QUALITY CONTROL IN THE CERAMIC INDUSTRY. WHAT SHOULD BE CONTROLLED, HOW, WHEN, WHY AND BY WHOM ? PROPOSAL FOR A GLOBAL SYSTEM FOR QUALITY IN PRODUCTION.

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INTRODUCTION

Recently, anything even vaguely to do with "Quality" seems to be in vogue, and even the sound of the magic word is enough to transport us to a different world - a world of certain success - competitive and modern. At the same time if it is missing we think of failure, lack of competiveness and missed opportunities in 1992, etc. Nothing is further from reality, because it is not only this association of ideas which leads to success for companies in the Ceramic Paving and Tiling sector, but also correct judgement in a much larger number of factors of which Quality is one of the important ones, but still only one of many. There are many, or at least some, other correct decisions which must be taken by the management of such companies.

Keeping more strictly to the subject of this presentation, it is obvious that "Quality" is one of the most important factors which must be mentioned when we are discussing success. Despite the necessary demystification which I began with, it would be frivolous not to give this factor sufficient importance. Even though by itself it doesn't guarantee anything, its contribution to success is obvious. In fact, it is an indispensable ingredient.

Once this is agreed, addressing this assembly of "The First World Congress on Quality in Ceramic Paving and Tiling" on such a broad subject as that proposed, it is difficult to decide whether to treat specific aspects of the subject or whether to cover global questions.

The sum total of the particular aspects of quality, whether related to the process, raw materials, etc., together can lead to Quality and will, without a doubt be the subject of a great number of the publications and presentations given, in congresses like this one. However, in this case, because of the wide scope of the Call for Papers, I have decided that it is sufficient to study the theme on a wider basis even though such presentations are usually branded as being "excessively theoretical". In reality, nothing could be further from the truth since this talk presents a totally practical proposal, up to and including the smallest details of its management and application, which has already afforded good results in practice.

HOW TO SOLVE THE PROBLEM

It has always been the case, but with greater emphasis in recent years, that the Ceramic Paving and Tiling industry has needed raw materials, especially clays, which come up to the exacting standards of this industry. This has imposed the need for rigid Quality Control of these materials.

There is an extensive and possibly even complete bibliography on the mineralogy of clays, their characteristics in terms of the product or the process being carried out, etc. Thus, we can find references on the relationship of the characteristics of the raw materials to the quality of the final product; but nearly always this quality is understood as something merely technical.

We will define Quality as the **sum total of all the properties and characteristics of a product which are essential to meet the demands of the consumer and are achieved at the lowest possible cost.** Using this premise it follows that, despite the importance of the studies on the characteristics of raw materials and their influence on the final product, it is also evident that they do not consider, or at least only briefly, the second part of the equation. That is, that quality must also be profitable for the company, and not only from the point of view of reputation and absence of complaints but also from the point of view of Industrial Cost and Total Cost.

In this presentation I would like to concentrate on this second aspect and, for this reason, take a look at materials - their control and management within the plant and in relation to the process, so that taking into account the basic studies mentioned before, we can achieve good quality in all aspects. In other words, knowing the relation between raw materials and the characteristics of the finished product, even when the materials are optimum, avert the possibility that bad management or defective control of quality may lead to substandard results.

Let's take an example: If we have satisfactory or even optimum quality raw materials for the production of vitrified paving stones with a water absorption of less than three per cent, and we know the relationship between the variables of the process and the characteristics of the materials, does this necessarily guarantee that we will obtain the desired final product every time? Or even more pertinent, are we sure that the product obtained will be profitable from a production point of view? Obviously not, since this initial knowledge does not take into consideration all the internal variables. On the other hand, it may be that the objective is achieved but involves an excess of wastage, product defects, low productivity, deformations, etc, which will eventually lead to global "poor quality". Although the customer is satisfied in the short term, in the long run his dissatisfaction will be because the supply will stop when the company becomes unprofitable because of these losses.

On the other hand, there are innumerable manuals which explain what controls should be carried out, both on the raw materials and on the variables of the process, together with indications on the periodicity of tests (this last section is not quite so complete). At this point one asks oneself. Will the simple fact of carrying out quality control checks improve quality profitably? Obviously not, control on its own does not improve quality. This assertion, so apparent and even obvious, is nevertheless worth repeating so that we can eliminate a certain tendency to confusion.

However, together with this last question one asks oneself a series of other questions: What should be controlled and what pattern should be used? When is the value obtained correct or incorrect? When can it be improved or adjusted? What margin of security is necessary for each value, that is to say, what is the tolerance? When should the control be made to ensure that it will always be within tolerance? What should be done when the value returned exceeds the required value ? ...

It is obvious that knowledge of the relationship between the nature of the raw materials and the characteristics of the final product is a tool which will help us to resolve such questions. The same can be said of the many tables and tests available. But it is also clear that neither of these factors would be of much use without a study of the methodology which regulates their use and supplies the answers to the innumerable questions like those posed above. This methodology considers the process as a whole, that is to say, the sum of the raw materials which are progressively elaborated until the final result is achieved, and finally incorporates cost and profitability as determining factors in the concept of quality.

We will start by going over some different definitions of quality:

- DICTIONARY: Grade of excellence
- CROSBY: Comes up to standard
- JURAN: Adequate for use
- GROOCOCK: Grade of adjustment of all the different elements and relevant characteristics of the product referring to all aspects of the needs of the client.
- DIN SPECS: Sum of all the properties and charac- teristics of a product, which meet the demands of the market where it is to be sent.
- E.O.Q.C.: Degree to which the product meets the demands of the client to whom it is destined and where the quality of the design and manufacture are successful.

In all these definitions we are talking about the Quality of the Final Product which is being sent into the Market. It is the aim of this presentation to consider and study the profitability of this product for the company manufacturing it as an intrinsic part of its Quality since, on the contrary, it would remain forever in the realm of pure hypothesis or a simple declaration of intentions since the product would never be made.

Finally we will use ISHIKAWA's definition of Quality Control:

"Quality Control means to develop, design, produce and supply a quality product, which should be the one most economically produced, useful and satisfactory to the client."

From this definitions it is easy to deduce that the factors which affect quality are innumerable, although some are more important than others. In the end, however, all of them should be subject to control or at least consideration. For example we can visualise some of these factors using one of ISHIKAWA's diagrams. (Fig. 1).

Fig.1

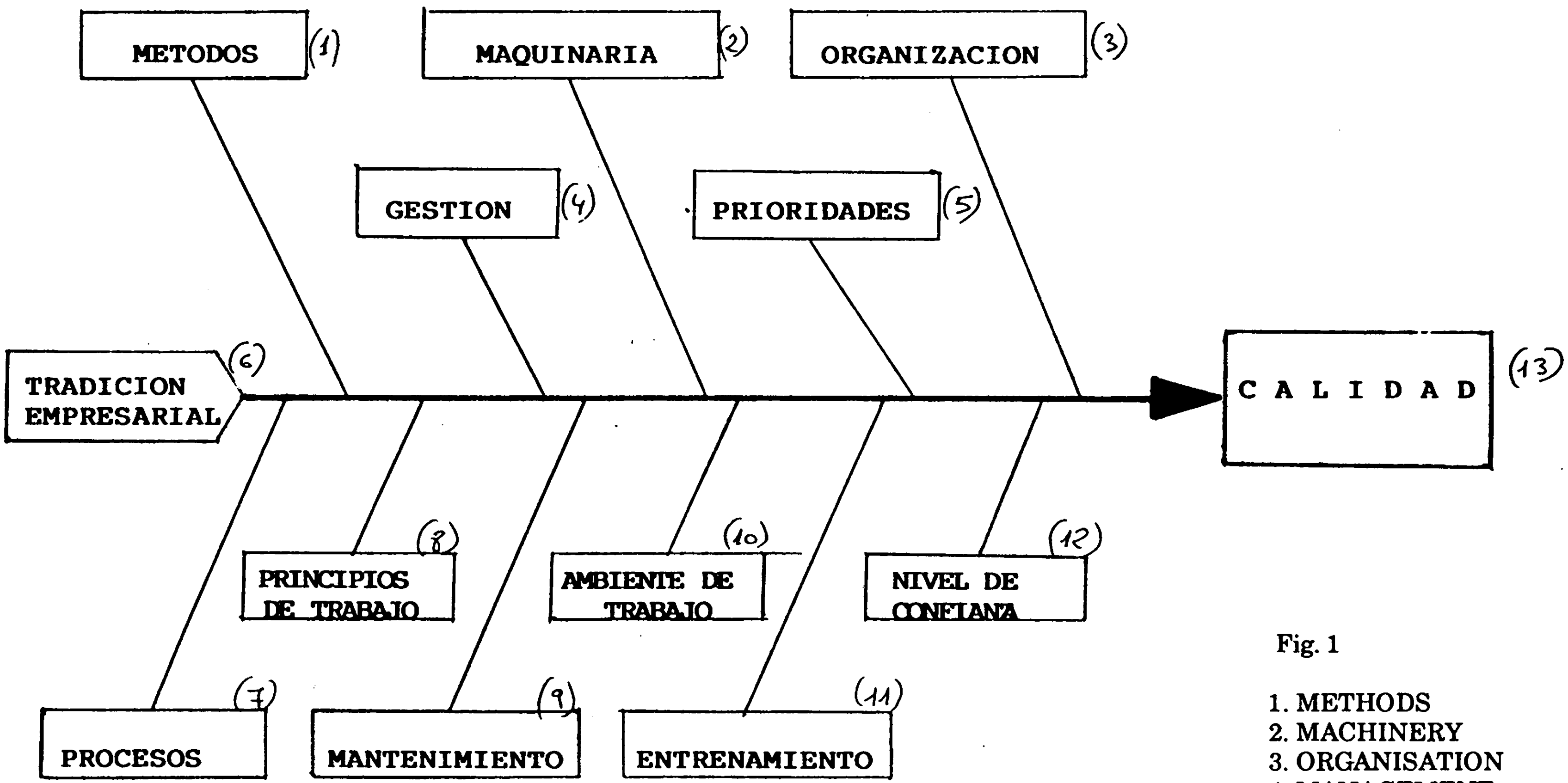

Fig. 1

1. METHODS
2. MACHINERY
3. ORGANISATION
4. MANAGEMENT
5. PRIORITIES
6. COMPANY TRADITION
7. PROCESSES
8. PRINCIPLES OF WORK
9. MAINTENANCE
10. WORKING ATMOSPHERE
11. TRAINING
12. LEVEL OF CONFIDENCE
13. QUALITY

All this is only an attempt to illustrate that quality of ceramic paving and tiling depends on an infinite number of variables which, in turn, are influenced by innumerable factors, and that only the consideration of the system as a whole can lead to success.

Once again we can take a concrete example: the nature of the raw materials has a significant influence on the quality of the final product. This is obvious, but how can we test the quality of the raw materials representatively? What values, margins of tolerance and deviations are acceptable? What is the best pattern? Where and how should the sampling and testing be carried out? What control will be the most representative? What should be done when a deviation greater than the pre-established margin is detected? How will the raw materials be affected by variations in other related variables during the process? What are these related variables? What is the cost of each degree or level of reliability of Control? ...

The subject is a lot more complicated than:

Good Raw Materials + Good Process = Good Product since among other things we would have to define what are good raw materials, good process and good product.

And neither is it as simple as :

Nature Of Raw Materials —> Final Quality since the nature must be constantly checked, is influenced by an infinity of related variables and must be controlled according to precise criteria which take everything into account.

METHOD

To answer the questions posed by Quality and how to Control it in the manufacture of ceramic paving and tiling, from this point of view, is an immense job. Eventually it forces us inevitably to create a system with a view to preventing the means going beyond the final objective. On this occasion we are presenting a summary describing an actual system which is in use or, to be more exact, is being implemented (as by definition the process does not have an end). In order to present this summary in a clear, visual way we will begin, in each case, with the general idea followed up by the actual pilot work already done. Given the large volume of information used it is impossible to cover it all in the time allotted. Details of some cases will therefore have to be omitted, but the author will make this information, along with other specific documentation and background information, available on request.

A. The fundamental assumption of this system is that in the concept "Quality Control", the word CONTROL covers four aspects:

   - Establishment of standards of quality
   - Estimate of accordance with standards
   - Action to be taken when the standards are not met
   - Project for the improvement of standards

B. The heart of the application of Quality Control is in the control on the "actual site of production" during the process of design and manufacture so that mediocre quality can be prevented and so that it is unnecessary to correct bad quality after it has been produced.

C. To ensure success with this system of Quality Control in any factory, the creation of a consciousness of quality among personnel on all levels, from the management down to the employees on the shop floor, is indispensable and vital (although intangible). Human relations are very important in the Quality Control system proposed.

The work of control is centred around the production and operational internal departments of the factory. In Fig 2 you can see the relationship between the principles of Quality Control and the Production processes.

The overall plan of the method is given in Fig 3.

Fig 4 takes us from general principles to something more detailed and demonstrates the particular case of raw materials up to the time of their acceptance: general plan of the operation, aim of the control and allocation of responsibilities.

What remains to be defined are the actual tests which should be carried out, the specifications for their realisation, the timetable (periodicity), standard values, the organizational flow chart for each variable, etc.

Following are some necessary definitions:

SECTION:	Preparation of raw materials
PROCESS:	Creation of mixing bed for clays - Warehousing of approved material
OPERATION:	From receipt until acceptance
CONTROL:	Variables on which checks and tests are carried out

Now we will take a look at a series of examples related to some of the many sections in the Company which can be studied, as this scheme does not only apply to Production exclusively. It can also be extended to cover all the operations of the Company (Figs 6, 7, 8, 9, 10).

Fig.2

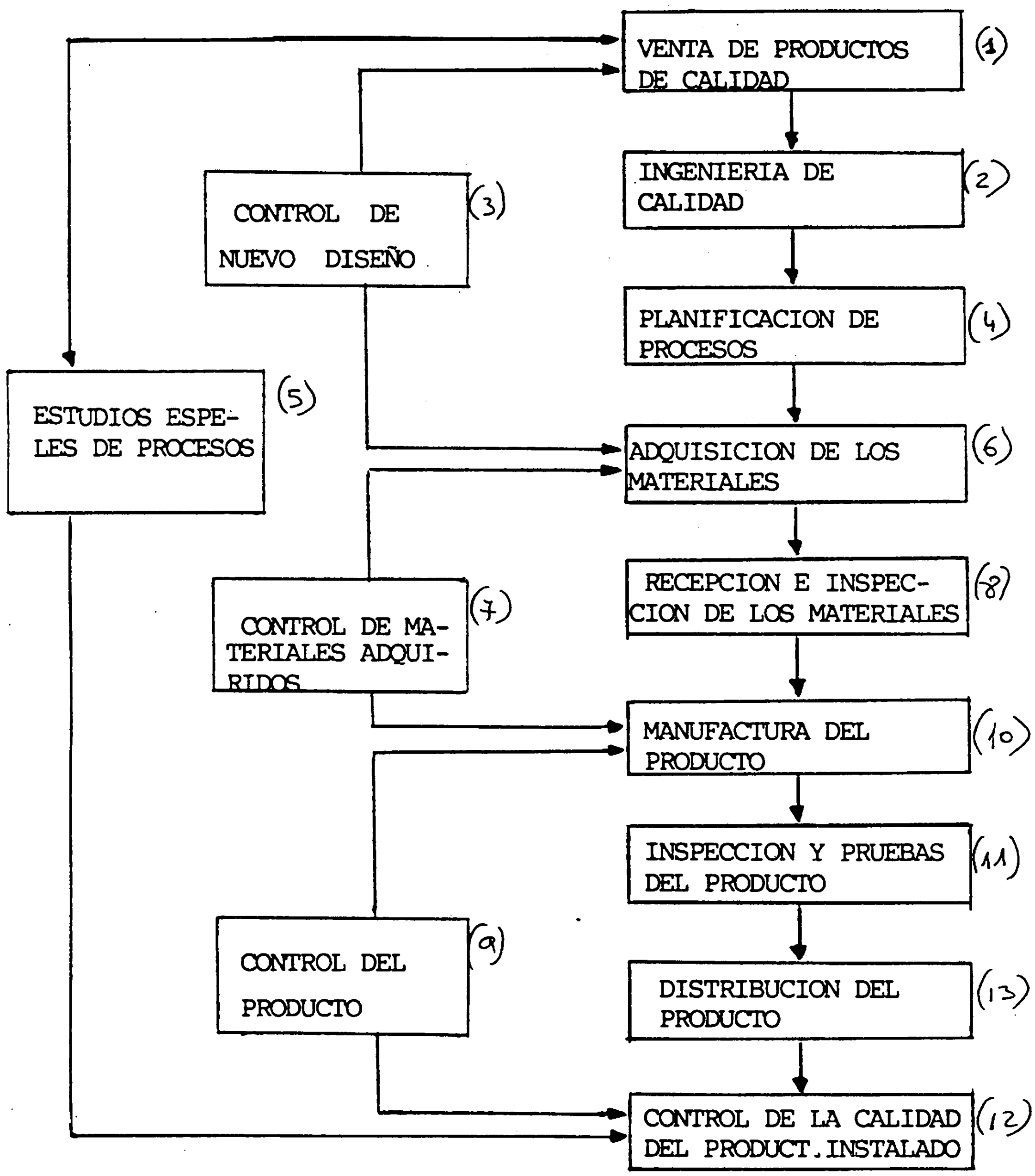

Fig 2

1. SALE OF QUALITY PRODUCTS QUALITY
2. CONTROL OF ENGINEERING
3. NEW DESIGN
4. PLANNING OF PROCESS
5. SPECIAL STUDIES
6. ACQUISITION OF MATERIALS
7. OF PROCESSES MATERIALS
8. RECEIPT & INSPECTION OF MATERIALS
9. CONTROL OF RAW
10. MANUFACTURE OF PRODUCT
11. PRODUCT INSPECTION AND TESTING
12. PRODUCT CONTROL
13. DISTRIBUTION OF PRODUCT
14. QUALITY CONTROL INSTALLED

Fig.3

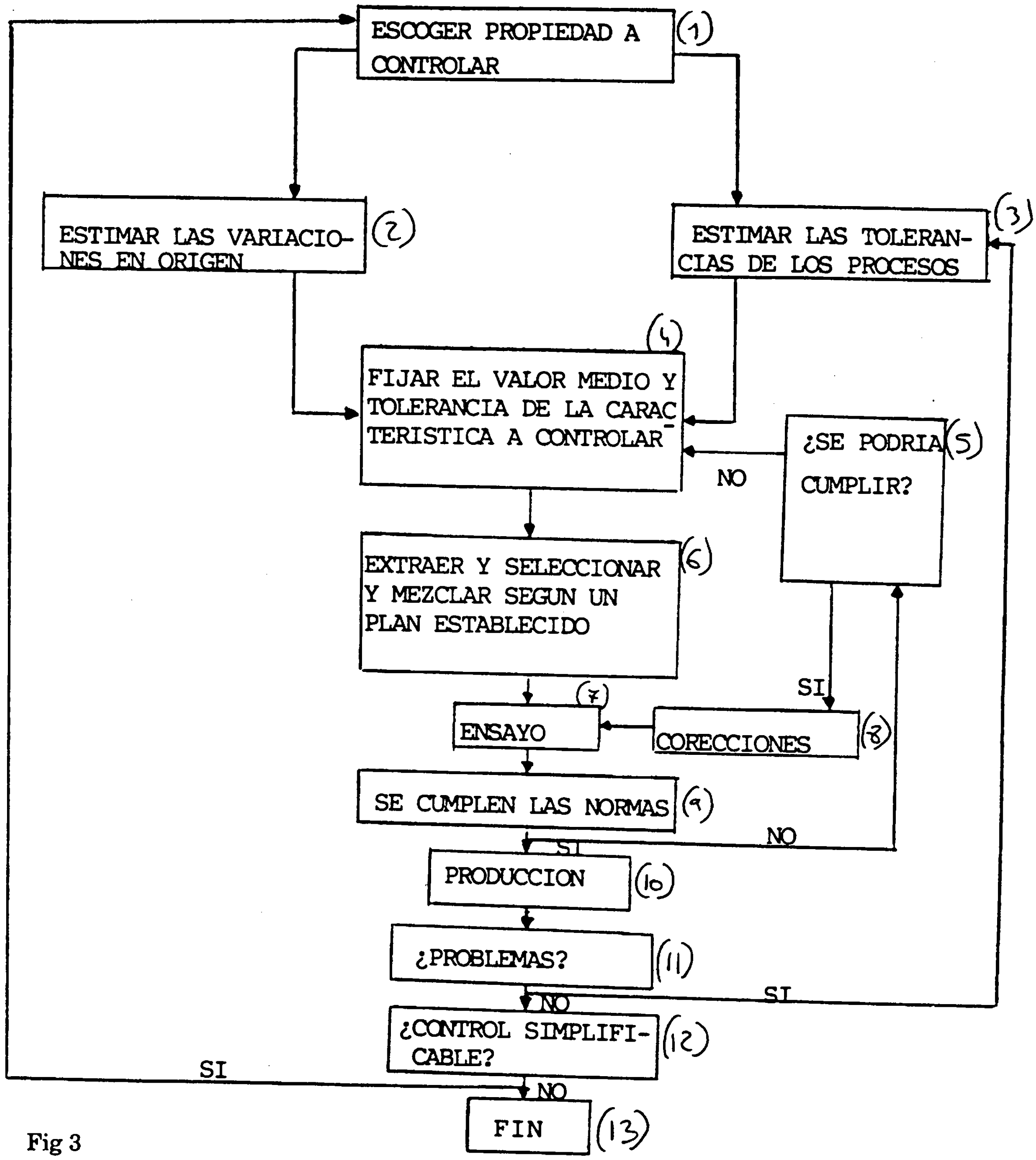

Fig 3

1. Choose variable to be controlled
2. Estimate variation in source
3. Estimate acceptable tolerance of process
4. Define mean value and tolerance of the characteristic to be controlled.
5. Is it possible?
6. Extract and select and mix according to established plan.
7. Test
8. Corrections
9. OK?
10. Production
11. Problems ?
12. Can procedure be simplified?
13. End

Si = Yes
No = No

Fig.4

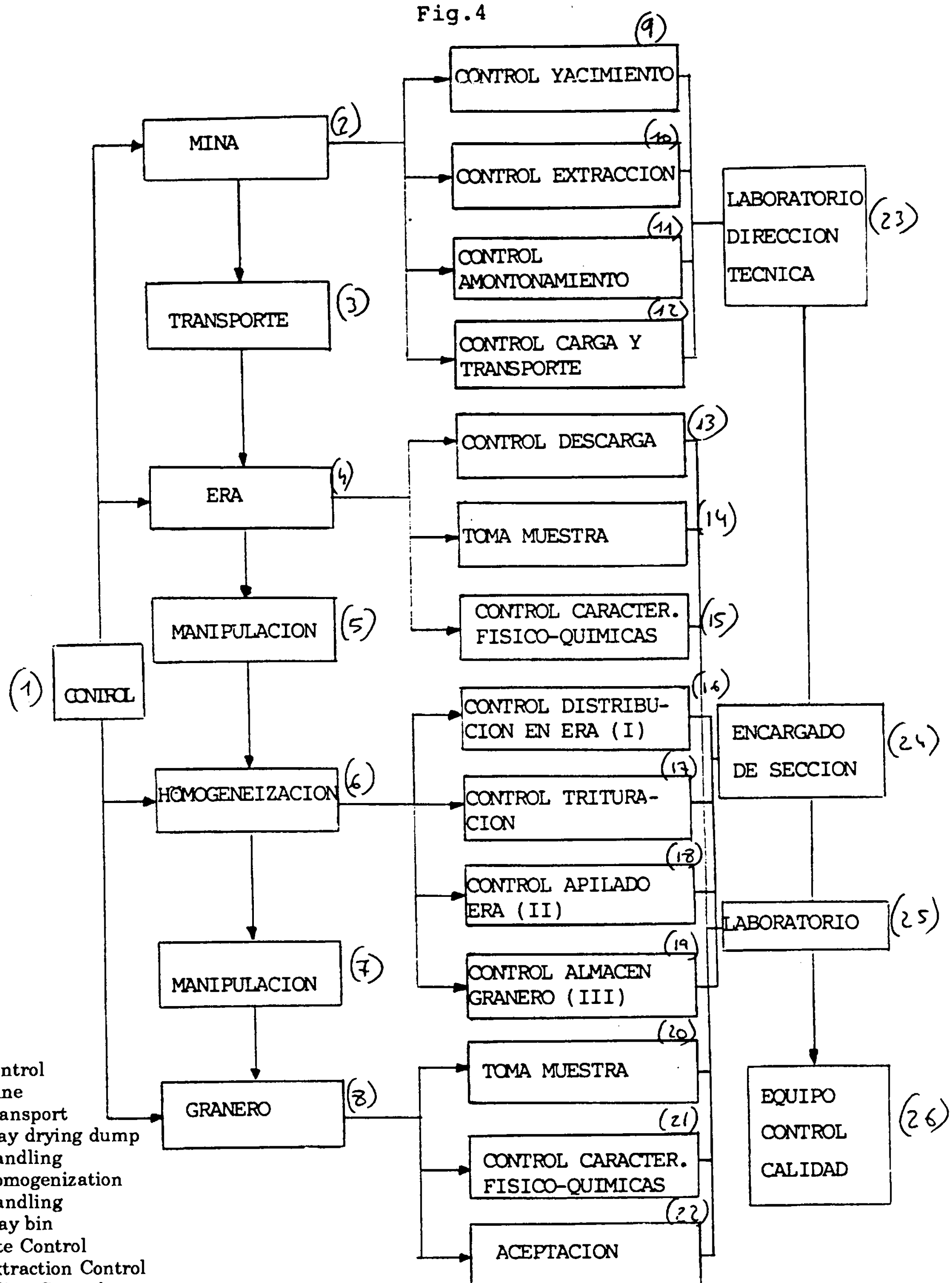

Fig 4

1. Control
2. Mine
3. Transport
4. Clay drying dump
5. Handling
6. Homogenization
7. Handling
8. Clay bin
9. Site Control
10. Extraction Control
11. Piling Control
12. Loading & Transport Control
13. Unloading Control
14. Sampling
15. Control of Physical-Chemical properties
16. Control of distribution in clay drying dump (I)
17. Trituration Control
18. Piling control in clay drying dump (II)
19. Warehouse control in clay bin III
20. Sampling
21. Control of Physical-Chemical properties
22. Acceptance
23. Management of Technical Laboratory
24. Section Head
25. Laboratory
26. Quality Control Team

Fig 6

Section	Process	Operation	Control
1 Preparation materials for the clays and secondary	1 Creation of of mixing bed	1 Receiving materials	1 Receiving of 2 Visual Inspection principal
		2 Test Quality	1 Take a sample raw 2 Particle measurement materials 3 Carbonates 4 Plasticity 5 Creation of specimens 6 Loss through calcination 7 Water Absorption 8 Mechanical Resistance
		3 Creation of mixing	1 Visual inspection 2 Test trituration 3 Humidity before bed storage 4 Creation of batch
		4 Acceptance batch of lot	1 Creation of pilot 2 Sampling of layers 3 Chemical analysis of sample 4 Plasticity 5 Carbonates 6 Creation of Specimens 7 Water Absorption

Fig 7

Section	Process	Operation	Control
			8 Resistance to flexing 9 Industrial test 10 Acceptance
	2 Storage of accepted	1 Serve the material from the mixing bed material bed	1 Serve the material from the mixing
3 Moulding	1 Pressing	1 Feed the hopper	1 Feeding 2 Humidity of grains 3 Regulation of sensors in the hopper
		2 Sieve	1 Check sieve mesh 2 Check vibrating motor 3 Particle measurement of reject
		3 Press	1 Load mould 2 Speed of carrier 3 Pressure of the press 4 Temperature of moulds 5 Cleaning of moulds 6 Size of moulds 7 Impacts per pressing 8 Cycles per minute

Fig 8

Section	Process	Operation	Control
		4 Test the pressed	1 Weight of each piece 2 Size of each piece piece 3 Compacting 4 Mechanical resistance 5 Texture and appearance of the surface
		5 Suck in powder	1 Aspiration of powder
	2 Pre drying	1 Pile up cart	1 Correct disposition in the of the base of the cart 2 Correct disposition of the pieces with each other
8 Classification	1 Revision	1 Take a represen-tative sample	1 Take a representative sample
Packing		2 Final quality	1 Size 2 Curvature control 3 Surface defects 4 Crazing 5 Chemical agents 6 Hardness 7 Perfect finish

Fig 9

SECTION	PROCESS	OPERATION	CONTROL
	2 Packaging	1 Receipt of Boxes	1 Check Transport Document 2 Receipt of Boxes
		2 Quality of Cardboard	1 Take sample 2 Measurements 3 Strength 4 Ink 5 Printing errors 6 Capacity
		3 Store	1 Store
		4 Take for packaging	1 Take for packaging
		5 Packaging	1 Packaging
		6 Receipt of pallets	1 Receipt of pallets
9 Warehousing and despatch	1 Entry	1 Reception	1 Reception Visual Inspection
		2 Test quality	1 Taking of representative sample 2 Check panels

Fig 10

SECTION	PROCESS	OPERATION	CONTROL
		3 Approval	1 Approval
	2 Warehousing	1 Piling	1 Perfect sorting 2 Perfect stacking 3 Check periodically
	3 Despatch	1 Shipping	1 Check stock 2 Perfect palletising 3 Correctly loaded in transport 4 Despatch registered
10 Claims	1 Receipt of Complaints	1 Notification of Complaint	1 Receipt of notification 2 Make contract with Sales person
		2 Analysis	1 Check shipment 2 Check whether controls were carried out 3 Diagnose cause of Complaint
		3 Solution	1 Visit customer 2 Solve problem from factory.

This is the pattern we will use for the section on the preparation of the slurry or slip: Pressed, Dried, Pressed, Dried, Preparation of Enamels, Enamelling, Storage, Firing, Classification and Wrapping, Warehousing and Despatch, Claims and Complaints etc (Sections outside of production will be included here).

Later the SPECIFICATIONS are defined, taking into account the qualifications of the operator, the means available in the Laboratory, the exactitude required. At this point we also define the distribution of responsibilities and the information flow (Figs 11, 12, & 13).

For convenience tables like figures 14, 15 and 16 are drawn up. These define the LIMITS OF CONTROL (MAXIMUM AND MINIMUM) and the WARNING LIMITS (MAXIMUM AND MINIMUM). These are the limits which define the range of the variable in question, in other words, we define the variations permitted for each parameter.

Fig. 17

INCORRECT VALUE
\+ -.-.-.-.-.-.-.-.-.-.-.-.-.- UPPER LIMIT OF TOLERANCE
↑ -.-.-.-.-.-.-.-.-.-.-.-.-.- UPPER WARNING LIMIT
———————————— STANDARD VALUE
↓ -.-.-.-.-.-.-.-.-.-.-.-.-.- LOWER WARNING LIMIT
\- -.-.-.-.-.-.-.-.-.-.-.-.-.- LOWER LIMIT OF TOLERANCE
INCORRECT VALUE

This table covers the periodicity of the test according to the state of the system as well as other information.

Fig. 11

SPECIFICATIONS

SECTION	1
PROCESS	1
OPERATION	1
N.º	0 (Receiving of material)

TEXT: Before unloading, the driver of the lorry must hand over the weight certificate to the Section Head responsible for clays (Head of Laboratory) or, in his absence, the Section Controller, who must subsequently notify the arrival of the material to the Section Head (Head of Laboratory).

The Section Head, or in his absence the Controller, must inspect the lorry.

The Section Head, or in his absence the Controller, is responsible for taking a sample from the lorry.

Fig. 12

SPECIFICATIONS

SECTION	1
PROCESS	1
OPERATION	1
N.º	1 (Receiving and inspection of material)

TEXT: Sampling will be carried out on a daily basis for control tests.

Every day a 50kg sample will be taken from each batch of lorries of the same clay. The sampling must be done carefully taking into account the requirements for good sampling: different sample points, different depths, different agglomerates etc. (5kg from each lorry).

The person carrying out the process will divide these until he has samples of 3kg each. These 3kg will be further broken down in the laboratory into 1kg samples - of which 500g will be dried in the oven at 105 ± 5ºC and the other 500g will be packaged and stored in the sample file. This file will be renewed approximately every 6 months.

These two samples will be labelled for future identification with a key something like the following:

a/b/c/d/e	a) interval between lorries		
10-20/2/4/5/82	b) clay, 1,2,3 e) year	c) day	d) month

Fig 13

SPECIFICATIONS

SECTION	1	
PROCESS	1	
OPERATION	2	
Nº	8	(Mechanical resistance)

TEXT: Take the piece fired according to specification 1126 and measure its length and thickness. Then place the piece on the two supports of the apparatus according to the corresponding DIN specification, that is to say, symmetrically distributed so that the ram will come down exactly in the middle. Once this is done trigger the mechanism or activate it manually until the piece breaks. At this point, the needle will indicate a value of A Kg. The value expressed in Kg/cm2 will be:

$$^{K}g/cm2 = \frac{3.A.d}{2\,h^2.\,L}$$

A = reading in Kilograms

d = distance between supports under the piece

h = thickness of the piece

L = width or cross section of the piece over which the mechanism acts

On the basis of this documentation the organizational charts and diagrams necessary to define the work flow path and the allocation of responsibilities for each variable controlled are made. Some examples are attached (Fig 21, 22, 23 and 24).

To ensure the proper functioning of a global system involving such a large number of variables, it is extremely useful to automate it with a computer program specially designed for the purpose. In this way, the results of each test for the variable in question can be put on the computer and registered automatically as follows:

a) Mean value
b) Standard deviation
c) Warning Limits deviation
d) Control Limits deviation
e) Work flow path and action in case c
f) Work flow path and action in case d
g) Register of trends
h) Periodical accumulation of data

h.1 - a
h.2 - b
h.3 - c
h.4 - d
h.5 - e
h.6 - f
h.7 - g

Fig.14

DEPARTAMENTO CONTROL DE CALIDAD — SECCION: RECEPCION ATOMIZADO

PROCESO OPERATIVO	MAGNITUD A CONTROLAR	ENSAYO	TIPO DE PRODUCTO	LIMITES INFER.	LIMITES SUPER.	LIMITES ADVERT.	FRECUENCIA TOMA MUESTRAS NORMAL	FRECUENCIA TOMA MUESTRAS ADVERT.	CANTIDAD DE LA MUESTRA	OBSERVACIONES Y VARIACIONES
ENTRADA CAMIONES ARCILLA ATOMIZADA	HUMEDAD ATOMIZADO	SPEEDY	GRES	5,0	5,6	5,2-5,4	CAMION	REPETIR ENSAYO	5 gr	
			P. ROJA	4,6	5,4	4,8-5,2	"	"	"	
			P. BLANCA							
		ESTUFA	GRES	5,0	5,6	5,2-5,4	CAMION	"	100 gr	
			P. ROJA	4,6	5,4	4,8-5,2	"	"	"	
			P. BLANCA							

Fig.15

PROCESO OPERATIVO	MAGNITUD A CONTROLAR	ENSAYO	TIPO DE PRODUCTO	LIMITES			FRECUENCIA TOMA MUESTRAS		CANTIDAD DE LA MUESTRA	OBSERVACIONES Y VARIACIONES
				INFER.	SUPER.	ADVERT.	NORMAL	ADVERT.		
	DISTRIBUC. GRANULO-METRICA	GRANU-LOME--TRIA	GRES				DIARIA	REPETIR ENSAYO	100gr	
			P. ROJA	CURVA Tabla	TIPO nº 2		"	"	"	
ALMACE-NAMIEN-TO EN SILOS	RECHAZO TAMIZ malla 65 mm		GRES	5,0%	6,0%	5,2-5,8%	DIARIA	REPETIR ENSAYO	100gr	
			P.ROJA	5,0%	6,0%	5,2-5,8%	"	"		
			P.BLANCA				"	"		
	CARBONA-TOS EN EL ATOMI-ZADO	CALCI-METRIA	GRES	1,0%	3,0%	1,2-2,8%	DIARIA	REPETIR ENSAYO	5 gr	
			P.ROJA	12%	14%	12,2-13,8	"	"	"	
			P.BLANCA				"	"	"	
	CARBONA-TOS EN EL RECHA-ZO	CALCI-METRIA	GRES	2,0%	4,5%	2,1-4,4%	DIARIA	REPETIR ENSAYO	5 gr	
			P.ROJA	4,0%	5,0%	4,1-4,9%	"	"	"	
			P.BLANCA				"	"	"	
	FLUIDEZ VOLUME-TRIA	FLUIDO-METRO	GRES	29	30	29,2-29,8	DIARIA	REPETIR ENSAYO		
			P.ROJA P.BLANCA	29	30	29,2-298	"	"		

Fig.16

MAGNITUD A CONTROLAR EN CADA OPERACION (X)	PATRON O MAGNITUD DIRIGENTE (W)	LIMITES propiedades medibles CONTROL		ADVERTENCIA		FRECUENCIA DE LA TOMA DE MUESTRA SEGUN ESTADO			CANTIDAD DE LA MUESTRA
		Infe. LCi	Super. LCs	Infe. LAi	Super. LAs	NORMAL	ADVERTENCIA	ALARMA	
423 <u>Control sobre esmaltes</u>									
1 Frita	Patron					CADA	PARTIDA		Muestreo lote piloto
2 Color	"					"	"		
3 Materias Primas	"					"	"		
4 Piezas laboratorio	"					"	"		
434 <u>Propiedades del esmalte molido</u>									
1 Rechazo	Ficha de esmalte					CADA	MOLINO		500 cc
2 Densidad		-0,02	+0,02	-0,02	+0,02	"	"		
3 Viscosidad		- 5%	+ 5%	- 2%	+ 2%	"	"		
451 <u>Acondicionar el esmalte</u>									
2 Densidad	Ficha aplicación	-0,02	+0,02	-0,01	+0,01	1 hora	30 minutos	15 minutos	200 cc
3 Viscosidad		- 4%	+ 4%	-1,5%	+1,5%	"	"	"	
453 <u>Probar la pieza</u>									
1 Peso aplicado	Ficha esmalte			-1 gm	+2 gm	1 hora	30 minutos	15 minutos	2 piezas
2 Velocidad de secado	Observar					"	"	"	
3 Defectos	"					"	"	"	

i) Proposal of a new standard for specific lines
j) ABC analysis for certain variables
k) Pareto analysis for some variables
l) Type n2+1 factorial statistical analysis for accumulated series.
m) Display of bibliographical report for systematic series in e and f.

EQUIPMENT AND COST

At first glance it might appear that a large team would be necessary to carry out this system, and a large quantity of material resources. This is not true, and in any case the problem consists in studying in advance the balance between such costs and the benefits which they bring.

A. In the first place an "on-site" and "just-in-time" control should be considered from various viewpoints:

- In the first place an AUTOCONTROL is required in each section. This must be carried out by the members of the Department at regular intervals.

- In the second place a CENTRAL CONTROL team is envisioned who repeat some of the checks done, using representative statistical sampling, and in addition carry out other checks, complementary or not, at defined regular intervals.

- In the third place the contraction of outside services is envisioned in order to repeat some tests of statistical sampling, totally representative, at defined regular intervals.

Thus, these three aspects must be taken into account when considering the team and therefore the costs, independently of whether or not the management of the system is centralised.

With regard to the previous statement, I would like to point out that this model contains a premise of outstanding importance:

Control which is exercised on-site while the operation is going on is only useful if it is dealt with in the same way, that is to say at the time of sampling, and in the same place. The mere accumulation of data does not resolve problems and if the data is not processed until later, the accumulated cost may be excessive. What we have to do is completely abandon the concept of a control team which collects data and makes this activity the principal reason for its existence.

Thus the information is increased by continuous feedback provided by AUTOCONTROL and CENTRAL CONTROL. This is done for more stable variables or those which affect a larger volume of intermediate material by AUTOCONTROL AND CENTRAL CONTROL and for those which affect the largest volume of partly finished products by CENTRAL CONTROL and OUTSIDE CONTROL.

B. A study of the cost of such a systems is shown in figures 25, 26, 27, and 28, which include the cost of quality (cost of prevention and evaluation) as well of those of lack of quality (internal and external losses), with the object of producing a balance which shows, or at least gives us an idea, of the profitability of the system.

Autocontrol only implies having adequate means at the work places because the members of the team belong to the production department. Therefore, the only requirements are material goods and processing of the information.

The equipment is that which is usually used in factories. In the case of a typical factory with a production capacity of 5 to 6 thousand m2 per day the whole cost might amount to 2 million pesetas.

The Central Control Team in the same example would be made up of three people so that one would deal with raw materials, another the process itself, and the third the finished product.

Two sets of equipment are needed for this team since on the one hand it shares the set which belongs to Autocontrol, and on the other hand it has another which is needed for specific tests, which is similar to that currently in existence in the laboratory of companies which already have it. We estimate the cost of this equipment to be around 5 million pesetas including the necessary computers.

The person in charge of the team has the title of Head or Director, depending on the size of the Company.

For the third type of control and checks a contract with an outside research centre is necessary, either annually or on a specific job basis.

The cost of such services might be around 1 million pesetas annually including the cost of training the team. Thus we have the totals of these costs for one year:

Work Force:	10,000 x 1,000 pts per annum
Material:	700 x 1,000 " "
Maintenance:	100 x 1,000 " "
Outside Contract :	1,000 x 1,000 " "
TOTAL:	11,800 x 1,000 pts per annum

A factory such as the one in the example will have an annual production of approximately 1,500 million pesetas so that this cost represents about 0.8% of total invoicing or in other terms 1.2% of the industrial cost, the equivalent of 5 ptas per m2.

C. Now we will show a typical example which permits us to calculate its profitability.

In the case of a defect which only shows up after firing such as a piece out of square, dents, or calibre between pieces.

Figure 29 shows the process of fabrication by stages and the accumulative of same with time is shown.

Supposing that the defect is predominantly caused during the pressing operating it is clear that, according to this diagram, we will have to store material for a day. We must add the delay starting up fabrication after the period of adjustment involved in such an operation to ensure total elimination of the defect.

If the usual classification results of the plant were:

FIRST: 80% SECOND: 12% THIRD: 8%

The result of the day would be very different depending on whether the material were all SECONDS, all THIRDS or even if there were 50% of FIRSTS. The financial loss would be 500,000 ptas, 1,300,000 ptas, or 200,000 ptas respectively.

These two examples which are examples of internal losses show that the proposed system is not only necessary, but also profitable. If to this we add external losses, which can be evaluated in the same way and occasionally are even more dramatic that what we have seen, the profitability of a model such as this one can be clearly seen.

To give an better idea of the costs and advantages of the system Figure 30 shows the figures prior to the implementation of the system together with experimental data taken from the field.

IMPLEMENTATION

The description of the method itself covers certain elements of its implementation and at this point we only make reference to the periodicity, that is, the timing (Fig 31).

CONCLUSION

This proposal of total quality control in the plant is a part of a broader program which we are developing called TOTAL QUALITY CONTROL which is summarised in Fig 32.

Fig.21

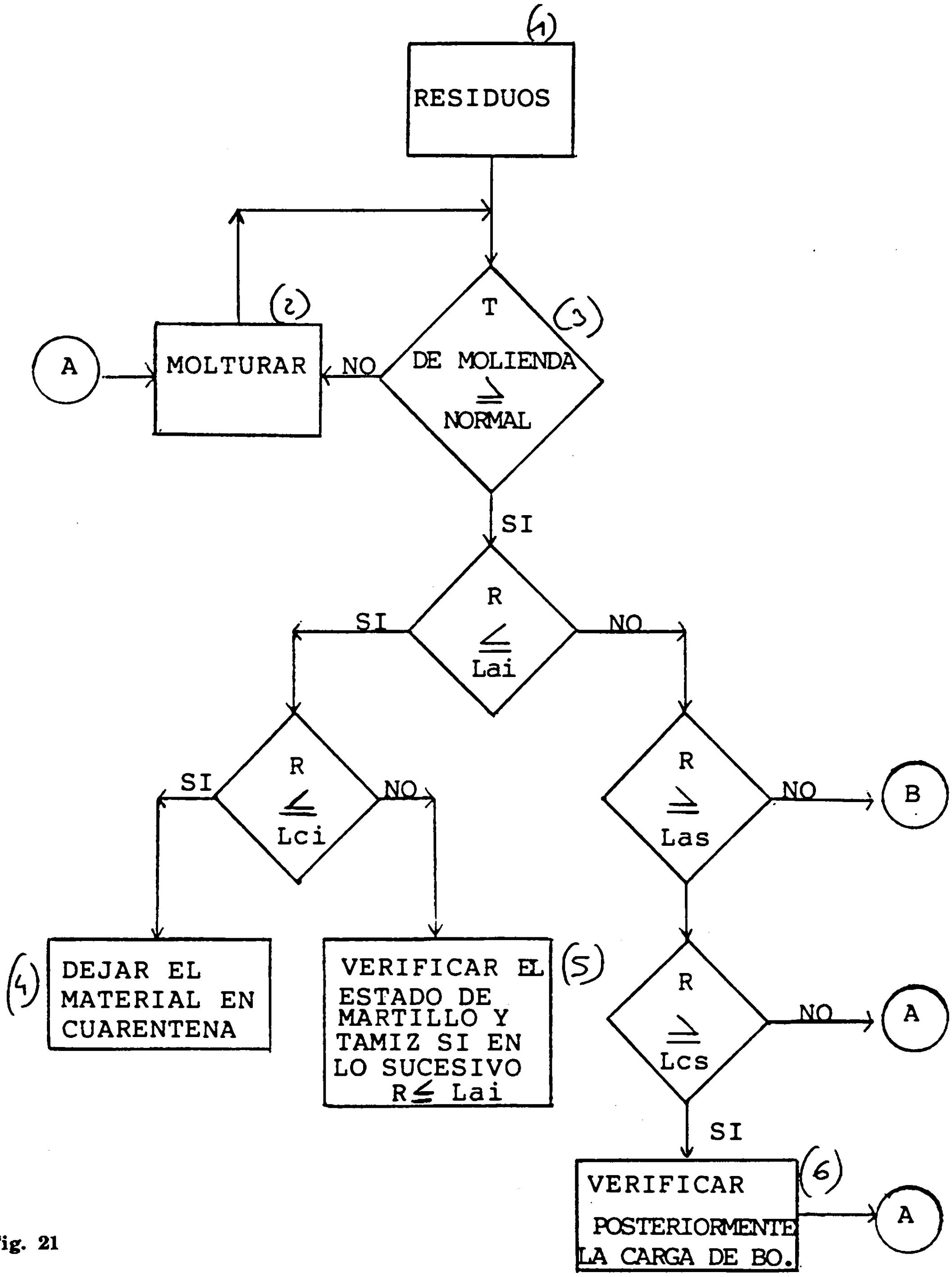

Fig. 21

1. RESIDUAL MATERIAL
2. GRIND
3. CORRECTLY GROUND - NORMAL
4. LEAVE MATERIAL IN QUARANTINE
5. VERIFY CONDITION OF HAMMER AND SIEVE IF IN THE NEXT ITERATION R Lai
6. VERIFY LOAD OF B.O. AFTER THIS STEP

Fig.22

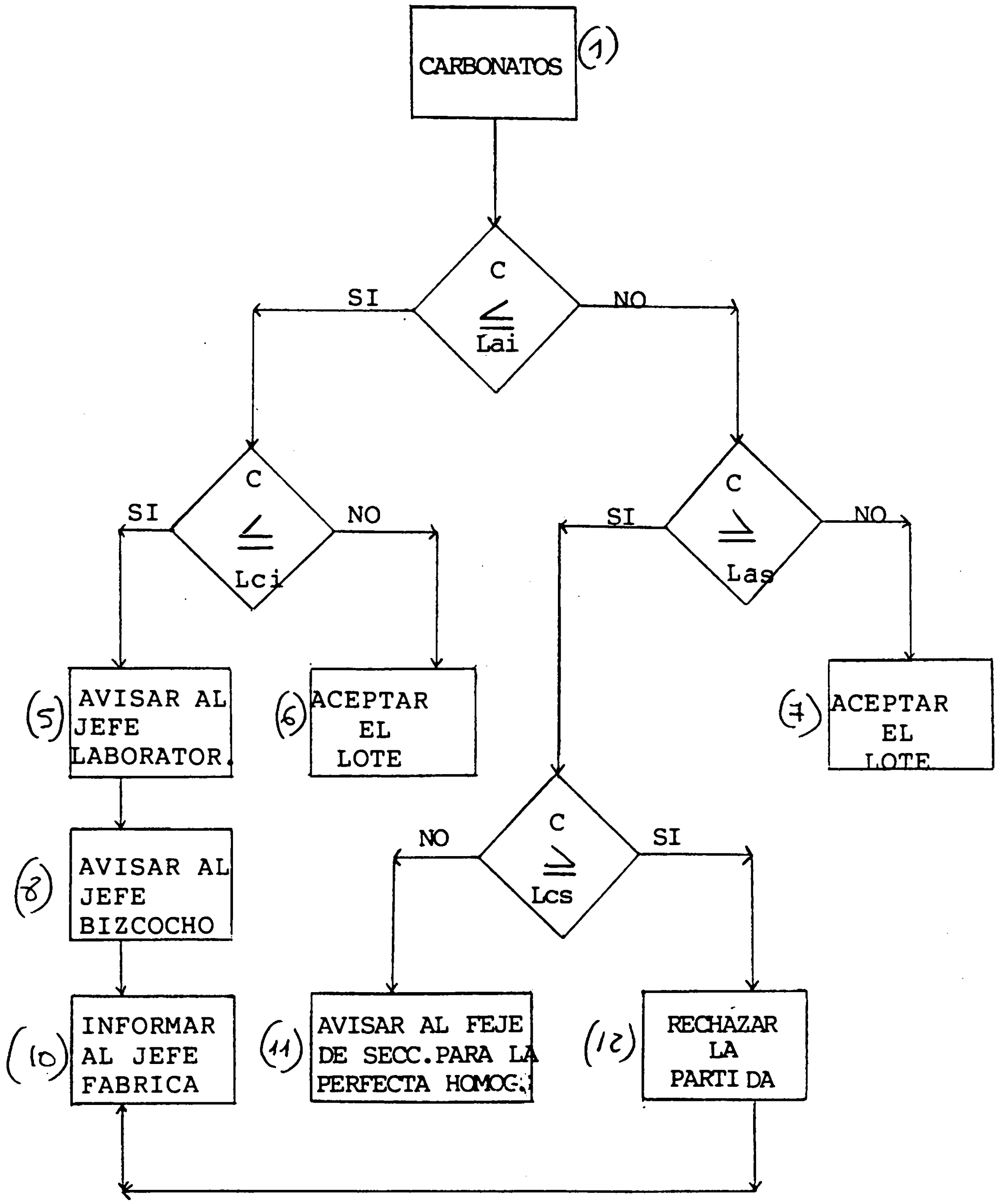

Fig 22

1. CARBONATES
5. ADVISE HEAD OF LABORATORY
6. ACCEPT LOT
7. ACCEPT LOT
8. ADVISE BISCUIT HEAD
10. INFORM FACTORY MANAGER
11. ADVISE SECTION HEAD TO PERFECT HOMOGENISATION
12. REJECT LOT

Fig.23

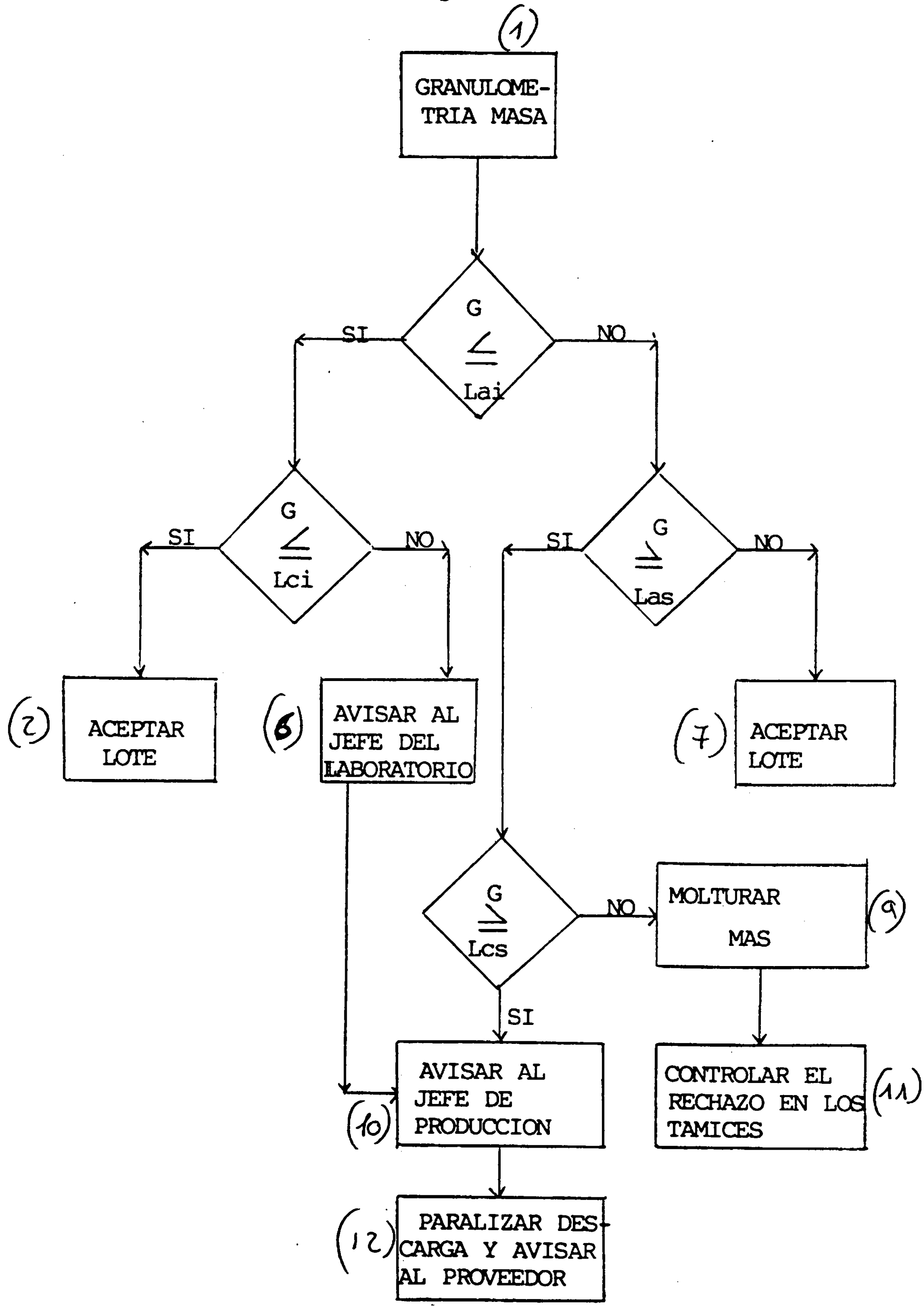

Fig 23

1. PARTICLE MEASUREMENT OF MIX
5. ACCEPT LOT
6. ADVISE LABORATORY HEAD
7. ACCEPT LOT
9. GRIND MORE
10. ADVISE PRODUCTION MANAGER
11. CONTROL SIEVE REJECTS
12. STOP UNLOADING AND ADVISE SUPPLIER

Fig.24

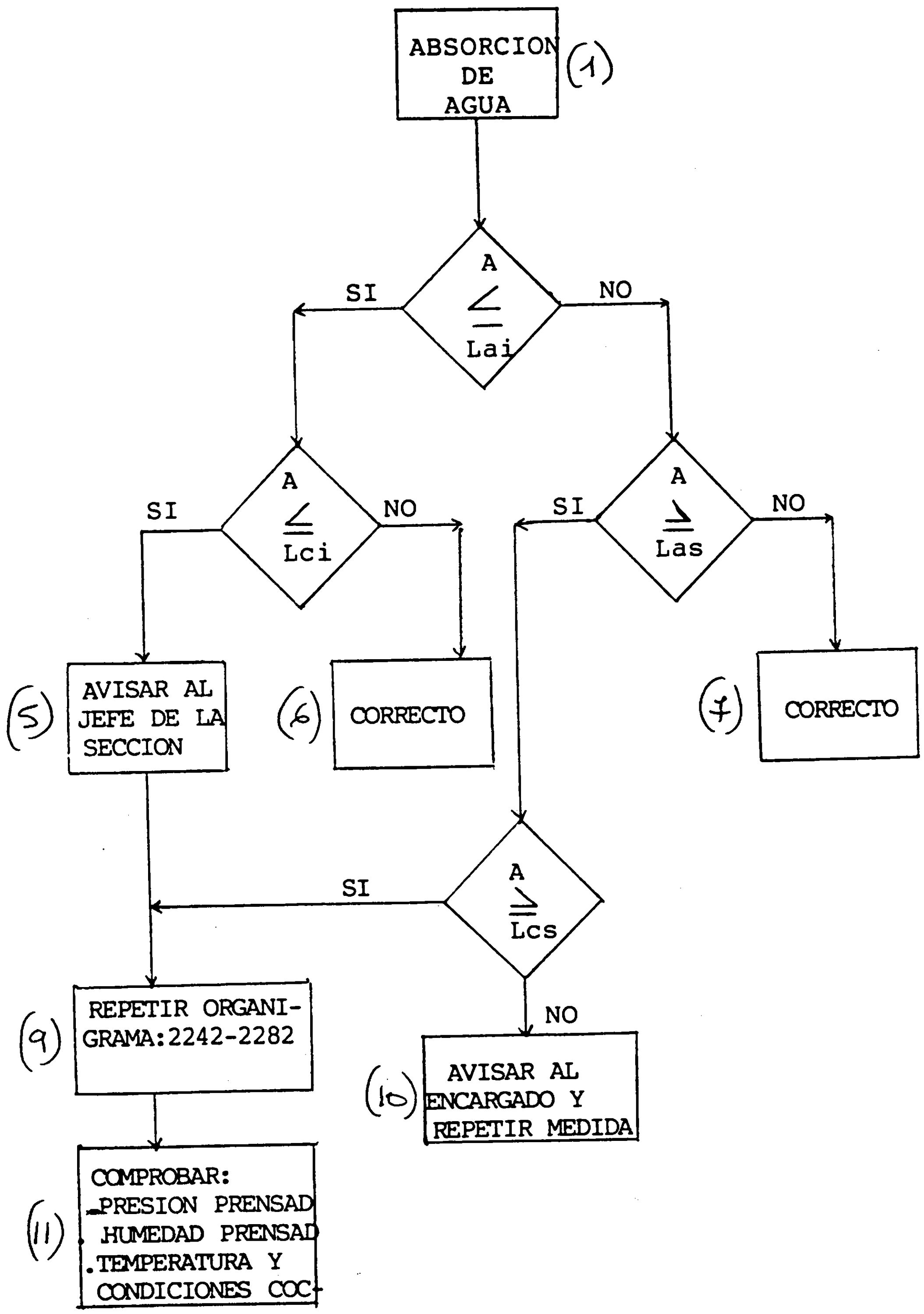

Fig 24

1. WATER ABSORPTION
5. ADVISE DEPARTMENT HEAD
6. CORRECT
7. CORRECT
9. REPEAT DIAGRAM: 2242-2282
10. ADVISE FOREMAN AND REPEAT MEASURE
11. CHECK: PRESSING PRESSURE HUMIDITY OF PRESSED CLAY TEMPERATURE AND FIRING CONDITIONS

Fig.24 bis

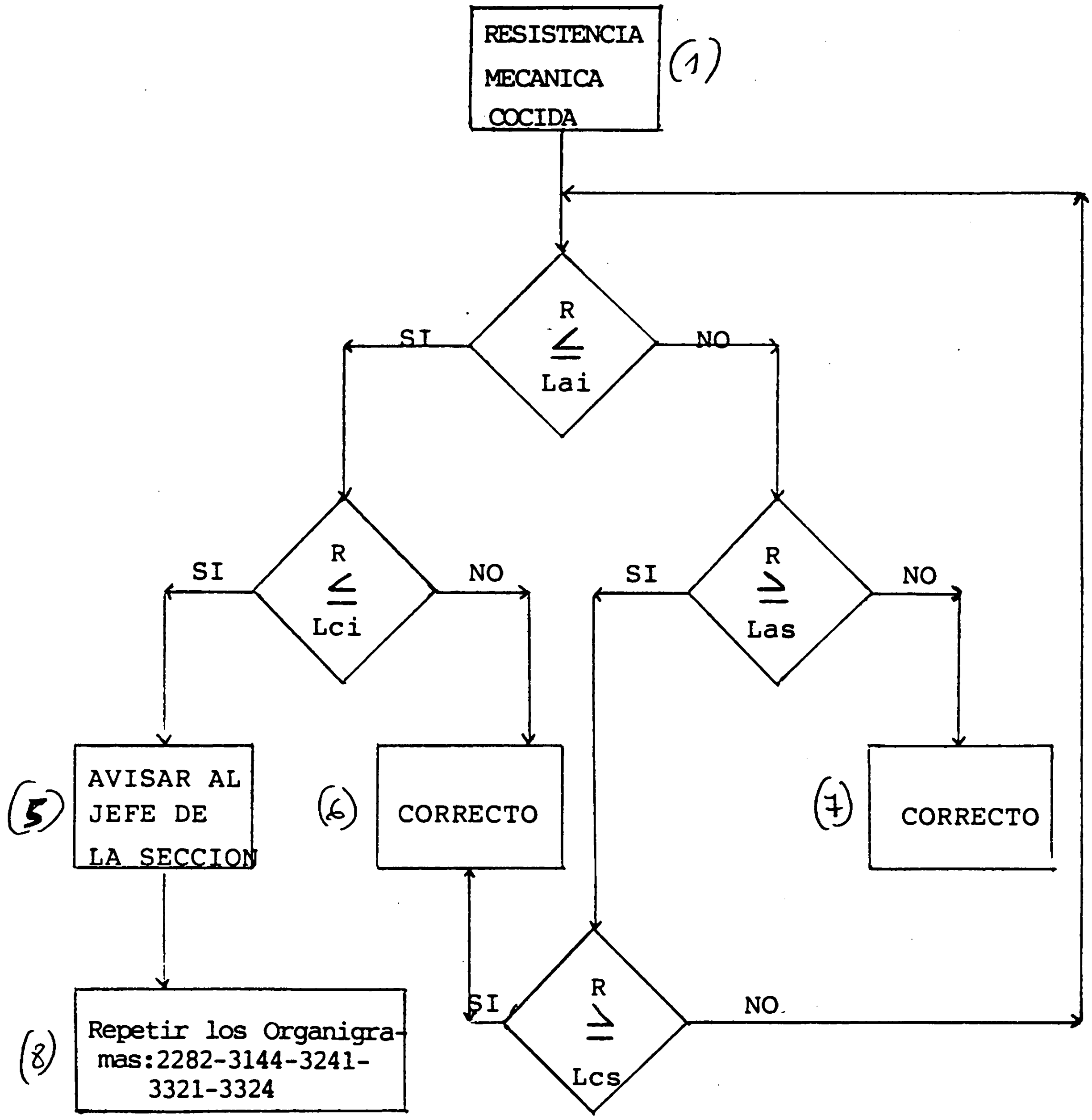

Fig 24 bis

1. MECHANICAL RESISTANCE OF FIRED PIECE
5. ADVISE DEPARTMENT HEAD
6. CORRECT
7. CORRECT
8. REPEAT DIAGRAMS: 2282-3144-3241-3321-3324

Fig.25

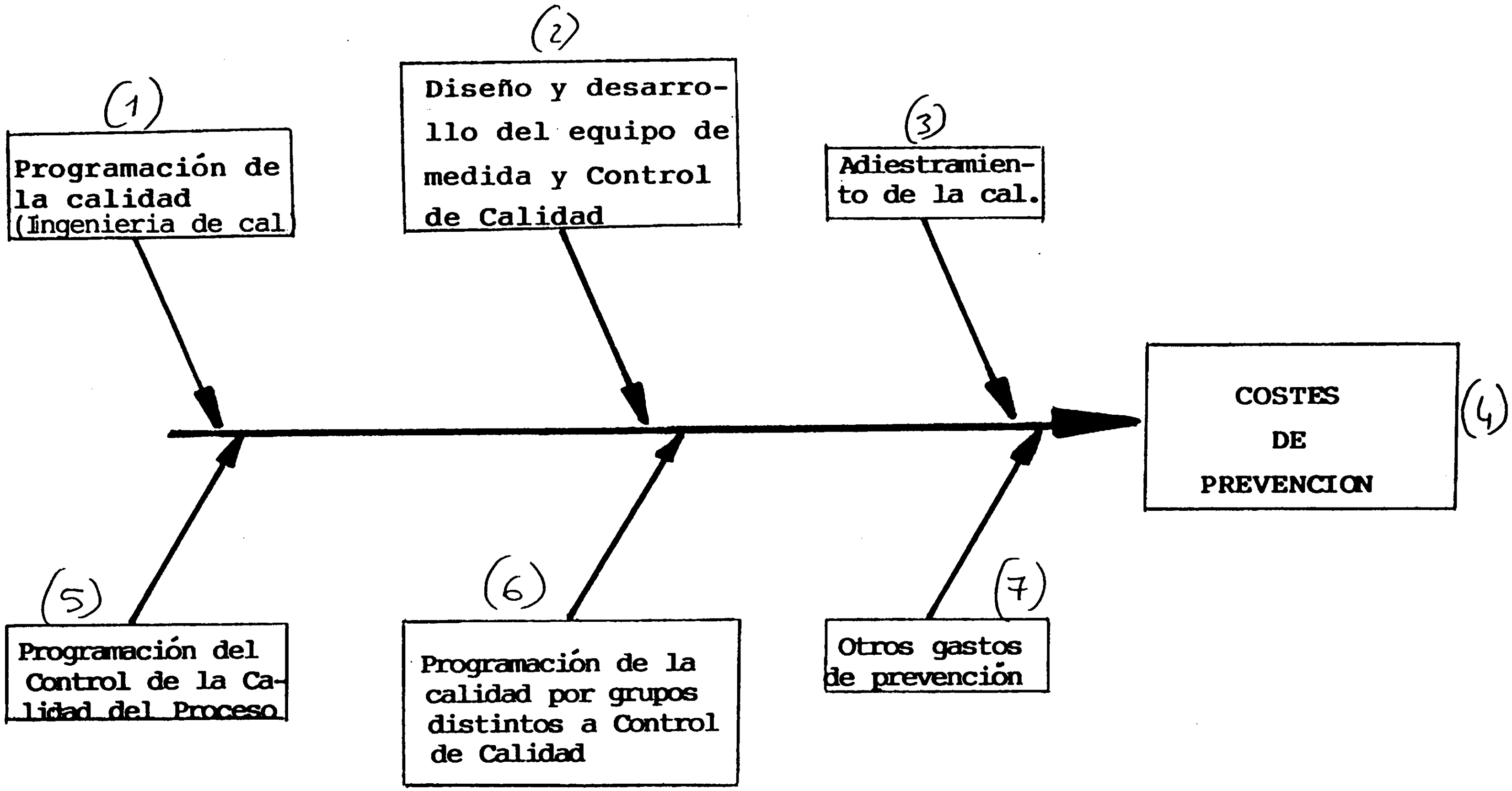

Fig 25

1. Programming of Quality (Quality Engineering)
2. Design and development of measuring and quality control team
3. Training for quality
4. Cost of Prevention
5. Programming of the Quality Control of the Process
6. Programming of Quality Control by groups other than the Quality Control Department
7. Other prevention costs

Fig.26

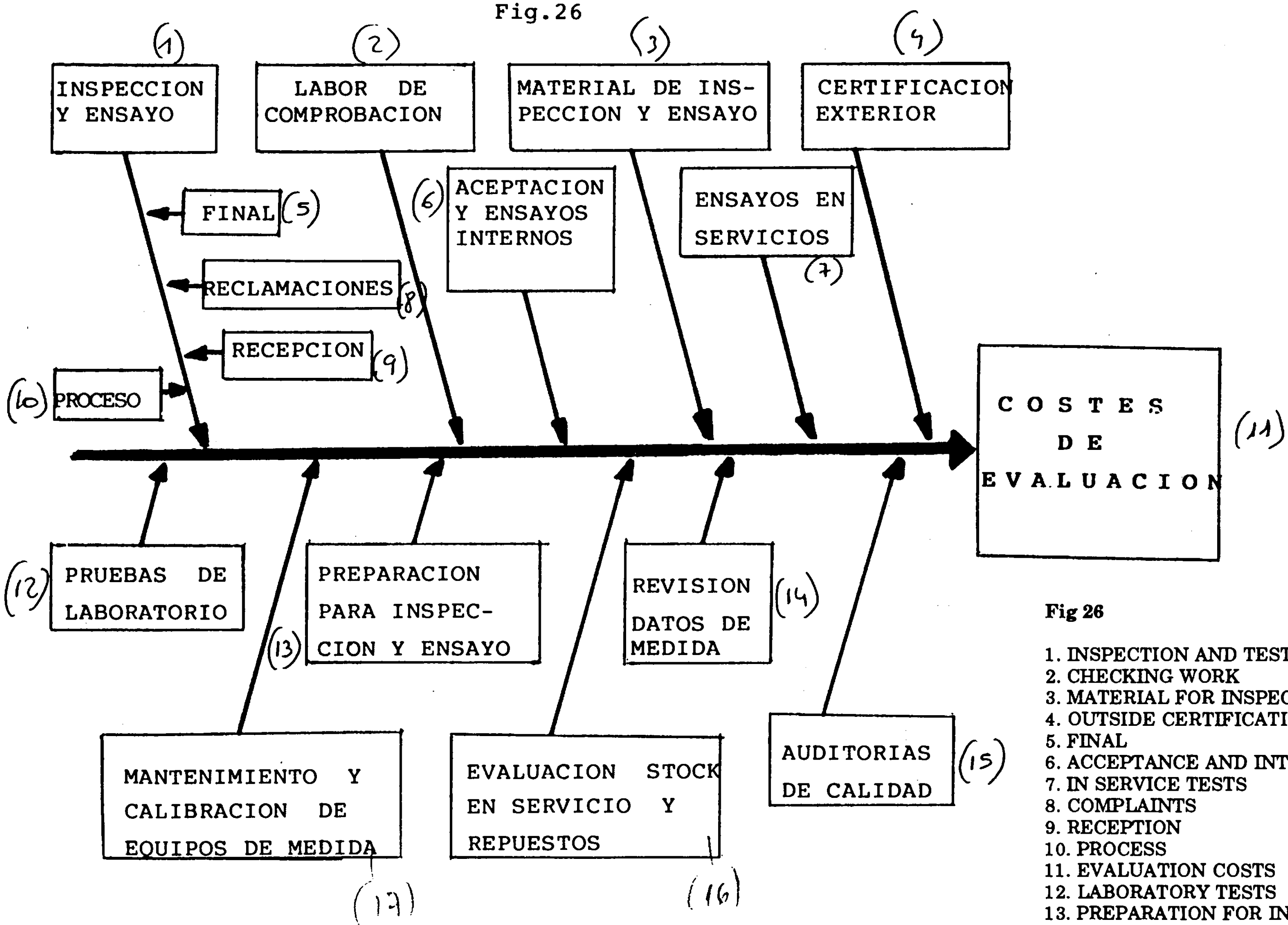

Fig 26

1. INSPECTION AND TESTING
2. CHECKING WORK
3. MATERIAL FOR INSPECTION AND TESTING
4. OUTSIDE CERTIFICATION
5. FINAL
6. ACCEPTANCE AND INTERNAL TESTS
7. IN SERVICE TESTS
8. COMPLAINTS
9. RECEPTION
10. PROCESS
11. EVALUATION COSTS
12. LABORATORY TESTS
13. PREPARATION FOR INSPECTION AND TESTING
14. REVISION OF MEASUREMENT DATA
15. QUALITY AUDITS
16. STOCK EVALUATION IN SERVICE AND STOCKS
17. MAINTENANCE AND GANGING OF MEASURAMENT TEAM

Fig.27

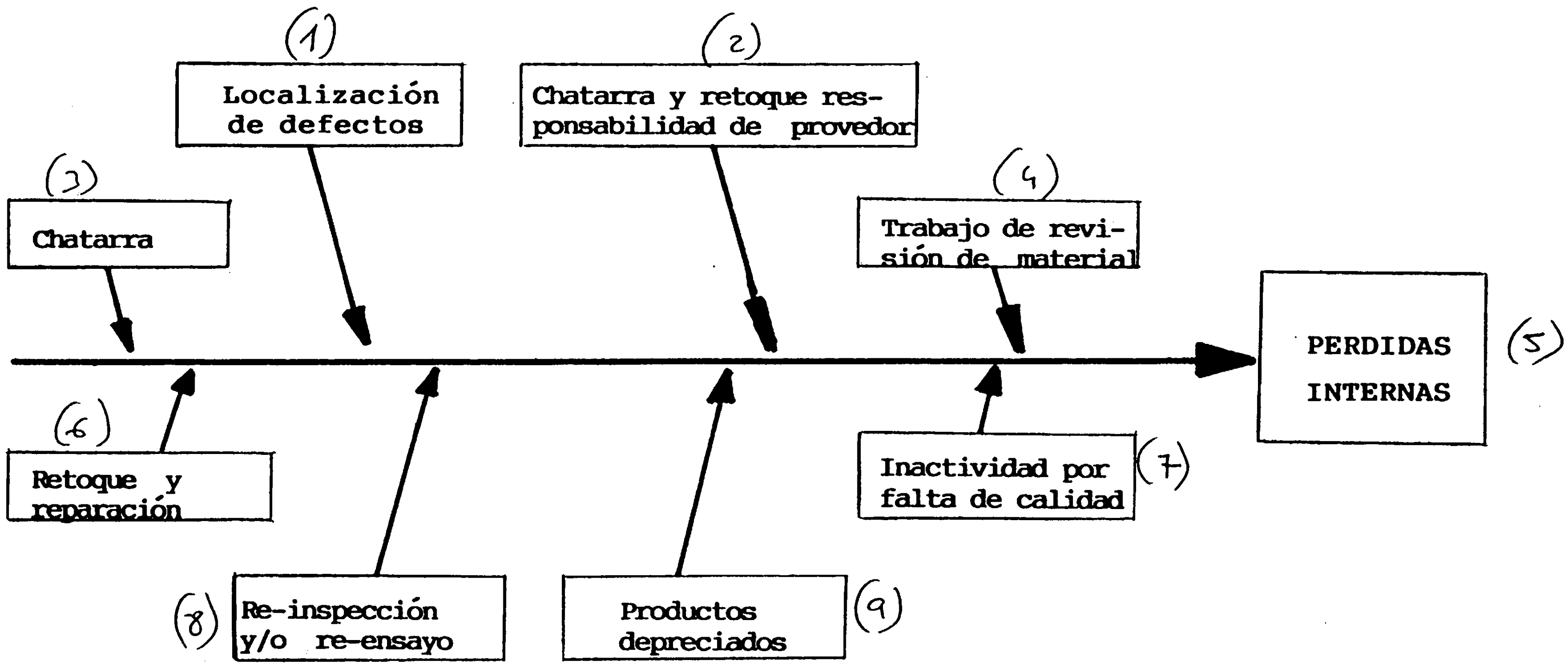

Fig 27

1. LOCALISATION OF DEFECTS
2. WASTAGE AND RETOUCHING - RESPONSIBILITY OF THE SUPPLIER
3. WASTAGE
4. WORK CHECKING MATERIAL
5. INTERNAL LOSSES
6. RETOUCHING AND REPAIR
7. INACTIVITY CAUSED BY LACK OF QUALITY
8. RE-INSPECTION AND/OR RE-TESTING
9. DEPRECIATED PRODUCTS

Fig.28

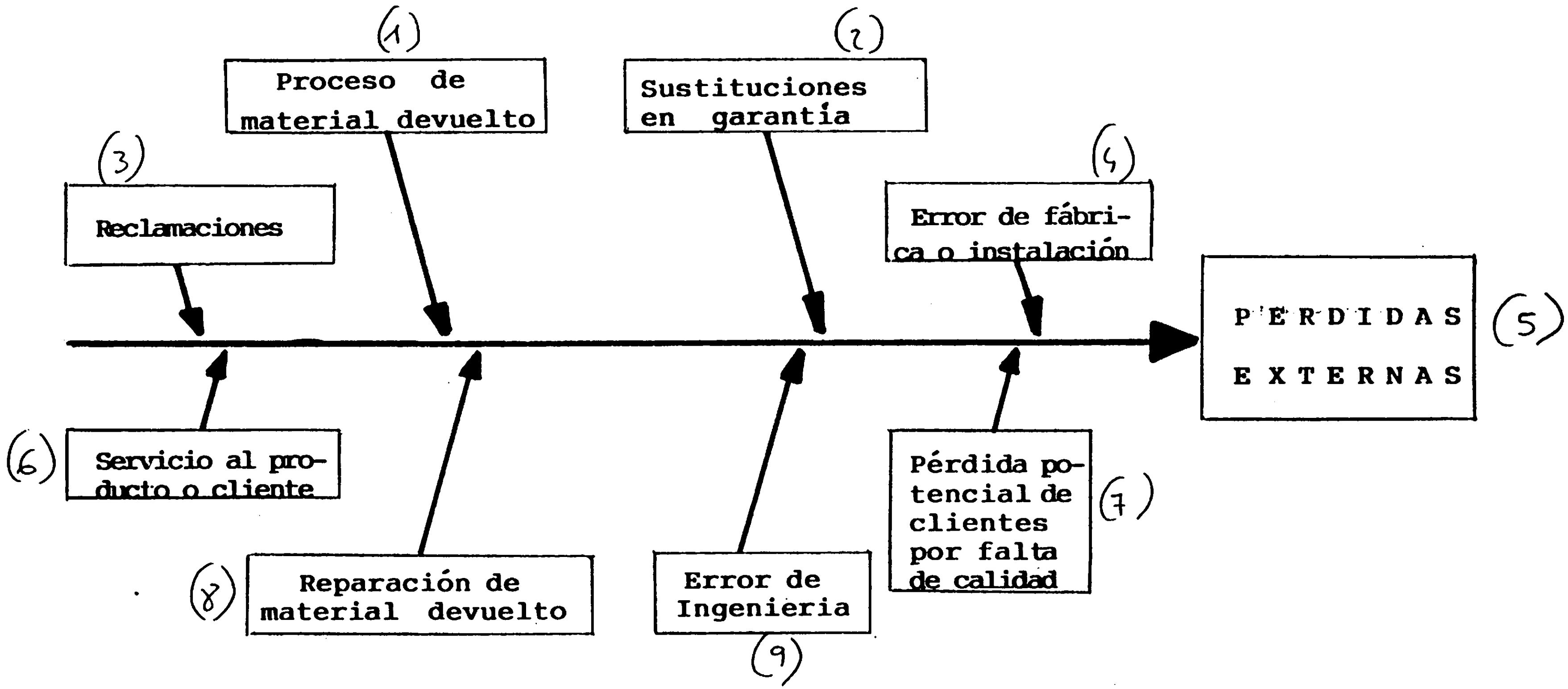

Fig 28

1. PROCESSING OF RETURNS
2. SUBSTITUTION OF MATERIAL UNDER GUARANTEE
3. CLAIMS AND COMPLAINTS
4. FACTORY OR INSTALLATION ERRORS
5. EXTERNAL LOSSES
6. CLIENT OR PRODUCT SERVICE
7. POTENTIAL LOSS OF CUSTOMERS THROUGH POOR QUALITY
8. REPAIR OF RETURNED GOODS
9. ENGINEERING ERROR

Fig.29

Etapas de Fabricación	0	1	2	3	4	5	6	7	8	9
MOLIENDA (M)	----									
STOCK BARBOTINA (B)		---------								
ATOMIZADO Y ENSILADO(AS)				------------						
PRENSA,ESMALTADO Y PARQUE(PES)							----			
COCCION (C)								----		
CLASIFICACION Y ALMACEN (CA)									----	

1. 3M+2B
2. 6M+5B+3AS
3. 7M+6B+4AS+1PES
4. 8M+7B+5AS+2PES+1C
5. 9M+9B+7AS+4PES+3C+1CA

Fig 29

FABRICATION STAGES
GRINDING (M)
STOCK SLIP (B)
SPRAY DRIED CLAY AND CLAY IN SILOS (AS)
PRESS, ENAMELLING AND STORAGE (PES)
FIRING (C)
CLASSIFICATION AND WAREHOUSING (CA)

Fig.30

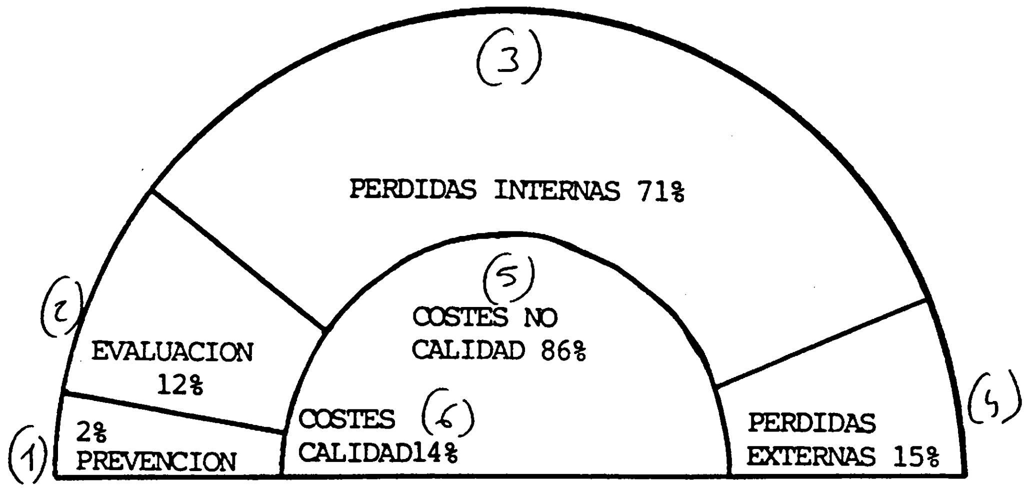

Fig 30

1. PREVENTION
2. EVALUATION
3. INTERNAL LOSSES
4. EXTERNAL LOSSES
5. POOR QUALITY COSTS 86%
6. QUALITY COSTS 14%

Fig.31

		SEMANAS: 1 4 6 8 10 12 14 16 18 20 22 24 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56
1	PARTICIPACION DE LA DIRECCION	XXX
2	EQUIPO DE MEJORA DE LA CALIDAD	XXX
3	MEDIDA DE LA CALIDAD	XXXXXX ---------------------------PERMANENTE
4	COSTE DE LA CALIDAD	XXXXXX ---------------------------XXX XXXXXX
5	MENTALIDAD DE CALIDAD	XXXXXXXXXXXXXXXXXXXXXXX
6	ACCION CORRECTORA	XXXXXX ------------------------PERMANENTE
7	SUPERVISION PARA PREVENCION DE DEFECTOS	XXXXXX
8	PREPARACION DE UNA CAMPAÑA	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
9	ENSEÑANZA DE MAN- DOS INTERMEDIOS	XXXXX
10	LANZAMIENTO DEL PROGRAMA	XX
11	ESTABLECIMIENTO DE OBJETIVOS	XXXXXXXXX
12	SUPRESION DE CAU- SAS DE DEFECTOS	XXXXXXX----------→

Fig 31

1. MANAGEMENT PARTICIPATION
2. QUALITY IMPROVEMENT TEAM
3. MEASURE OF QUALITY ———PERMANENT
4. COST OF QUALITY
5. QUALITY MENTALITY
6. CORRECTIVE ACTION
7. SUPERVISION FOR THE PREVENTION OF DEFECTS
8. PREPARATION OF A CAMPAIGN
9. TEACHING MIDDLE MANAGEMENT AND SUPERVISORS
10. LAUNCH OF PROGRAM
11. DEFINING OBJECTIVES
12. ELIMINATING CAUSES OF DEFECTS

Fig.32 CONSTRUCCION DE LA CALIDAD EN SIETE ETAPAS

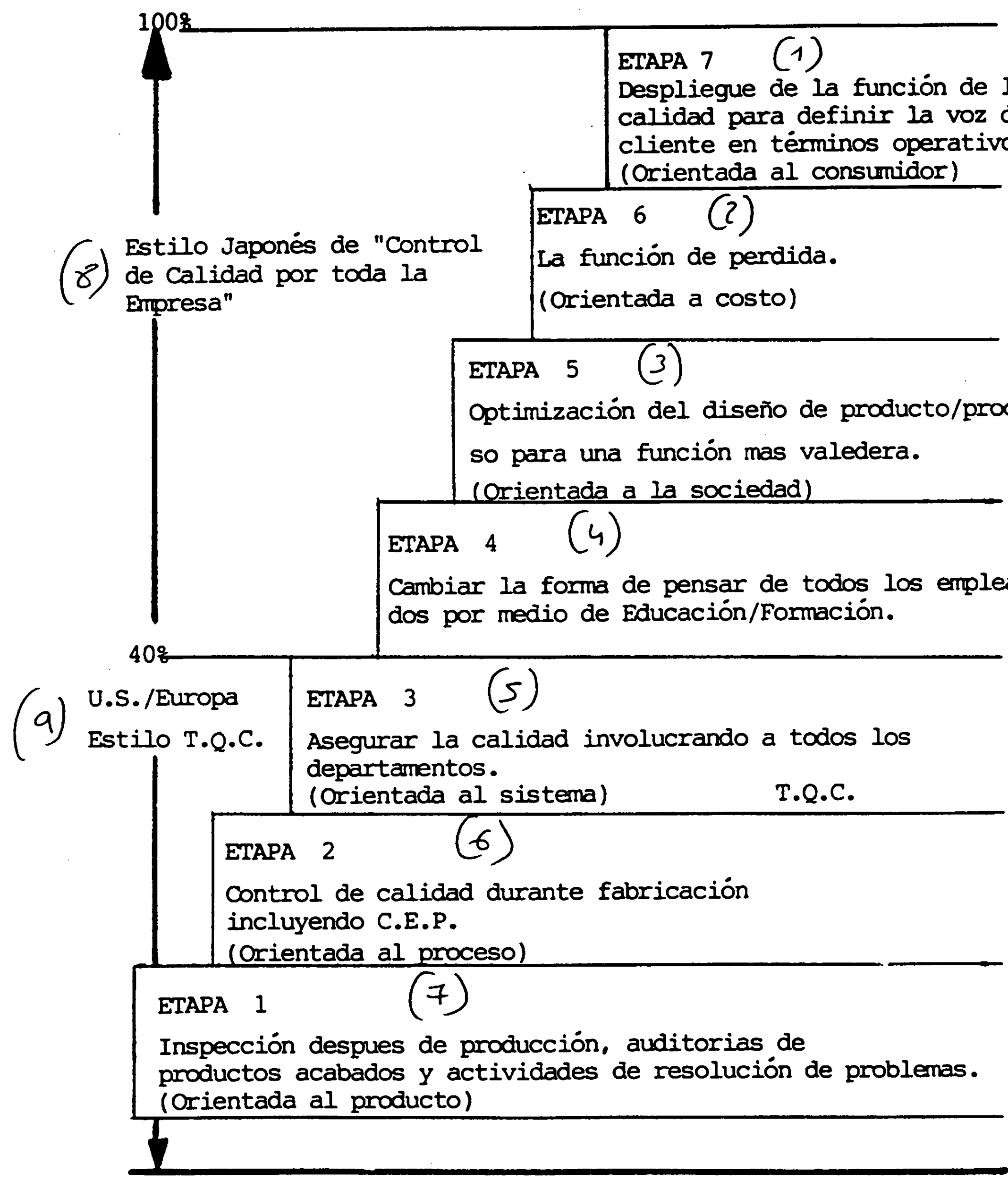

Fig 32 - CREATING QUALITY IN SEVEN STAGES

1. **STAGE 7** - Define the function of quality in order to include the wishes of the client in operational terms. (Consumer oriented)
2. **STAGE 6** - The function of loss (Cost oriented)
3. **STAGE 5** - Optimisation of Product/Process Design to achieve a more valid operation. (Company oriented)
4. **STAGE 4** - Changing the way of thinking of all employees through education and training
5. **STAGE 3** - Ensure quality by involving all departments (System oriented) T.Q.C.
6. **STAGE 2** - Quality Control during fabrication including C.E.P. (Process oriented)
7. **STAGE 1** - Post production inspection, finished product audit and problem solving activities. (Product oriented).
8. **Japanese style "Quality Control by the whole company".**
9. **U.S. / European style T.Q.C.**