4 Mill juice
B5 = n°5 Mill Bagasse J5 n°5 Mill juice.
F = Fiber % Cane
% CANE
INERT = 1,25 F
JUICE = 100-1,25 F

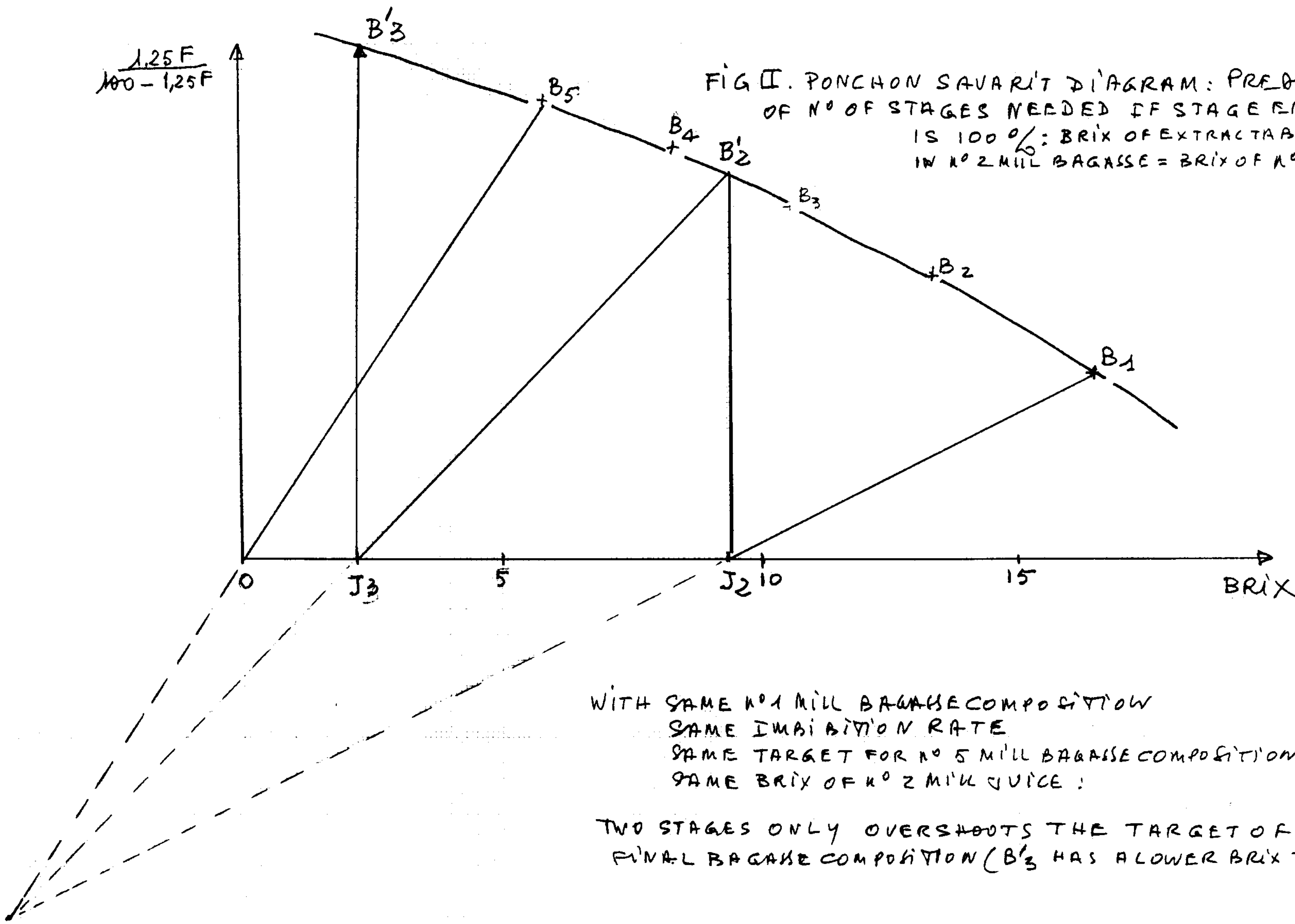


FIG II. PONCHON SAVARIT DIAGRAM: PREDICTION OF N° OF STAGES NEEDED IF STAGE EFFICIENCY IS 100 %: BRIX OF EXTRACTABLE JUICE IN N° 2 MILL BAGASSE = BRIX OF N° 2 MILL JUICE

WITH SAME N° 1 MILL BAGASSE COMPOSITION
SAME IMBIBITION RATE
SAME TARGET FOR N° 5 MILL BAGASSE COMPOSITION
SAME BRIX OF N° 2 MILL JUICE :

TWO STAGES ONLY OVERSHOOTS THE TARGET OF FINAL BAGASSE COMPOSITION (B'3 HAS A LOWER BRIX THAN B5)

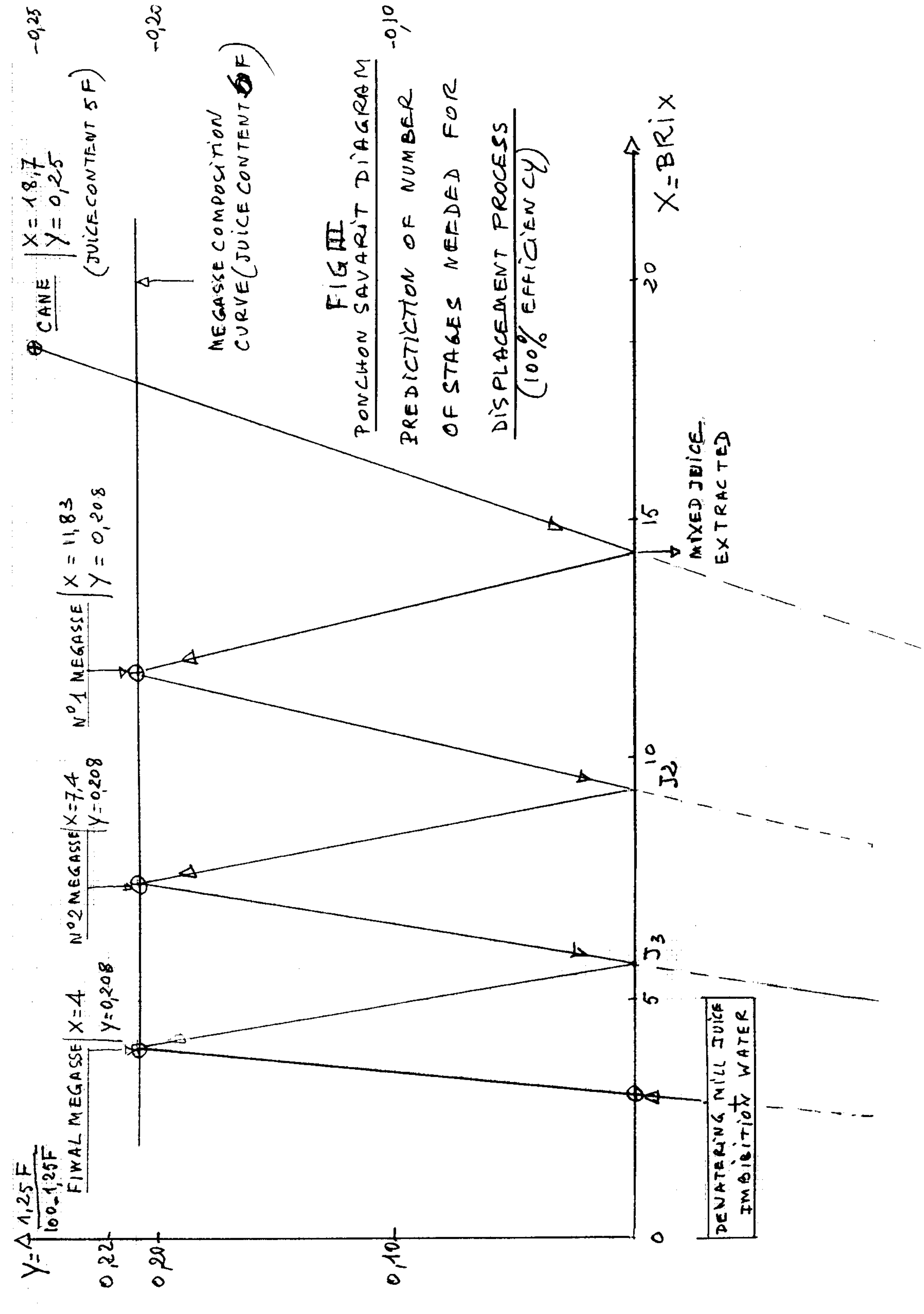
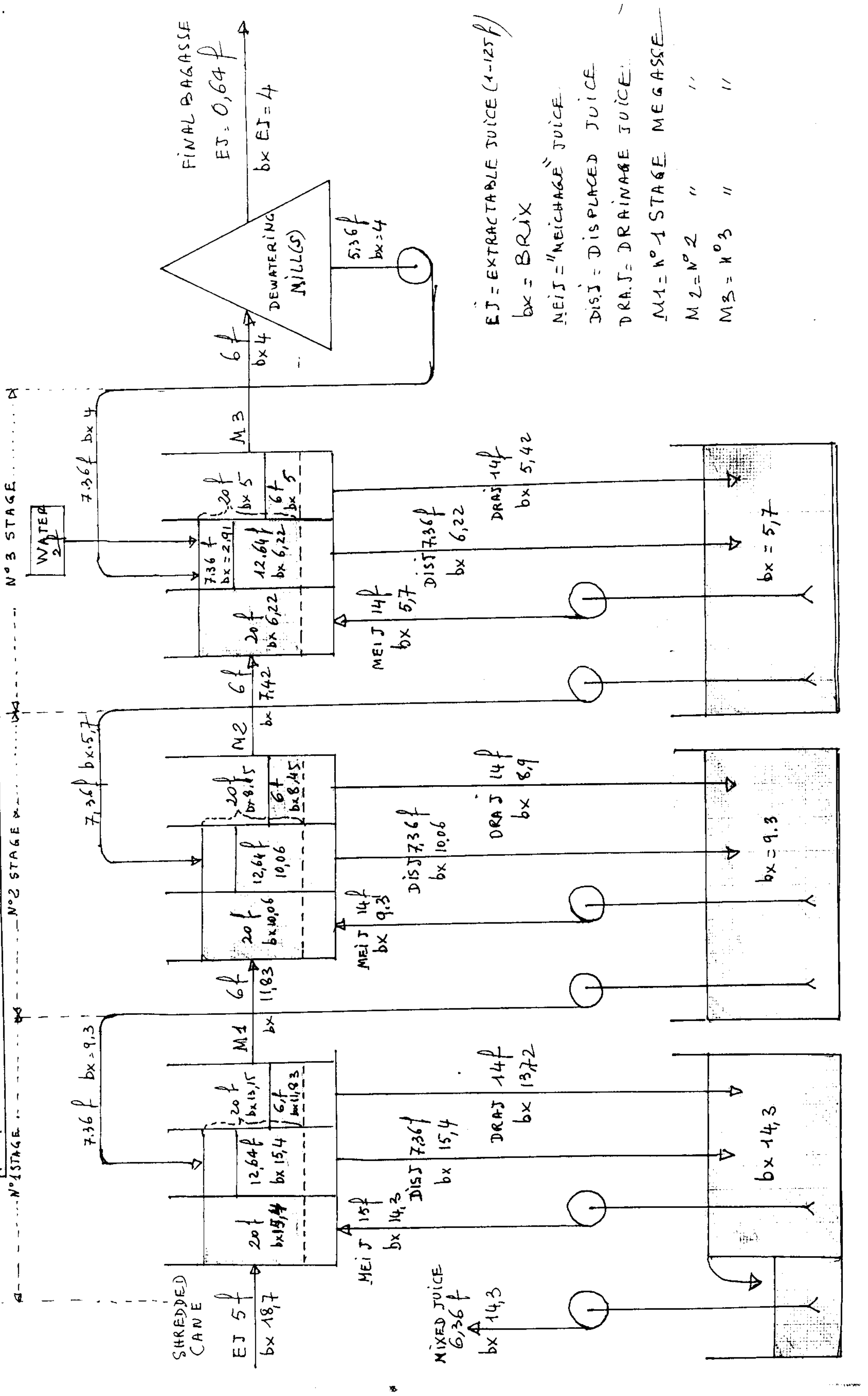
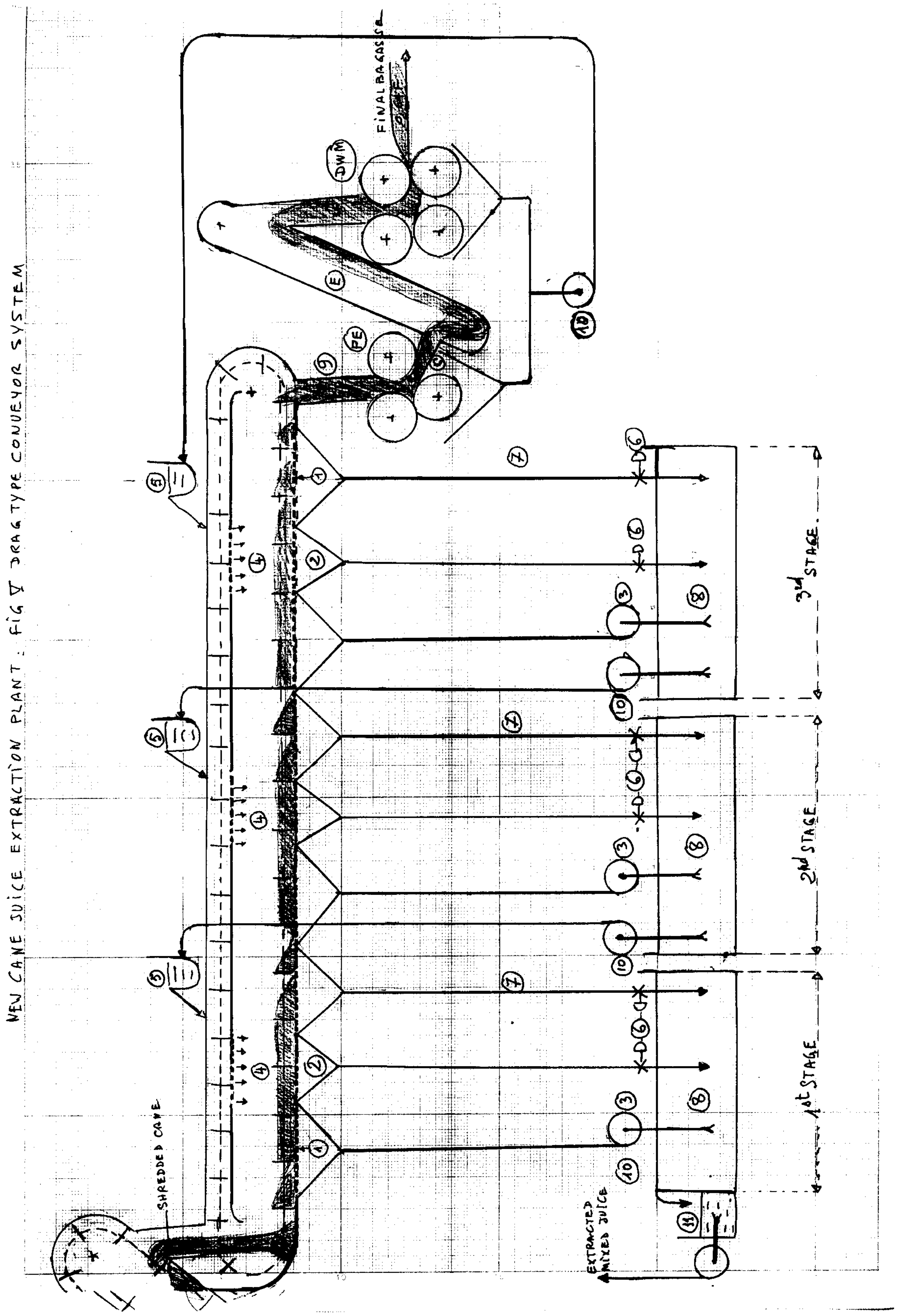


FIG III
PONCHON SAVARIT DIAGRAM
PREDICTION OF NUMBER OF STAGES NEEDED FOR DISPLACEMENT PROCESS
(100% EFFICIENCY)

NEW CANE JUICE DISPLACEMENT PROCESS

FIG IV. TYPICAL FLOW DIAGRAM




NEW CANE JUICE EXTRACTION PLANT : FIG V DRAG TYPE CONVEYOR SYSTEM
FINAL BAGASSE
DWM
PE
SHREDDED CANE
EXTRACTED MIXED JUICE
1st STAGE
2nd STAGE
3rd STAGE

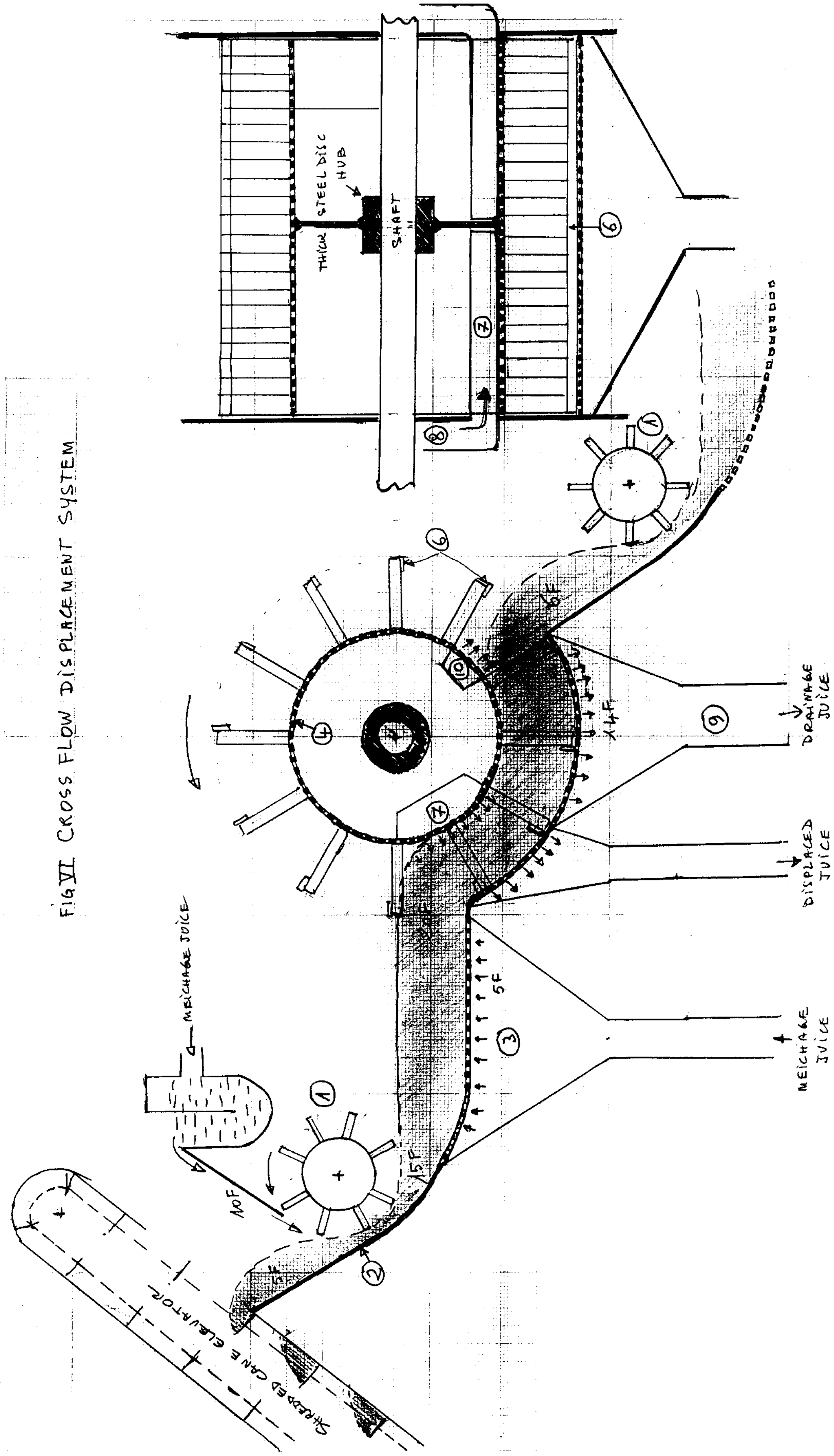


FIG VI CROSS FLOW DISPLACEMENT SYSTEM

European Patent Office

PARTIAL EUROPEAN SEARCH REPORT

which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number: EP 94 40 2832

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	GB-A-1 095 787 (BRAUNSCHEIGISCHE MASCHINEBAUANSTALT) * the whole document * ---	1	C13D1/02 C13D1/04
A	GB-A-1 143 640 (FIVES LILLE-CAIL) * the whole document * ---	1	
A	FR-A-2 310 409 (FIVES-CAIL BABCOCK ET AL.) * the whole document * ---	1	
A	FR-A-2 507 621 (RECHERCHES GEOLOGIQUES ET MINIERES) * the whole document * ---	1	
A	FR-A-2 477 177 (FIVES-CAIL BABCOCK ET AL.) * the whole document * ---	1	
A	FR-A-2 050 660 (FIVES LILLE-CAIL) * the whole document * ---	1	
A	G.P.MEADE ET AL. 'Cane Sugar Handbook' 1978 , JOHN WILEY & SONS , NEW YORK ,N.Y. pages 81-90 * the whole document * -----	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) C13D

INCOMPLETE SEARCH

The Search Division considers that the present European patent application does not comply with the provisions of the European Patent Convention to such an extent that it is not possible to carry out a meaningful search into the state of the art on the basis of some of the claims

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 May 1995	Van Moer, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EP 94 40 2832

- C -

INCOMPLETE SEARCH

Claims searched completely : none

Reason : The application is not submitted with a set of numbered claims.
The "claims" submitted page 10 do not permit to know exactly what the invention is.