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(71) Applicant : **TESSITURA LANDINI S.r.l.**
Via Trieste, 31
I-21050 Marnate (IT)

(72) Inventor : **Sommaruga, Massimo**
Via Vercelli, 128
I-21050 Marnate (IT)

(74) Representative : **Pellegri, Alberto et al**
c/o Società Italiana Brevetti S.p.A.
Via Puccini, 7
I-21100 Varese (IT)

(54) **Textile disc or wheel impregnated with resin containing abrasive particles, process of preparation thereof and lapping/buffing process.**

(57) Textile discs and wheels for surface lapping/buffing are impregnated with a resin solution containing an abrasive powder suspended therein. Following vacuum impregnation and centrifugation, the impregnated buffing discs and wheels are oven-treated for polymerizing the resin. The abrasive powder incorporated in the impregnating resin provides a source of abrasive material in the work area of the disc or wheel, thus making up for the abrasive paste shortage during intervals between successive paste applications. This allows a considerable saving of abrasive paste while increasing buffing disc life.

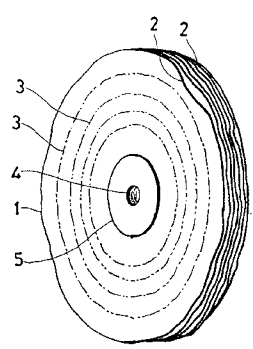


FIG. 1

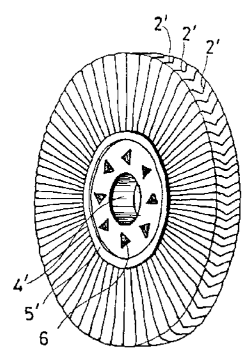


FIG. 2

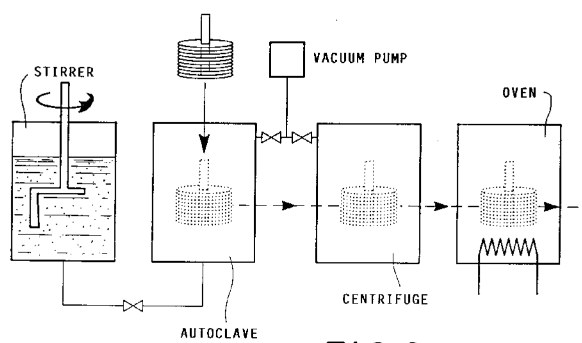


FIG. 3

EP 0 635 334 A2

Jouve, 18, rue Saint-Denis, 75001 PARIS

This invention concerns the mechanical surface treatment by which the untreated surface is lapped and eventually buffed in the final treatment stages. This type of surface treatment can be carried out on metals, painted or varnished surfaces, cast or injection-molded plastics and the like.

In lapping/buffing treatments (mechanical buffing), textile buffing discs or wheels are almost exclusively used and an abrasive paste is intermittently distributed on the work area. The cloths or plaits used are usually made of natural fibres such as cotton, agave sisal, flax, hemp, wool and jute, on account of these natural fibres' higher resistance to overheating during treatment. A wide range of cloths and abrasive pastes selections may create operating conditions ranging from highly abrasive lapping to almost purely buffing treatments. As experienced operators know, there may be several intermediate stages of leveling/buffing through which abrasive properties are progressively reduced and viceversa buffing/polishing properties increased.

The so-called simple discs, which commonly consist of many cloth discs superimposed and sewn together by means of concentric quilts, are generally used only on "hand-operated" buffing machines. The rotating disc is in fact quite compact which may cause overheating that can be controlled only in the case of non-continuous machining and under the operator's supervision. At any moment, an experienced user is able to assess abrasive paste losses due to melting and overheating and take appropriate measures. On the contrary, in continuous operations, both with flatbed machines and rotary-table machines, almost only the so-called "ventilated discs" are used. These discs - or wheels, as they are more appropriately called - are obtained by assembling radially oriented cloth strips or plaits. They are pleated or undulated, often with special oriented pleats or "discs". The work area is the wheel outer periphery. Therefore, the air radially flowing from the wheel center towards the periphery - accelerated by appropriately-shaped holes or air intakes in the wheel truing plates - "cools down" the peripheral work area of the wheel, thus allowing nonstop machining. The abrasive paste is intermittently distributed on the work area, by injecting it through appropriately oriented nozzles.

Both in the case of simple discs and ventilated wheels, the intermittent feeding of abrasive paste in the work area entails periodic, even drastic changes in the operating conditions. Actually, the work run shows performance "peaks" alternating with performance "drops", "synchronized" through repeated feeds of fresh abrasive paste during treatment. Moreover, a lot of the abrasive paste is inevitably lost due to the centrifugal force. Losses increase when the disc or wheel work area gets overheated, since the paste tends to become more fluid as the temperature rises. On the other hand, the lost abrasive paste cannot be recovered, nor can it be recycled. Therefore, the lost paste not only represents an important cost item in the working process, but its disposal also causes environmental problems.

Buffing discs and wheels are essentially expendable materials, since they undergo progressive wearing. Ventilated wheels are to be replaced when their outer diameter has decreased below a certain limit, which in many cases can be as low as 60÷70% of the original wheel diameter.

Moreover, a widely-used technique to increase the cloth or plait wear resistance, thus making working conditions more gradual, is to provide "rigidity" to the cloth of which the wheel or disc are made by impregnating it with special emulsions of an acrylic, vinyl, epoxy or oily resin. If necessary, the resin impregnating the cloth is then submitted to a polymerization heat-treatment. Usually, the cloth is vacuum-impregnated by placing it in a special evacuable "autoclave" into which the impregnating emulsion is poured. After draining the emulsion from the vacuum chamber, the buffing discs or wheels are removed and then heated in the oven, to eliminate possible traces of solvent, till the temperature reached and the time elapsed are sufficient to allow resin polymerization.

This being the state of the art, a method has now been developed - the subject of this invention - for drastically reducing the consumption of the abrasive paste used in these surface lapping/buffing treatment cycles. What is more, this breakthrough involves a remarkable reduction of the time needed to obtain a certain lapping/buffing result as compared to the traditional technique.

Basically, this new techinque consists in impregnating a buffing disc or wheel with an emulsion-suspension containing both a polymerizable resin and an abrasive powder and successively polymerizing the resin. This treatment of the textile discs or wheels brings about an unexpected series of highly positive effects.

First of all, a reduction ranging between 30% and 45% in the abrasive paste consumption - as compared to the amount used with a similar buffing disc or wheel impregnated with resin (without abrasive powder) according to the known technique - was observed under the same conditions and for the same end result.

Together with this important outcome, a remarkable reduction in the time needed for the treatment, as well as an increase in the disc or wheel life, were observed. This increase is estimated between 20% and 35% - as compared to the average life of a similar disc or wheel made according the known technique under the same working conditions.

The abrasive powder (of a given particle size) incorporated in the resin with which the lapping/buffing disc/wheel cloth is impregnated produces an extra source of lapping agent (e.g., a metal oxide) "in situ".

In the course of treatment, the abrasive powder incorporated in the impregnating resin of the disc/wheel cloth is gradually released onto the surface or work area. This extra abrasive powder, rather than merely adding to the intermittently fed abrasive paste, tends to supplement it during the intervals between intermittent distributions of abrasive paste on the work area, so as to make up for and decrease the occurrence of abrasive powder shortages occurring between two successive distribution cycles of fresh abrasive paste. On the one hand, this not only helps maintaining suitable lapping properties, but it also reduces overall treatment time and allows a drastic reduction in the amount of abrasive paste to be progressively distributed during the entire working cycle. On the other hand, this technique reduces cloth disc overheating and wearing, during the abrasive paste shortage phases between two subsequent abrasive paste feeds, thus prolonging the life of the ventilated disc or wheel.

The different aspects and advantages of this invention will be further clarified by the following description concerning important implementations and by making reference to the enclosed drawings, wherein:

Figure 1 shows a "simple" buffing disc;

Figure 2 shows a ventilated disc or wheel, suitable for continuous operation;

Figure 3 shows the layout of an impregnation, centrifugation and polymerization system used for the production of the buffing discs of this invention;

Figure 4 shows a performance chart comparing discs made according to this invention and discs impregnated according the known technique;

Figure 5 shows a comparative test results chart indicating disc wearing when operating according to this invention and to the known technique.

Fig. 1 shows a buffing disc 1 consisting of a "pack" or pile of cloth discs (2), piled up one on top of the other and joined by concentric seams (3). Hub (4) allows the disc to be installed on a rotating spindle. The disc may also include two side strengthening discs (5) made of cardboard or other suitable material.

Fig. 2 shows a ventilated buffing disc (or wheel) obtained by placing together a certain number of strips (2') of slanting cloth folded into a "V". Cloth strips are anchored to a metal hub (4') which may include two side discs (5'), provided with openings or air intakes (6) to let cooling air flow from the hub core towards the peripheral work area of the wheel, through air passages.

Naturally, there are discs with many different shapes: some have fan-pleated or undulated pleat cloth, others are made of cloth plaits instead of cloth strips or discs.

The cloth may be made up of cotton, agave sisal, wool, flax, hemp, jute, or similar fibres with adequate resistance against overheating. The fabric may be made up of a single type of fibre or may be obtained by combining different fibres in different amounts. Cotton and sisal are among the most widely used fibres. The latter is particularly suitable for roughing discs. This fiber can in fact generate a higher abrasive power and is therefore recommended for preliminary surface lapping. During the following buffing treatments, abrasive power is gradually reduced and buffing conditions are enhanced by using increasingly "softer" (e.g., cotton) buffing discs and increasingly thinner abrasive pastes.

Furthermore, the type of cloth or plaited cord used for these discs may change depending on the characteristics required. Therefore, besides combining different fibres, more or less "napped" cloths are used to adjust the abrasive and/or buffing power of the disc.

According to this invention procedure, outlined in Fig. 3, a number of preassembled discs with the required characteristics for specific uses are placed inside an evacuable chamber (autoclave) , wherein a preset vacuum is created.

An abrasive powder suspension of the required particle size and characteristics is prepared in a special tank - fitted with a stirrer - containing a liquid mixture consisting of an aqueous dispersion of a soluble resin, which may be an acrylic, vinyl, or epoxy resin, together with emulsifying agents, such as fatty acids obtained from tallow or other oily compounds. The mixture is kept homogeneous through continuous stirring.

When a preset vacuum level (between 10 and 30 Torr) is reached inside the autoclave, a valve letting the suspension flow into the autoclave is opened and the disc cloth gets deeply impregnated.

Once impregnated, the discs are removed from the autoclave and centrifuged in a special centrifugal chamber (centrifuge) until they reach a substantial dynamic balance. This centrifugation process, besides eliminating the impregnating mixture in excess, ensures a substantially uniform distribution of the impregnating substance.

The impregnated and centrifuged discs are finally oven-treated by progressively raising the temperature of the oven up to about 140°-170°C. During this process, the impregnating mixture is dried by evaporation of the aqueous solvent and the resin is polymerized and fixed onto the cloth fibres incorporating the particles of the abrasive material contained in the impregnating suspension.

Thereafter, the discs are removed from the oven and cooled off, having completed their manufacturing cycle.

The mixing ratio between the resin and the abrasive powder usually ranges in weight between 0.5:1 and 1.5:1. Tests show that if aluminum oxide (Al_2O_3), with a 50% to 98% α-alumina content, in terms of overall weight, is used as abrasive material together with an acrylic resin, the ratio between the abrasive material absorbed and the incorporating resin should be about 1:1.

Usually the particle size of the abrasive powder incorporated in the cloth-impregnating resin may range between 20 and 100 μm. The particle size is selected according to the type of disc required. A coarse particle size is recommended for the preparation of "roughing" discs, whereas a finer size is more suitable for discs to be used at the lapping/buffing stage, to get extremely leveled and buffed surfaces.

The addition of fatty acids or similar emulsifying compounds in percentages ranging from about 10% to 20% of the overall mixture weight facilitates the dispersion and suspension of the abrasive particles in the mixture.

Other compounds, such as pigments used for providing the produced article with a certain visual colour code, may also be added to the impregnating mixture. Different colours are used to differentiate between the abrasive/buffing powers of the discs.

The discs produced according to the procedure of this invention, hereinafter referred to with acronym I.R.A. (Impregnazione Resistenza Abrasiva, i.e. Abrasive Resistance Impregnation) prove to be unexpectedly effective and long-lasting as compared to the discs impregnated according to the traditional technique, i.e. without incorporating abrasive particles in the dressing resin.

A basic feature of the discs manufactured according to this invention is the improvement in the overall performance of the mechanical surface treatment, as compared to the discs produced according to the former technique. This important advantage has been quantified through a series of tests comparing I.R.A. discs with discs having the same features but without abrasive particles incorporated in the impregnating resin. This study was carried out for buffing processes on rotary tables mainly using discs of the so-called ventilated type. The highly automated and continuously operated type of treatment actually provides ideal conditions, on the one hand for detecting the effects produced by the treatment as a function of time, according to observable "indexes", and on the other, for comparing the actual effectiveness of the treatment. As already mentioned, this treatment provided for a timed feed of abrasive paste in the work area at preset intervals.

The lapping performance was assessed according to an empiric 0 to 100 scale. Efficacy was rated by observing the ability of the disc to level off grooves created on the surface of brass and stainless steel workpieces by sanding it with a 80 to 360 grain size sanding paper.

Test results are plotted in Fig. 4. As shown in this diagram, a 0 to 100 scale was created to rate the effectiveness index according to the effects produced on a certain surface as a function of time. Then, I.R.A. discs manufactured according to this invention were compared with conventional discs manufactured according to the traditional impregnation technique which did not incorporate abrasive particles in the resin. The "instantaneous" effectiveness of a disc was thus determined in order to assess the decrease of effectiveness rate between subsequent feeds of abrasive effectiveness rate between subsequent feeds of abrasive paste, as well as the disc performance over time, namely after a working period of ten hours. The (I.R.A.) broken line connects effectiveness or performance peaks and valleys for I.R.A. discs, whereas the (NORM.) broken line connects performance peaks and valleys for "conventional" discs.

It should be noted that, in the case of a "conventional" disc its effectiveness "swings" considerably between maximum and minimum values in syncronism with the repeated abrasive paste feeds onto the work area. Viceversa, with I.R.A., disc produced according this invention, performance fluctuations are extremely reduced and almost negligible, even though operating parameters, such as the frequency of the abrasive paste feed onto the work area remain unchanged. Furthermore, the diagrams clearly show a higher effectiveness, or overall operational performance of an I.R.A. disc as compared with a conventional disc. Also the decline of operational effectiveness with time is remarkably slower for an I.R.A. disc, as shown in the relevant table below the diagram.

Comparative tests proved that with I.R.A. discs abrasive paste consumption was 35% by weight lower than with conventional discs, for identical results of the surface treatment.

This result seemed to stem from a considerably increased effectiveness of I.R.A. discs as compared to conventional discs. In the course of tests, it has been shown that by reducing the amount of paste intermittently supplied to the work area and/or by increasing the interval of time between subsequent abrasive paste feeds, a reduction in abrasive paste consumption up to 45%, as compared to the amount of abrasive paste normally used with conventional discs, was achieved.

These unexpected results combine with a considerable conventional discs. A direct comparison between the "wearing rates" of conventional and I.R.A. discs is shown in Fig. 5. Also in this case, results refer to ventilated discs used in a rotary table buffing system. The comparison is shown in terms of progressive decrease of disc diameter as a function of hours of operation, under conditions which were substantially the same for both I.R.A. discs and "conventional" discs (i.e., discs impregnated with the same amount of resin but without abrasive powder incorporated in the impregnating resin).

The buffing discs used in a first comparative test series were ventilated discs made of agave sisal cloth and with a configuration similar to that shown in Fig. 2.

In the case of "conventional" discs, the impregnating mixture was the following:

- acrylic dispersion with an 80% purity : 500 parts in weight
- H_2O : 200 parts in weight
- fatty acids from tallow (emulsifying agents) : 100 parts in weight
- blue pigments : as required.

The impregnating mixture of I.R.A. discs manufactured according to this invention was the following:

- acrylic dispersion with an 80% purity : 500 parts in weight
- H_2O : 200 parts in weight
- fatty acids from tallow (emulsifying agents) : 100 parts in weight
- aluminum oxide (Al_2O_3) powder with an α-alumina content between 50% and 98% in weight and 50/60/70 μm particle size : 200 parts in weight
- blue pigments : as required.

A second set of test discs had the same configuration as the one shown in Fig. 2, but made with cotton cloth strips.

In the case of the "conventional" discs used for comparison purposes, the impregnating mixture was the following:

- acrylic dispersion with an 80% purity : 300 parts in weight
- H_2O : 350 parts in weight
- fatty acids from tallow (emulsifying agents) : 150 parts in weight
- red pigments : as required.

On the contrary, in the case of the I.R.A. discs produced according to this invention, the impregnating mixture was the following:

- acrylic dispersion with an 80% purity : 350 parts in weight
- H_2O : 350 parts in weight
- fatty acids from tallow (emulsifying agents) : 150 parts in weight
- aluminum oxide (Al_2O_3) powder with an α-alumina content between 50% and 98% in weight and 60/70/90 μm particle size : 150 parts in weight
- blue pigments : as required.

Impregnation was carried out after a 25 Torr vacuum was created in the autoclave.

The impregnated discs were centrifuged at about 1,400-2,800 r.p.m. for about ten seconds.

The drying-polymerization process was carried out by gradually heating the discs from room temperature up to 150°C in one hour, and by keeping the 150°C temperature constant for a further 30 minutes.

Claims

1. Cloth for discs or wheels for the mechanical treatment of surfaces to be lapped and buffed, impregnated with an "in situ" polymerized resin for increasing the disc or wheel rigidity and resistance to overheating and wearing, characterized by the presence of particles of an abrasive material incorporated in the above-mentioned impregnating resin.

2. Cloth for discs or wheels for the mechanical treatment of surfaces according to claim 1, characterized by the fact that said resin is an acrylic resin and said abrasive material is a metal oxide powder whose particle size ranges between 20 and 100 μm.

3. Cloth for discs or wheels for the mechanical treatment of surfaces according to claim 1, characterized by the fact that the above-mentioned cloth is made up of at least one of the natural fibres belonging to the group composed of cotton, sisal, wool, hemp, flax and jute.

4. Cloth for discs or wheels for the mechanical treatment of surfaces, according to claim 2 characterized by the fact that the above-mentioned metal oxide is an aluminum oxide with an α-alumina content ranging between 58% and 98% in weight.

5. Cloth disc or wheel, for the mechanical treatment of surfaces, comprising a plurality of textile elements piled up or coupled with one another and fixed to a central hub for the installation of the disc on a spindle, characterized by the fact that its textile elements are impregnated with a resin incorporating particles of an abrasive material.

6. Disc or wheel for the mechanical treatment of surfaces according to claim 5, characterized by the fact that said resin is an acrylic resin and said abrasive material is a metal oxide powder whose particle size ranges between 20 and 100 μm.

7. Disc or wheel for the mechanical treatment of surfaces according to claim 5, characterized by the fact that said cloth is made up of at least one of the natural fibres belonging to the group composed of cotton, sisal, wool, hemp, flax and jute.

8. Disc or wheel for the mechanical treatment of surfaces according to claim 6, characterized by the fact that said metal oxide is an aluminum oxide with an α-alumina content ranging between 58% and 98% in weight.

9. Manufacturing process for textile discs or wheels,

for the mechanical treatment of surfaces to be lapped and buffed comprising the assembly of a number of discs or strips or plaits of at least one of the natural fibres belonging to the group composed of cotton, sisal, wool, hemp, flax and jute, anchored to an assembly hub for installation on a spindle, characterized by the fact that it comprises:

- suspending the abrasive powder into a fluid mixture consisting of an aqueous dispersion of a polymerizable resin and at least one emulsifying compound;
- vacuum-impregnating said textile discs strips or plaits with said suspension;
- centrifuging the impregnated textile disc or wheel till it reaches a substantial dynamic balance;
- heating the impregnated and centrifuged disc or wheel at a temperature and for a time sufficient to evaporate the solvent and to polymerize the resin incorporating said abrasive powder.

10. A process as defined in claim 9, characterized by the fact that said resin belongs to the group of acrylic, vinyl and epoxy resins.

11. A process according to claim 9, characterized by the fact that said abrasive powder is an aluminum oxide powder.

12. In a lapping and buffing process by means of a rotating textile disc or wheel with an abrasive paste feeding, the improvement provided by the fact that a) the textile of which the disc or wheel is made is impregnated with a resin incorporating abrasive powder; and b) the feeding of abrasive paste is reduced during the lapping and buffing process.

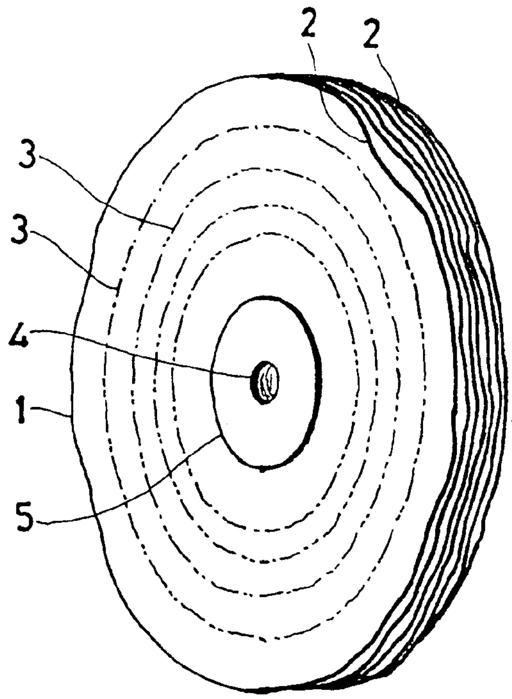


FIG.1

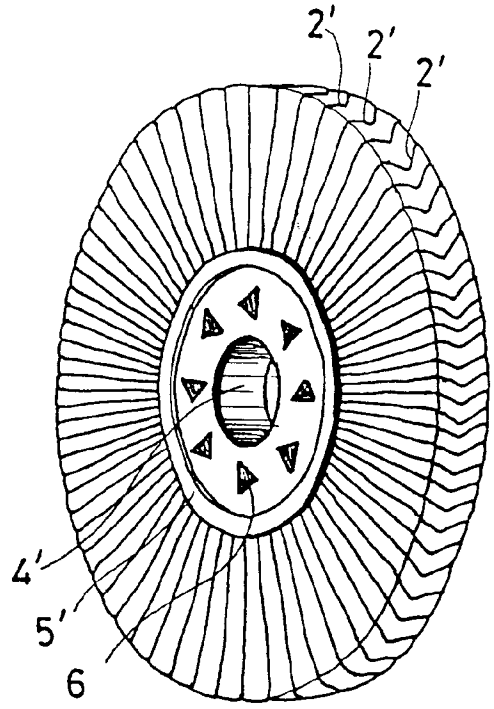


FIG.2

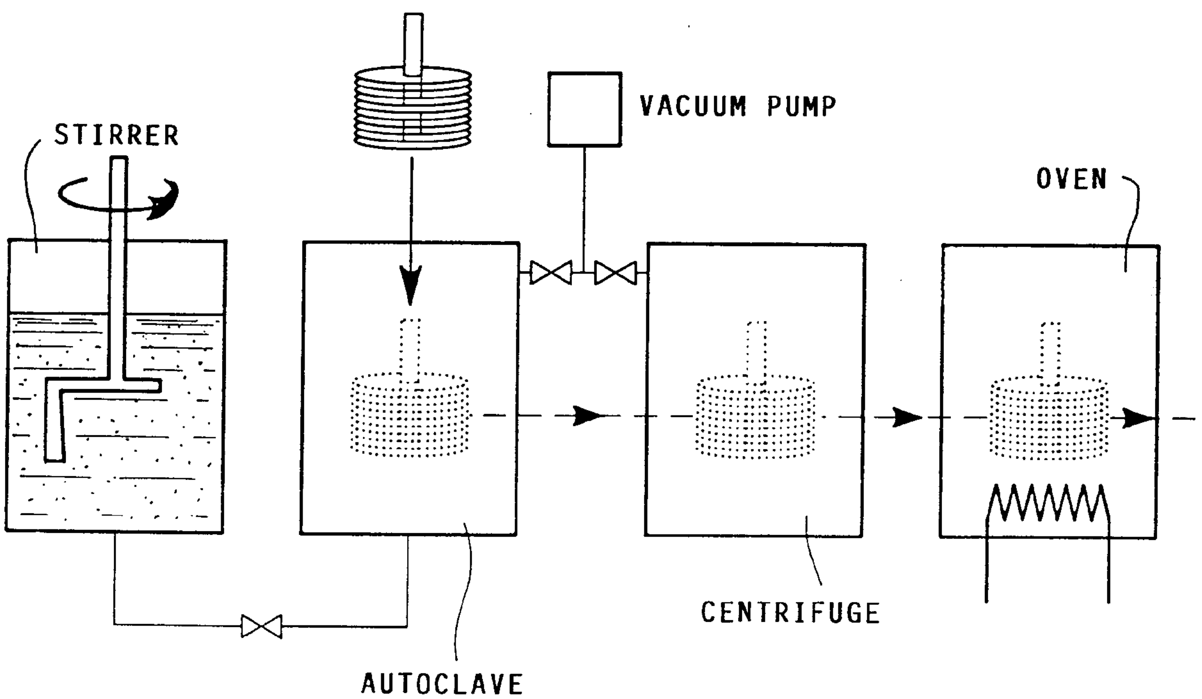
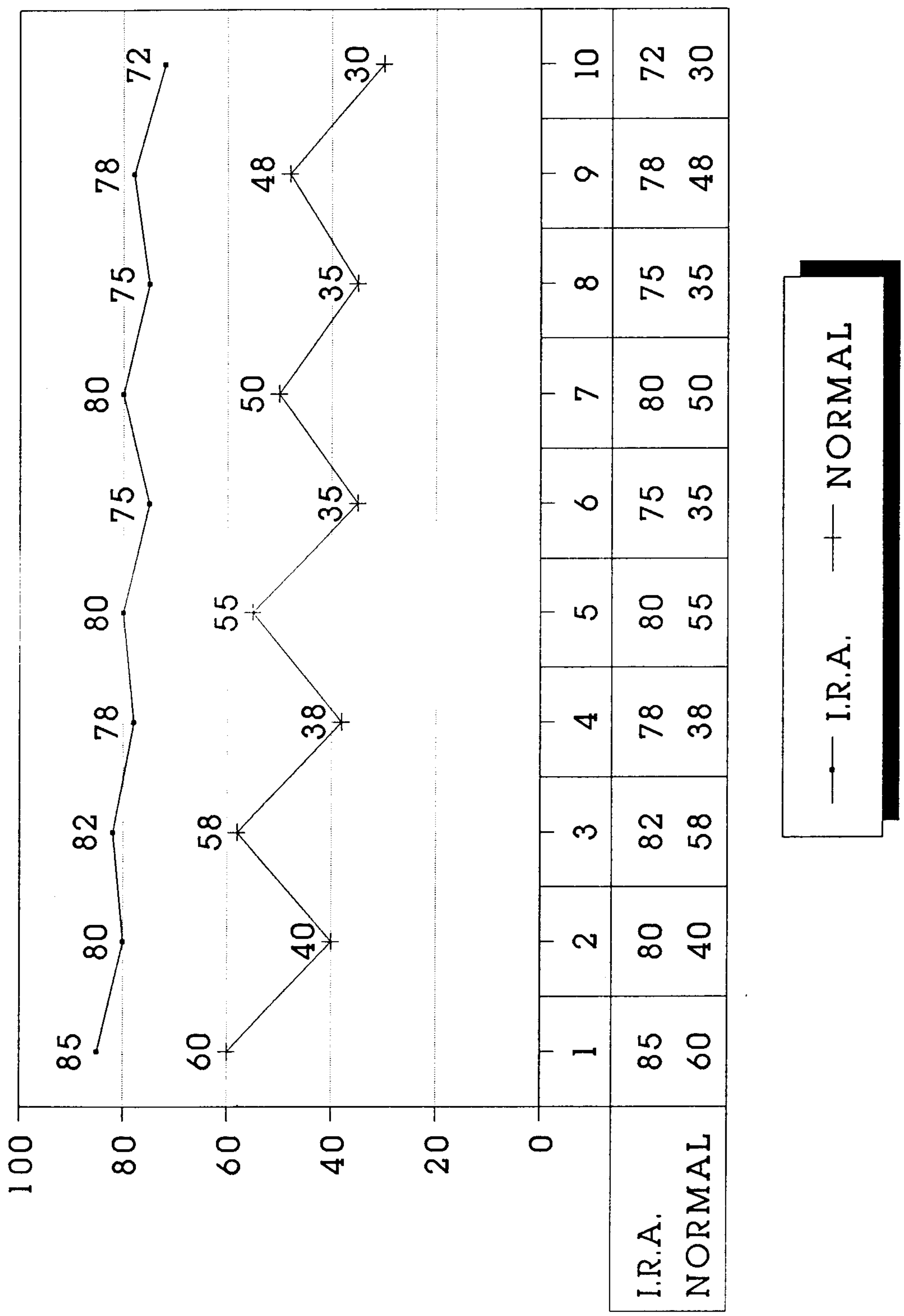
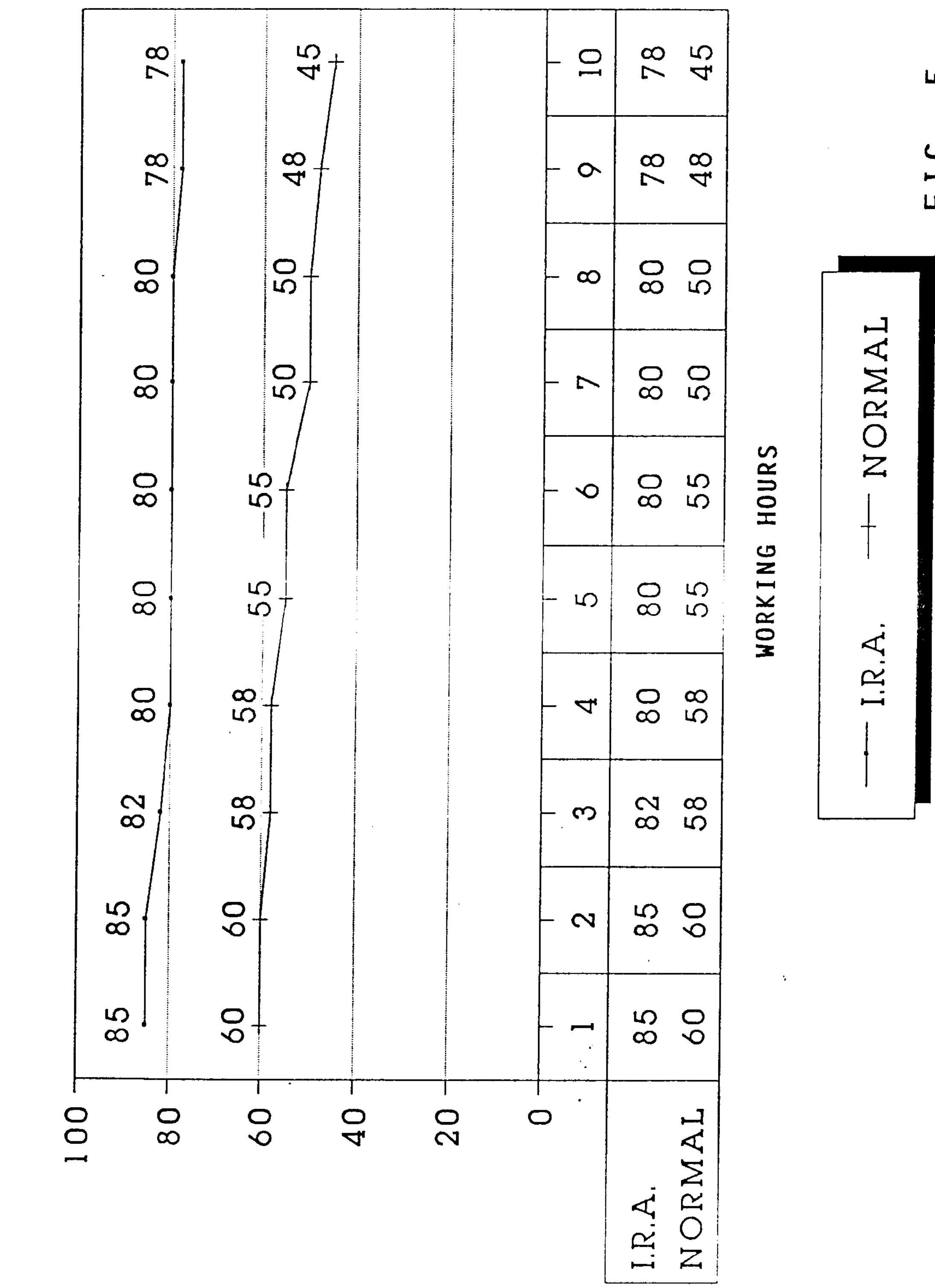


FIG.3



	1	2	3	4	5	6	7	8	9	10
I.R.A.	85	80	82	78	80	75	80	75	78	72
NORMAL	60	40	58	38	55	35	50	35	48	30

FIG. 4



	1	2	3	4	5	6	7	8	9	10
I.R.A.	85	85	82	80	80	80	80	80	78	78
NORMAL	60	60	58	58	55	55	50	50	48	45

FIG. 5