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PROCESSING OF BY-PRODUCTS IN MODERN SLAUGHTERHOUSES[1/]

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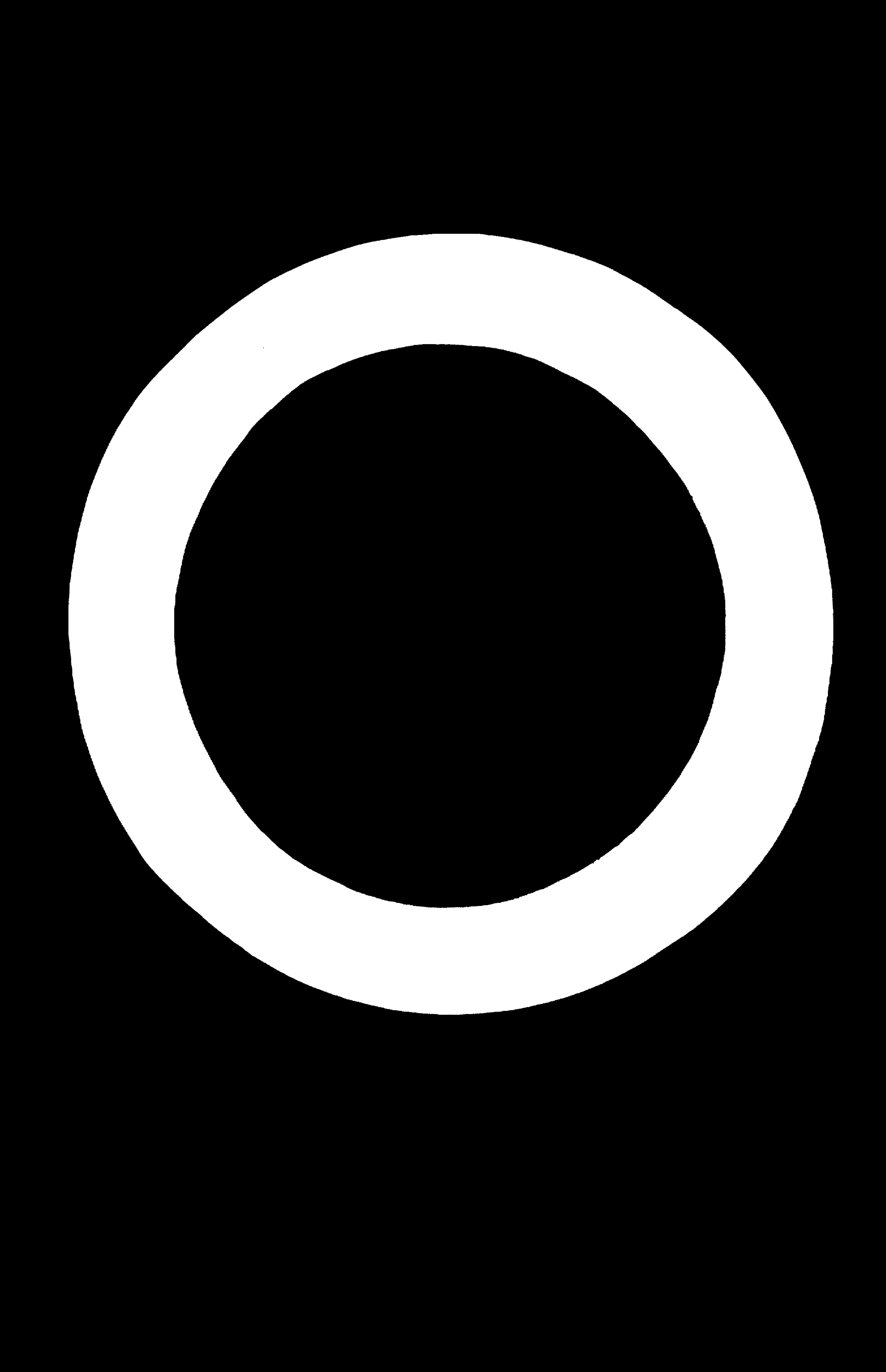


BY-PRODUCT RECOVERY IN MODERN SLAUGHTERHOUSES

It is a well-known fact that the world's population increases rapidly and that it will be increasingly difficult to produce enough animal protein and other animal products to meet man's increasing need.

It will, therefore, become more necessary to economize with the products available and to utilize as much as possible of the existing raw materials of animal origin. This applies to products for human consumption directly as well as to protein products which can be produced and fed back to breed new and healthy animals.

In keeping with the title of this paper, which touches upon a very broad subject, attention is drawn to the importance of efficient and economical processing of such by-products as non-edible raw material, blood and edible raw fat. Thus the paper shall concentrate upon some plants and equipment which have been developed for converting such raw material into valuable commercial products.

In order to give you a rough idea about the quantity of raw material in percent of live weight, cattle can be split up as follows:

Table 1: By-Products in percent of live weight	Per cent[1]
Into carcass and other edible meat product	62-64
Hide	about 7
Paunch and manure content	8
Shrinkage	2-10
Inedible raw material	8-10
Blood	3-4
Raw edible tallow	3-4

Complete plants have been developed for the processing of the last three products, in total 14-18 per cent of the live weight.

[1] See Diagram 1

Three in particular are the subject of this paper:

1.) Plant for the production of technical fat and meat-bone-meal, the non-edible raw material in-put including condemned material and whole condemned animals;

2.) Plant for the mechanical dewatering of whole blood before final drying into blood meal;

3.) Plant for the production of edible fat from raw material with a high fat content.

In order to facilitate the understanding of the difference in the design of these plants, a few words should be said about the composition of the raw material.

The animal raw material can be said to consist of three main products: fat, water and dry substance. Raw blood is an exception as it consists mainly of water and dry substance, and nearly no fat.

In order to gain a commercial product from the raw material, it has to be separated into its components, see Diagram 2.

In the case of inedible raw material, effective treatment in the plant mentioned above will result in two commercial products: meat-bone-meal and technical fat. Depending on the composition of the raw material, the total yield of these two products will be about 35 - 45% of the quantity of raw material fed in to the plant.

Raw blood, if passed through the dewatering plant mentioned above and dried, can be transformed into blood meal. The yield will be about 21 per cent of the quantity of raw blood fed in to the plant.

As for the treatment of edible fat, fat constitutes the major portion, the yield being 75 - 90 per cent edible fat depending on the quantity of raw material fed in to the plant.

The commercial value of these different products contributes extensively to the profitability of the whole slaughterhouse.

The treatment of inedible raw material

Conventional plants for this kind of processing have existed for many years and no remarkable developments have been achieved during the past few years.

A conventional plant consists of a so-called dry melter in which the material is cooked for about 3 hours; during which time the water is evaporated. After cooking, the remaining drained crackling is passed through a press in order to lower the fat content in the meal to about 10 - 12 per cent.

The amount of available raw material is increasing as is the demand for a better quality final product. Consequently, a new, completely unconventional processing method has been developed with these considerations in mind.

This new plant consists of three main sections, **see Diagram** 3

Section I	Heating and Sterilization
Section II	Separation
Section III	Drying

In the first section, the material is cooked and sterilized, and only a part of the water is evaporated. The material remains in the cooker for about 55 minutes with the result that the protein coagulates, the fat cells are ruptured and a completely sterile liquidized product is discharged into the next section of the plant.

In the second section, the fat is continuously removed and purified leaving the plant as a ready, commercial product before the dry substance is dried.

In the third section, the defatted dry substance - discharged from the separators - is fed in to the continuous dryer and, within a passage time of about 20 minutes, leaves the dryer as partly granulated meal with a fat content of 6-8 per cent and a moisture content of less than 10 per cent.

The water which is separated will be fed to a process water tank from which a given quantity is charged into the cooker with the next batch of raw material, resulting in a very high heat transmission in the cooker.

A balance of process water is kept constant within the plant and no other products leave the plant except for ready purified fat, dried meal and condensed water.

Condensed water is evaporated in two places: about 70 per cent from the cooker and 25 per cent from the dryer. 5 per cent remains as moisture in the meal.

Variations in water content in the raw material are balanced within the plant by evaporating lesser or greater amounts in the cooker, this being regulated by a control mechanism for the cooking and sterilizing cycle.

A conventional dry melter is also part of this plant. Originally, the idea had been to introduce a continuous cooker. Thus, as the very first step in the research work stage, a questionnaire was sent out to the veterinary authorities in about fifty different countries all over the world requesting details of local regulations regarding sterilization time and temperature.

From the answers received, it was soon realized that the only heat treatment acceptable to all parties was a treatment in which the material was cooked in a closed cooker allowing no material to be charged or discharged during the heat treatment and sterilization stage.

In the opinion of the veterinarians, no existing cooker could guarantee that not a single particle would pass through the cooker in a shorter time than that stipulated by the regulations.

The outcome, therefore, was to include a dry melter for use as a cooker in the first stage, arranging treatment in an automatic time cycle, thus obtaining the advantages of a continuous cooker and at the same time guaranteeing that sterility met veterinarian standards.

Operation of the plant

The plant has been designed in such a manner to ensure that the processing time is short, the material is treated gently and thus a high quality meal is produced with a low fat content and a brilliant and lighter-coloured fat. See Illustration 1.

Following conversion to plants of this design, it has been found that the fat content in the meal has dropped from 10-12 per cent to 6-8 per cent.

The digestibility of raw protein in meal has been raised from 85 per cent to more than 90 per cent and available lysine increased by about 15 per cent.

The fat produced is much lighter in colour and has a lower moisture and impurity content as before.

The reason for these qualitative improvements is the new processing technique and mainly the fact that not all the water is removed during cooking thus leaving water to protect both the meal and fat from burning and discolouring. Furthermore, the fat is removed <u>before</u> a final drying of the meal is effected.

It can be seen that neither presses nor solvent are required in this process.

Furthermore, the plant is of a closed design and thus all vapours can be directed towards one central ventilation pipe, which in turn can be easily connected to a deodorization plant, a factor of importance today if a plant is to be erected within an urban area.

Production of blood meal

The question as to the nature of blood will be answered differently depending on whether a poet, doctor or technician is asked. Having no wish to be either poetical or diagnostic the matter can be treated purely from a technical and economical point of view.

As mentioned above blood is a liquid consisting of 80 per cent water and 20 per cent dry substance: a dry substance that has an appreciable value. The quantity of blood that can be collected in a slaughter-house from a slaughtered animal can be estimated at about 3 - 3.5 per cent of its live weight, i.e. 10-15 kg blood is collected from each head of cattle and about 3 kg from pigs.

The problem of what to do with all this blood is one that many slaughter-houses have to face, and many try, of course, to make the best of it.

As large quantities of blood have to be transformed into a commercial product, the only economical solution is to turn it into blood meal to be used as an additive for the enrichment of animal food.

The conventional way of producing blood meal today simply involves filling a dryer with a batch of raw blood and continuing to dry it until all the water has been removed. Besides requiring a large drying capacity, such an operation also consumes an appreciable amount of steam. The drying time per batch is about six hours and steam consumption is in the region of 1.3 kg steam per kg of blood water removed. An easier and more economic way of doing this is to use the installation described below in combination with the dryer.

As previously mentioned, the raw blood consists of up to 80 per cent water and 20 per cent dry substance, which means that only a small part of the blood can be turned into a useful product. In other words, nearly 80 per cent of the total volume has to be removed in the form of water or to be more exact 78 per cent, as 2 per cent remains as moisture in the finished blood meal. **Diagram 4 shows an outline of the blood dewatering plant.**

Basically, the blood processing plant operates along the following lines. The raw blood, after having first passed through a coarse strainer, arrives at a storage tank, usually part of the standard equipment in a slaughterhouse.

From the collecting tank the raw blood is pumped to the preheating tank, the first part of the blood processing plant.

In order to allow the plant to operate continuously, the plant is delivered with an additional mono pump with variable speed drive, the same size as the one in the plant.

The two pumps are adjusted so that the flow of blood to the plant is even. However, should the level in the intermediate tank rise or fall more than the allowed limit, the pump will stop or start automatically according to whether the level is high or low.

The intermediate tank is used to preheat the blood, this being done by direct steam injection. The correct heating temperature is controlled by an automatic steam regulating valve. The tank is also equipped with a slow-moving agitator or stirrer, which keeps the blood in circulation, making sure that all the blood in the tank is of even temperature.

The heated blood is transported from the intermediate tank by a variable speed pump that allows for adjustment of the feed to a blood coagulator.

In the blood coagulator, the blood is heated continuously to the temperature necessary to coagulate the blood. The coagulator is of special design suitable for blood processing, and it ensures complete coagulation of the raw blood. The coagulator is heated by direct steam injection supplied by an automatic pressure regulating valve. (See **Diagram 5 and Illustration 2**).

After coagulation the thickened blood is fed to a decanter, where about 75 per cent of the water is separated from the coagulated blood. The dewatered blood substance is discharged through an outlet at the bottom of the narrow end of the decanter, while the water is discharged through an outlet at the other end to be run-off as waste.

The dewatered blood discharged from the decanter has a low moisture content and the consistency and form of granulated cork. The remaining water in the blood substance can be reasily reduced to less than 10 per cent in a conventional or continuous dryer. The drying time is reduced considerably in the latter case.

A conventional raw blood dryer consumes about 1.3 kg steam to remove 1 kg water from the blood, whereas this particular plant used in conjunction with the same dryer will require less than 0.3 kg steam per kg water, which is comparable to a 3-stage evaporation. The steam consumed in this plant is used to heat the blood only, and amounts to about 13 per cent of the weight of the blood.

The time required for final drying will be about 1/2 - 1/3 of what is normally required for meal drying using a conventional system.

Blood can be processed using a variety of equipment combinations; as shown in Diagram 6.

(A) Conventional blood drying plant (drying of whole blood).

(B) The newly designed plant in combination with conventional dryer.

(C) The newly designed plant in combination with a continuous dryer, which can be used in countries where sterilization above 100°C is not required.

It should be noted that the existing storage tank is used in all three combinations and that the conventional dryer is also used in the second alternative. Should the conventional dryer be retained, as in the second alternative, it must be complemented by an intermediate tank that can store the semi-dry blood while one batch is in the dryer. This tank is not required, if a continuous-type dryer is used.

It is now easy to compare the results obtained in the three different types of blood drying plants.

The figures quoted for the conventional dry-melter type dryer in (A) and (B) are those for a dryer of 5,000 litre size charged with 2,500 litres of blood. With a dryer of this type, the distance between the agitator and the shell is reduced to a minimum to shorten the drying time.

In plants (A) and (B) the blood can be exposed to a sterilization temperature above 100°C, but if no special requirements exist regarding time and temperature above 100°C, the plant can be used in the configuration shown in (C).

In alternative (B), the processing plant is charged to only 36 per cent, the conventional dryer being the limiting factor. The same size plant is used in case (C), but here the continuous dryer allows it to operate at full capacity.

Previously, most of the blood from slaughterhouses was drained off, as the processing methods used were not profitable. In many cases, space was insufficient for installing dryers or steam for its processing.

The low steam consumption and labour costs, compact dimensions and the simplicity of operation of this particular plant offer slaughterhouses of today the opportunity of making a handsome profit from a previously undesirable by-product.

Treatment of edible fat

A plant has been designed for the treatment of edible fat, i.e. for the fatty raw material deposited in the animal's body or the fatty part trimmed from the body. The fat content in such raw material ranges in the order of 70-95 per cent.

The plant is a continuously operating plant in which mechanical and thermic treatment has been combined in order to obtain a short processing time.

The flow chart in diagram 7 shows the principle according to which the plant operates. The raw material to be treated consists of a system of fat-containing cells, held together by muscles, sinews and connective tissue.

When extracting the fat from the raw material, pre-treatment is necessary: the fat cells have to be ruptured.

In this particular plant mechanical disintegration combined with heat treatment has been adopted, a method by which time and temperature can be held at a minimum, resulting in a fat of high quality.

The raw material passes through a mincer in which it is cut into pieces, goes on to an air-tight melter where the material is heated to about 60°C. The material is fed to an intermediate tank in a condition suitable for pumping.

The material is then pumped through a holding cell and heated to about 80°C, whereupon the material enters the first stage separator i.e. a decanter specially designed for the continuous removal of solids from the liquid.

The solids leave the plant at this point, and the liquid consisting of fat, water and some fines goes through an intermediate tank and pump to final purification in a separator, which ejects solids.

The final, purified fat passes on to a plate heat-exchanger where it is cooled down to about 40°C before it leaves the plant, see Illustration 3.

The design of the plant as a semi-closed continuously operating unit working with direct steam injection makes it possible to process the raw material in few minutes free of any contact with the air, thus resulting in the production of a high quality fat.

Diagram 1: By-products in per cent of live weight

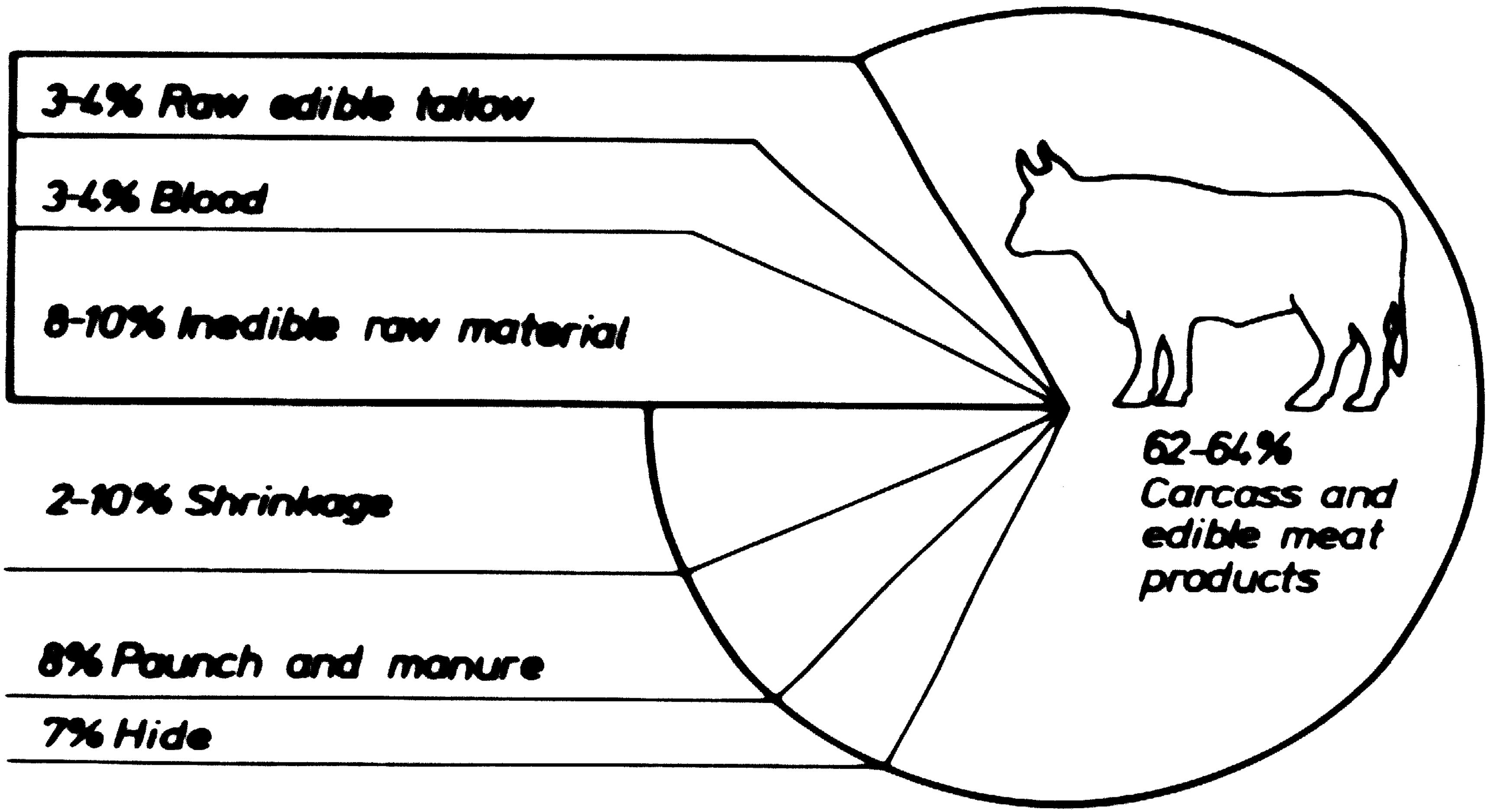


Diagram 2: Raw Material Components

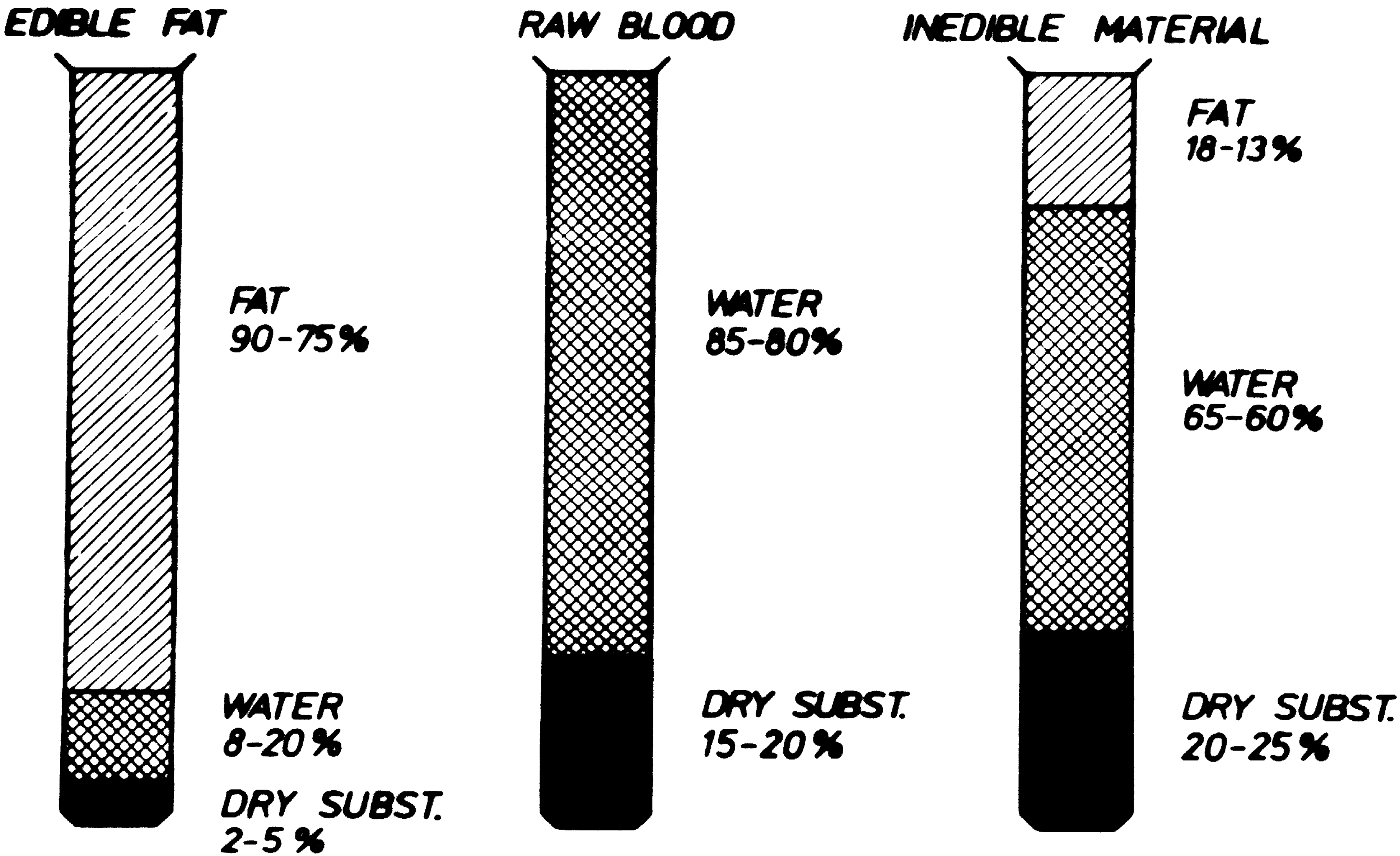


Diagram 3: Flow chart of plant for treatment of inedible raw material

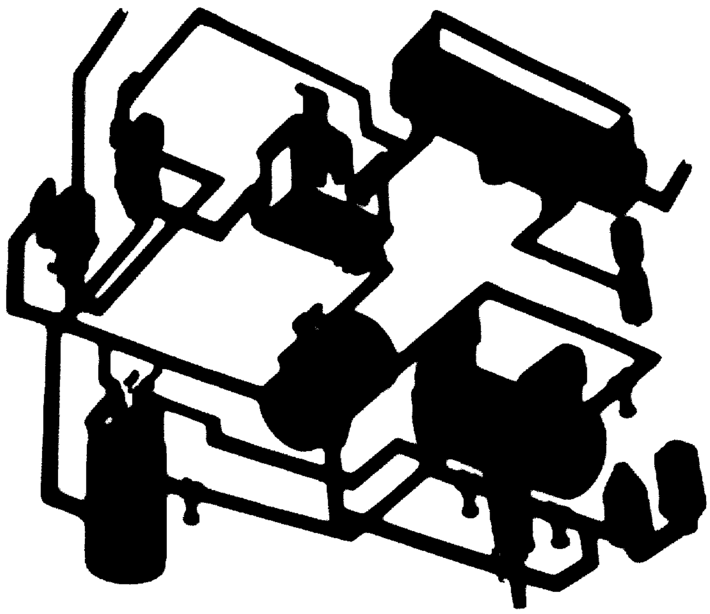
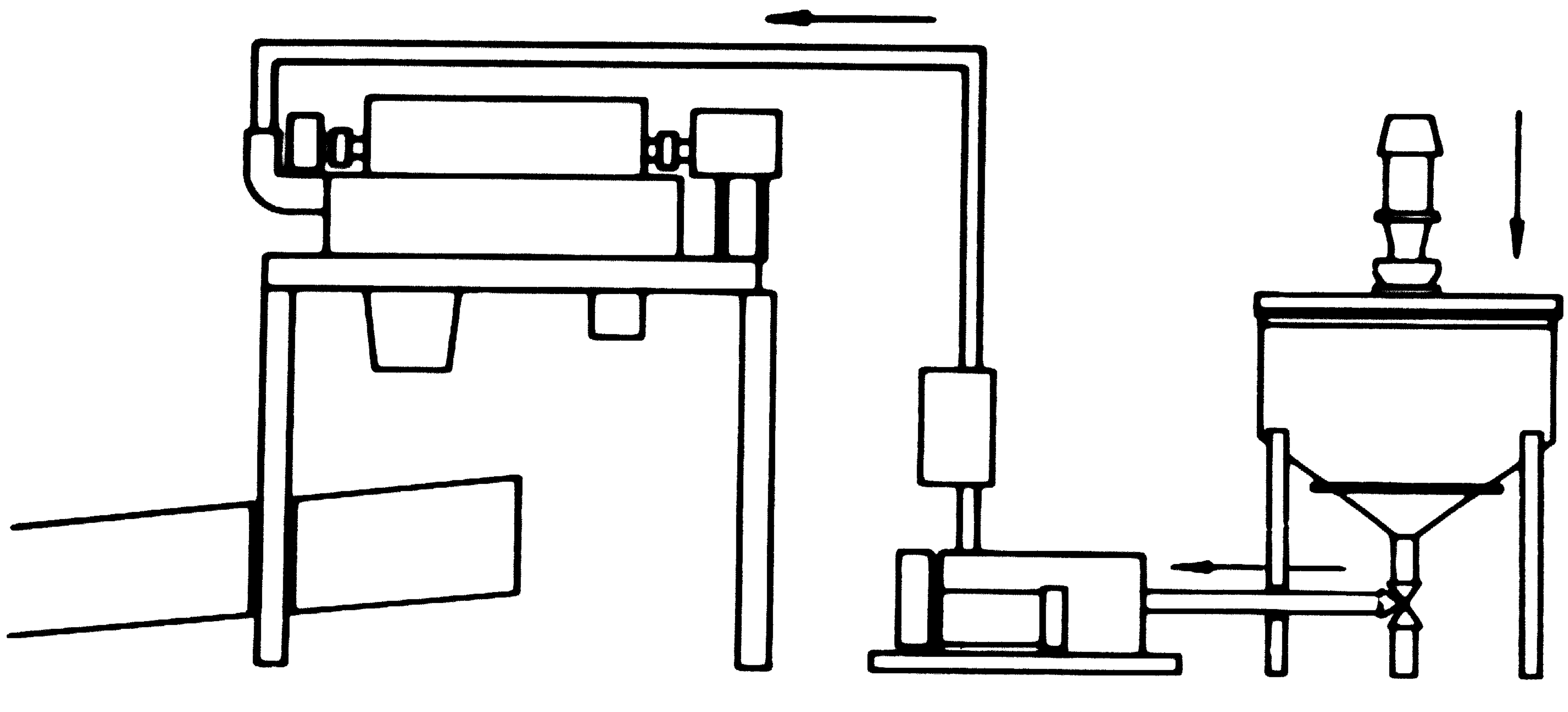


Illustration 1: Processing plant in situ

Diagram 4.



Blood dewatering plant.

Diagram 5: Separation in the decanter

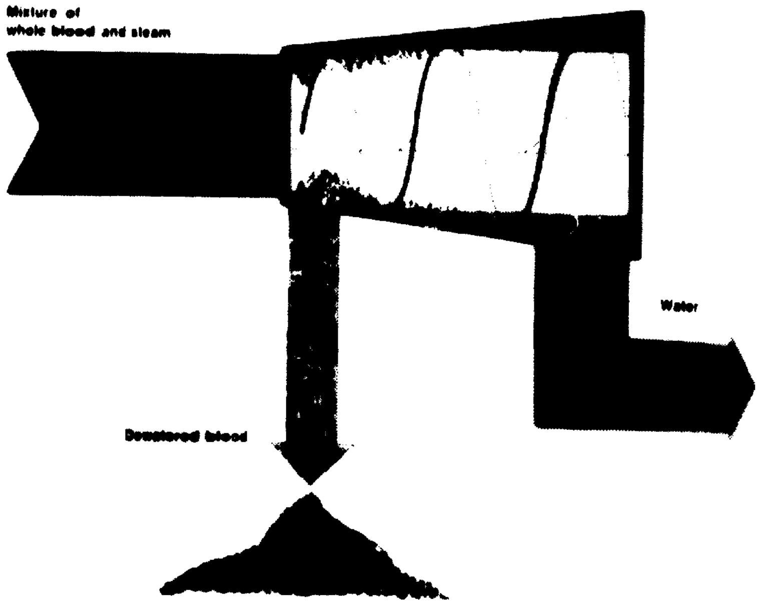
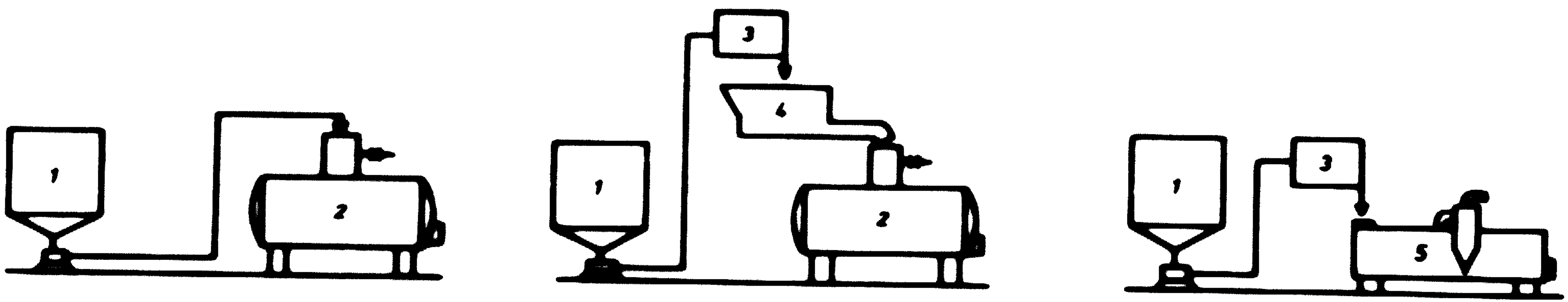


Illustration 2: Blood processing plant in situ

Diagram 6: Comparison of blood drying plants

A.	B.	C.
Conventional blood drying system.	Blood dewatering plant combined with conventional dryer	Blood dewatering plant combined with continuous dryer



1.Existing storage tank   2.Existing dry-melter used as dryer   3.Blood dewatering plant   4.Intermediate tank for semi-dry blood   5.Continuous dryer

	A	B	C
Capacity raw blood:	415 l/h	850 l/h	2200 l/h
Processing time:	6 h	2 1/2 h	continuous
Steam consumption:	1160 kg/ton	370 kg/ton	370-500 kg/ton
Blood dewatering plant charged to:		36 %	100%
Dryer charged to:	100 %	100 %	continuous

COMPARED TO A.	B	C
Increase in capacity.	105 %	530 %
Reduction in process time.	50 %	continuous
Reduction in steam consumption.	68 %	68-57 %

Diagram 7: <u>Flow-chart of edible fat processing plant</u>

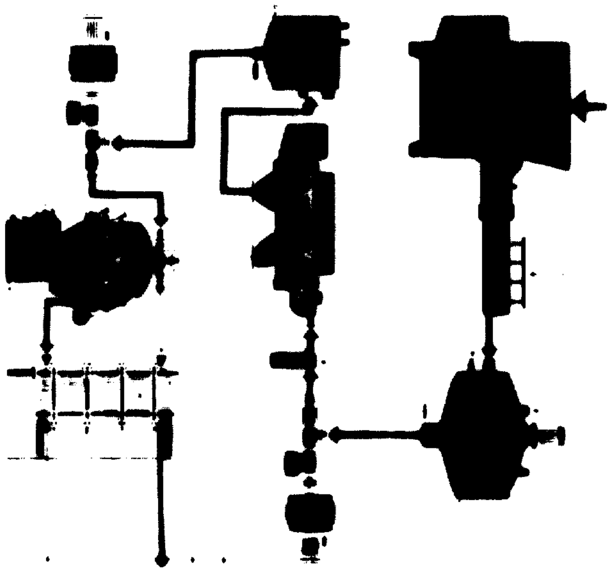
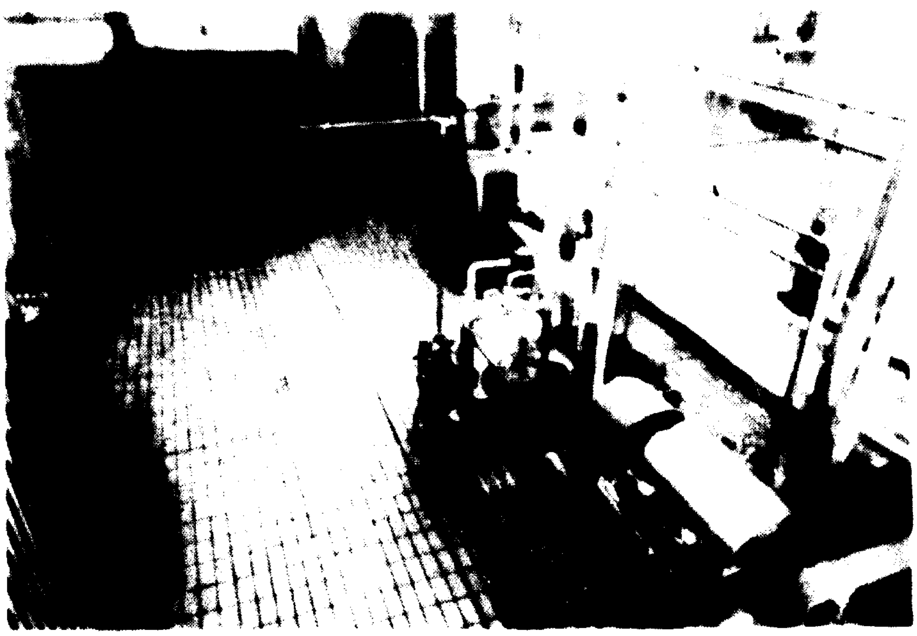


Illustration 3: <u>Processing plant in situ</u>



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