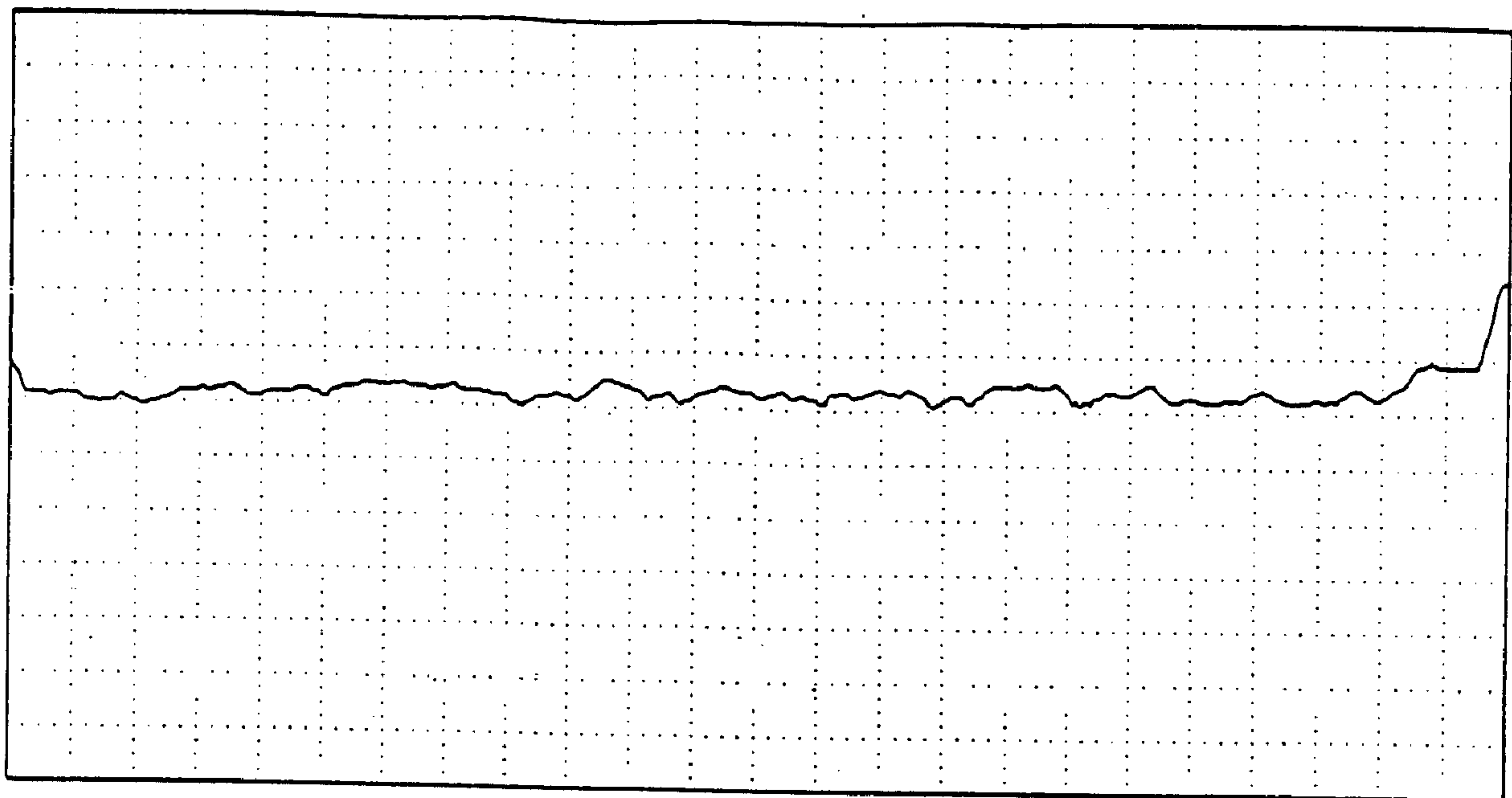




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(54) Titre : PAPIER COUCHE POUR IMPRESSION ET PROCEDE DE FABRICATION
(54) Title: COATED PAPER FOR PRINTING AND MANUFACTURING METHOD THEREOF



(57) Abrégé/Abstract:

The process for manufacturing a coated paper having a thermal shrinkage force (R), which satisfied the relationship $0 \leq R \leq 35$ gf, comprises coating a paper web on both sides with an aqueous solution of polyvinyl alcohol to form coated paper web, drying the coated paper web to form a base paper with PVA coating, applying a coating composition composed of an adhesive and a pigment to the base paper, followed by drying in order to form a coating layer on the base paper.

Abstract

The process for manufacturing a coated paper having a thermal shrinkage force (R), which satisfied the relationship $0 \leq R \leq 35$ gf, comprises coating a paper web on both sides with an aqueous solution of polyvinyl alcohol to form coated paper web, drying the coated paper web to form a base paper with PVA coating, applying a coating composition composed of an adhesive and a pigment to the base paper, followed by drying in order to form a coating layer on the base paper.

Coated paper for printing and manufacturing method thereof

Background of the Invention

1. Field of the Invention

5 The present invention relates to a coated paper used in printing and, particularly, to a new coated paper for use in printing which hardly generates any fluting in web-offset printing (in the Japanese printing industry, this may be referred to as "hijiwa") which has been frequently generated during a process of drying after
10 printing in web-offset printing. In addition, it also includes the manufacturing method of the coated paper. This is also very useful when used in rotogravure printing or flexographic printing from the standpoint that it will not cause so much out-of-register, i.e. mis-registration.

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2. Description of the Related Art

 First of all, an explanation will be given on the fluting in web-offset printing. The trend toward less man-power and higher speed in the printing industry in recent years is changing printing
20 process from sheet-fed offset printing to offset rotary printing (hereinafter referred to as "web-offset printing"). Not only high-speed printing and simultaneous-double-sided printing but also saving labor in its back-end process can be carried out by the web-offset printing. The productivity of the web-offset
25 printing is significantly higher than that of the sheet-fed offset printing in consideration of labor saving of its following process.

 However, since a hot air drying process is conducted immediately after its printing process in case of web-offset printing, there are several quality defects that are not produced
30 in sheet-fed offset printing. Among them, a problem that is known

as most significant and difficult to solve is fluting in web-offset printing. Hitherto, the fluting in web-offset printing has been considered as a problem peculiar to web-offset printing, and is a phenomenon in which stripe-shaped wrinkles have been generated along the machine direction of the paper after a web-offset printing operation is applied. In a worse case, the printed material would become waved, like a waved zinc sheet, so that its substantial commercial value will be greatly lowered. Thus, a coated paper for printing which will not generate such fluting or wrinkles in web-offset printing has been strongly demanded for a long time. However, such a paper has not been provided to the market as of yet.

Now, several study reports have been issued on the aforementioned fluting in web-offset printing and they may be roughly classified into the following two types:

One is based on the thought of "tension wrinkles." In this theory, it is considered that fluting in web-offset printing is formed by wrinkles which is initially generated by the tension added to the paper in web-offset printing and is then stabilized by offset ink.

As to the other, it is considered that wrinkles are generated by the difference in the drying shrinkage between the imaged area and the non-imaged area during the drying process in the web-offset printing operation (Takeshi Yamazaki / Abstracts of Research Presentations of the JAPAN TAPPI JOURNAL: Vol. 49, P110-113/1982.)

One of the methods proposed as concrete means to suppress such a phenomenon is disclosed in Japanese Patent application laid-open Publication No.S58-186700. In this method, such fluting in web-offset printing are considered to be prevented by keeping the freeness of pulp used in a paper web within a specific scope and by controlling the air

permeability simultaneously within a specific scope.

However, at the time of manufacturing coated paper for use in web-offset printing, since the products are made through various processes such as the preparation of pulp, paper-making, coating, 5 press finishing with a calender and winding, it is not possible to obtain products in satisfactory quality merely by adjusting the pulp freeness. Any product that avoids the fluting in web-offset printing has not been made as of yet.

Further, according to Japanese Patent Appln. laid-open publication 10 No. H9-291496, it is proposed that the fluting in web-offset printing can be either solved or alleviated by specifying the web moisture and the strength between inner inter-layers of a base paper. However, if strength of the inner inter-layers is lowered, this will accompany lowering of web (product) moisture in view of countermeasure for blister 15 resistance, which is considered as another problem of the coated paper for web-offset printing. As a result, there is a fear of causing a problem so called "fold-cracking trouble" which is a phenomenon that the surface of the coated paper for web-offset printing is cracked in a subsequent bending process. Furthermore, 20 the improvement effect thereof is not satisfactory.

We, the inventors of the present invention, have sought for the factor generating the fluting in web-offset printing which is an important problem in quality and to be solved with regard to the coated paper for web-offset printing as mentioned above. And 25 we have repeated careful studies so as to solve the problem. Consequently, we achieved to the present invention, in which the fluting in web-offset printing can be prevented in advance by using a paper having small thermal shrinkage force in the cross direction (the CD direction).

30 Needless to say, the coated paper according to the invention

will show significant effects in solving the fluting in web-offset printing, and besides "the mis-registration" which is easily caused by thermal drying can be effectively suppressed if it is utilized as paper for printing used in printing machine equipped with drying
 5 units, such as gravure printing machines and flexographic printing machines.

Summary of the Invention

According to the invention, there is provided a coated paper
 10 for printing provided with coating layer mainly composed of a pigment and a binder on a base paper. The coated paper for printing is characterized in that the drying shrinkage force R in the cross direction (CD direction) of the said coated paper satisfies the equation (1) when measured pursuant to the measuring method
 15 specified below.

$$0 \leq R \leq 35 \text{ gf} \quad \text{----} \quad (1)$$

[Measuring Method of Drying Contractile Force R]

A sample coated paper whose moisture is previously adjusted
 20 pursuant to JIS P8111 (moisture adjustment is made under the condition of room temperature of 20°C, relative humidity of 65%) is cut off to obtain a span of 2mm wide in the machine direction with a length of 2cm in the cross direction. Then, thus obtained coated paper is set to a Thermo Mechanical Analyzer [TMA / SS6000:
 25 manufactured by Seiko Electronics Industries Co., Ltd.]. As PID Control Values of the terminal probe at the analyzer, P (Proportion) = 100, I (Integration) = 1, D (Differential) = 100 are used. The contractile force "R" is obtained by the steps of expanding the span at the rate of 0.01 μm / minute under the condition that the
 30 initial load of 5 gf is added, raising the temperature from 20°C

at a heating speed of 200°C/ minute to the predetermined temperature of 300°C, maintained at the predetermined temperature of 300 °C for 2 minutes, then measuring the contractile force generated by thermal drying of 1.5 minutes after the commencement of the raise
5 of the temperature.

Namely, TMA / SS is abbreviation for [Thermo Mechanical Analyzer / Stress Strain] and indicates a type of measuring device for thermal physical properties.

Moreover, as one of preferred embodiments of the invention
10 which satisfies R in the above described equation (1), a base paper used for the coated paper for printing is obtained by application of aqueous solution of polyvinyl alcohol (hereinafter referred to as PVA) having a saponification degree of not less than 85 mol% to both sides of the web in an amount of 0.5 - 3 g/m² per surface
15 after being dried. It may have air permeability of 3,000 seconds or higher when measured pursuant to JIS-P8117.

Furthermore, in the above-mentioned coated paper for printing which has coated layer mainly composed of pigments and binders on the base paper coated with PVA since the paper surface
20 is covered with above-described coated layer, the air permeability will become so much higher in comparison with the base paper that it is not possible to measure it by the measuring method pursuant to JIS-P8117. Thus, the air permeability will be measured in accordance with J. TAPPI Pulp and Paper Testing Method No. 5 (B),
25 and it can be used preferably as the coated paper for printing of the invention if the air permeability of the paper shows 100,000 seconds or above.

In addition, it was verified that a paper web can be used as the aforementioned base paper if it is obtained by coating an
30 aqueous solution composed of PVA having a saponification degree

of not less than 85 mol% and inorganic pigments (300 parts or less of inorganic pigment relative to 100 parts of PVA as solid matter) to both sides of the web in an amount of 0.5 - 3 g/m² per surface after being dried and dried.

5 In this invention, the technical reason for using the aforementioned PVA is to heighten the air permeability of the paper by forming a kind of resin film on the surface of the paper by the said PVA. Thereby, it aims at preventing the wrinkles generated by the difference of in the amount of shrinkage between in the imaged
10 area and in the non-imaged area during the drying process in the web-offset printing operation. In other words, it aims to prevent beforehand the phenomenon of base paper shrinkage caused by evaporation of moisture in the paper during drying process. Thus, the resin film applied in order to prevent the evaporation
15 of the aforementioned moisture can be formed by something other than the aforementioned PVA. For example, various SBR latex and synthetic resins such as polyester resins can also be used.

 Incidentally, we, the inventors of this invention, have earnestly repeated studies on the mechanism of generation of the
20 fluting in web-offset printing which has been conventionally considered as a problem and also on the measures to solve this problem. As a result, we finally obtained the following knowledge on the generating mechanism of the fluting in web-offset printing.

 First of all, if we observe the basic characteristics of
25 fluting in web-offset printing, it may be considered to be a state that the printing material, which should be flat in its nature, has been folded several times over in the transverse direction. This may be considered that fluting in web-offset printing is the same as a phenomenon that an object has been buckled after it has
30 been given compressive force in the transverse direction. Thus,

its behavior may be defined by using equation (2) derived from the Euler's formula.

$$P = (n^2 \pi^2 b h^3) E_c / 12 L^2 \quad \text{----} \quad (2), \text{ where}$$

P: Stress to buckle the imaged area.

5 n: Number of buckling in the imaged area.

E_c : Modulus of elasticity of the imaged area in the transverse direction.

b: Length of the imaged area.

h: Thickness of the imaged area.

10 L: Width of the imaged area.

The right side of the equation (2) represents factor which resists the force to buckle the paper, and it is considered as buckling resistance force.

In this regard, in order to make the right of the equation
15 (2) more easily understand, we applied Gurley stiffness to the right side of this equation. This Gurley stiffness is commonly used in to explain the characteristics of paper. Now, the Gurley stiffness is defined as the equation (3) shown below:

$$S = k h^3 E_c \quad (\text{Derived from the definition of Gurley stiffness})$$

20 ---- (3), where

S: Gurley stiffness

E_c : Modulus of elasticity of the paper

h: Thickness of the paper

k: Constant

25 Substituting the equation (3) into the equation (2), we can now obtain equation (4), which represents the number of fluting N. The number of fluting N is 1/2 of the number of buckling n in the imaged area.

$$N = k L (P / b S)^{1/2} \quad \text{----} \quad (4), \text{ where}$$

30 N: Number of fluting

k: Constant

L: Width of the imaged area

P: Compressive force in the transverse direction

b: Length of the imaged area

5 S: Gurley stiffness of the imaged area

Now, we would like to explain what the imaged area and the non-imaged area means, i.e. the imaged area means the portion where the ink has been transferred in web-offset printing, and the non-imaged area means the portion where the ink has not been
10 transferred.

By the way, when the width (L) of the aforementioned imaged area is specified, the number of the fluting in web-offset printing is determined by three factors, namely, the compressive force P in the transverse direction, the length b of the imaged area, and
15 the Gurley stiffness S of the imaged area. If the compressive force in the transverse direction increases, the fluting in web-offset printing will increase proportionally to the square root of such compressive force. On the contrary, if either the length of the imaged area becomes longer or the Gurley stiffness of the imaged
20 area becomes larger, the fluting in web-offset printing will decrease in reverse proportion to their respective square root.

The compressive force P in the transverse direction which buckles a paper may be classified into two forces such as the Poisson's force which is generated by the tension and the
25 contractile force which comes from the difference of in the amount of shrinkage between the imaged area and the non-imaged area during the drying process.

With regard to the Poisson's force, if an object is stretched in the longitudinal direction, there is a property in which the
30 object tends to shrink in the cross direction. In this regard,

if we express the expansion in the longitudinal direction by ϵ_m , and the contraction in the cross direction by ϵ_c , the ratio $\nu = \epsilon_c / \epsilon_m$ has a value proper to the object, which is called Poisson's ratio.

5 If the paper had an infinite length, even if it were pulled in the longitudinal direction, the paper would merely bring the shrinkage in the lateral direction in accordance with its Poisson's Ratio. It does not mean, however, that the paper is able to shrink freely since both ends of the paper are actually fixed. In addition,
10 because the tension is subject to change, the contractile force will be generated in the lateral direction, which results in buckling of the paper. This is the mechanism in which wrinkles are generated by the Poisson's force.

As for the other lateral compressive force, it may be
15 considered that the contractile force during the drying process is affecting thereto. In other words, in the web-offset printing operation, the paper shrinks during the drying process after the printing operation. In this instance, the shrinkage begins from the beginning of the drying process in the non-imaged area. On
20 the contrary, the shrinkage will begin later in the imaged area in comparison with in the non-imaged area because the imaged area has been masked by the ink layer which prevents the moisture contained in this area from being evaporated. Consequently, the shrinkage force of the non-imaged area will affect the imaged area
25 as compressive force so as to form buckling in the imaged area.

It is thus concluded that the aforementioned fluting in web-offset printing is the buckling formed in the imaged area by the two forces as described above. When an object is buckled, it will form such a shape that the object is folded at only one point
30 where the least stress is required. However, the fact that the

paper receives the tension in the longitudinal direction during the web-offset printing means that the reaction will work on the paper so as to sustain the surface even. This is the reason why the fluting in web-offset printing forming small peaks like a waved
5 galvanized iron is generated.

We, the inventors of this invention, conducted research and studies on compressive forces in the lateral direction that forms the fluting in web-offset printing in connection with all kinds of coated paper. As a result, it was found that the lateral
10 compressive force generated by drying shrinkage was larger than the lateral compressive force generated by the Poisson's force. In addition, it was also found that it greatly varied in accordance with the changes of orientation of fiber or types of size presses, which made it clear that the compressive force in the lateral
15 direction in the web-offset printing depended on the drying shrinkage force. Thus, as a result of studies made on the measurement of the drying contractile force, we finally became to realize that what is required primarily is the compressive stress which acts on the imaged area which shrinks simultaneously with
20 the non-imaged area. However, regretfully, at present there is no means to measure such a stress completely.

On the other hand, as a result of the repeated studies, we found that the drying contractile force measured by the following method had close correlation with the generation of the fluting
25 in web-offset printing so that it could be used sufficiently as an index of the compressive force in the lateral direction which forms the fluting in web-offset printing.

Thus, the measuring method of drying contractile force R of this invention may be specified as follows:

30 In other words, sampling coated paper which has been prepared

with moisture control [under conditions of the room temperature of 20°C and the relative humidity (RH) of 65%] when measured pursuant to JIS-P8111 is cut off to obtain a span of 2mm wide in the machine direction with a length of 2cm in the cross direction (i.e. a direction that is perpendicular to the machine direction). Then, attach it to Thermo Mechanical Analyzer [TMA / SS6000: Seiko Electronics Industries Co. Ltd.] with an initial load of 5 gf. In this instance, in order to control the span changes caused from shrinkage of the sample papers, $P = 100$, $I = 1$, and $D = 100$ are used as a PID control value of the probe in the TMA apparatus. In addition, the span shall be set up so as to be expanded at the rate of $0.01 \mu\text{m}/\text{minute}$ while being measured in view of that the program for the TMA apparatus will require minimum change of the span. It is, however, believed that the span is substantially almost fixed.

To pursue the relation between the thermal contractile force of the paper samples and the fluting in web-offset printing, the temperature will be raised at a raising speed of $200^\circ\text{C} / \text{minute}$, up to the set temperature of 300°C , and maintain in that state for 2 minutes so that the drying shrinkage force is measured 1.5 minutes after the raising of temperature has been started. We found that the relation of the generation of the fluting in web-offset printing and the contractile force caused from thermal drying is obtained with good reproducibility if such conditions have been set.

By the way, by specifying both the drying shrinkage force R which will become the substitute value of the contractile force in the cross direction of paper products and the Gurley stiffness S , it is possible to specify the degree of the generation of the fluting in web-offset printing as well. However, we dare describe this invention without referring to the Gurley stiffness S in the specification of the invention, which causes from their

consideration of the circumstances when the users select papers and print the papers actually.

In other words, in case the users, i.e. the printers, select papers for printing between of high basis weight and of low basis weight, the range of tolerance to the fluting in web-offset printing will vary upon their selection. For example, if they adopt the papers of high basis weight, they will take the attitude of not allowing even the slightest fluting in web-offset printing. On the other hand, if they adopt the papers of low basis weight, a large number of the wrinkles in web-offset printing, in general, will appear so that even a slight decrease of the fluting in web-offset printing will be evaluated as a sufficient improvement effect. Thus, it is considered that the commercial value will be greatly improved.

In consideration of the above mentioned circumstances, we, the inventors, ardently repeated the study as to the relation between the thermal contractile force during the drying process of the paper and the generation of the fluting in web-offset printing. As a result, we found that the fluting in web-offset printing are alleviated quite effectively when the drying contractile force R of the coated paper measured under a certain condition satisfies the specified value as mentioned above. Thus we have finally completed this invention without referring to the Gurley stiffness which has extremely high correlation with the wrinkles in web-offset printing.

In addition, the reason why the drying contractile force R in equation (1) is specified at 35 gf or below, is that if R exceeds 35 gf, the contractile force in the cross direction during the drying process after printing operation will become large, which makes the fluting in web-offset printing worse.

Furthermore, it is necessary that R is a positive value. The reason is that if R is a negative value, in other words, if such a phenomenon to elongate occurs, the contractile force will affect rather the non-imaged area than the imaged area, which results in the buckling in the non-imaged area so that the fluting in web-offset printing is generated. However, as long as an ordinary coated paper for printing is used, R seldom takes a negative value. Accordingly, R can be expressed by $0 \leq R \leq 35$ gf, and more preferably, it will be specified at 30 gf or below.

As to the lower limit, zero, that is, a level where absolutely no thermal shrinkage occurs is desirable. However, considering the fact that the product is mainly composed of natural fibers which contain moisture, it usually accompanies some thermal shrinkage by its nature.

By the way, there are various adjustment methods of the drying contractile force R, and are not specifically limited. For example, adjustments can be made by suitably adjusting the beating condition of the pulp, types of chemicals for the size press, coating amount, conditions for the paper making, orientation of the fiber, types of pigments in the coated layer, types of binders, compounding ratio of binder and pigment and its coating amount or drying conditions at the coating process.

Furthermore, the inventors look into the characteristics of the coated paper that is the product. If the paper has extremely high air resistance (= poor permeability), concretely speaking, if the product is finished so as to have air resistance of 100,000 seconds or above when measured pursuant to J. TAPPI Pulp and Paper Testing Method No. 5 (B) (for example, a base paper is covered with water soluble polymer film such as PVA and then is provided with a pigment coated layer on the surface of such film to make the coated

paper), the drying contractile R specified in this invention can be obtained rather easily. The reason for this is that since the base paper for the coated paper is covered with resin film, the moisture of the base paper will not be dispersed by the heat so that the drying shrinkage of the base paper will not occur easily. In other words, it is believed that the fluting in web-offset printing are hardly generated because the drying contractile force will not be so high.

Moreover, according to our repeated study, it was found that the coated paper indicating the desired drying contractile force R can be obtained quite easily by applying PVA of high saponification to the base paper under appropriate conditions. In other words, PVA having a saponification degree of not less than 85 mol%, more preferably, 90 mol% or greater, shall be used. When such PVA is applied to the base paper and is dried, it is required to apply and dry it with high viscosity so long as there is no problem in the handling and in the operation. As a result, a base paper whose air resistance (when measured pursuant to JIS-P8117) of the surface of the base paper after applying and drying PVA is maintained at 3,000 seconds or above, or more preferably, 5,000 seconds or above, is used to make a coated paper for web-offset printing. Because the coated paper thus obtained has drying contractile force that is lowered significantly, it is considered as a particularly preferred embodiment.

In addition, at the time of applying PVA to the paper web, although there is no limitation as to the coating equipment in particular. However, for example, a size press coater, a gate roll coater, a bar coater, a roll coater, a blade coater, a film metering size press coater or the like will be suitably used. Among them, in order to apply compositions having high viscosity, a gate roll

coater, a film metering size press coater, Symsizer or the like will be favorably used.

Furthermore, according to the invention, at the time of coating PVA, if inorganic pigments are added to the PVA solution, not only the fluting in web-offset printing is dissolved but also both printability and runnability for the coating process are improved. Thus, it will be a more preferable embodiment. In this instance, there is no special limitation as to the inorganic pigments to be used, Pigments such as clay, kaolin, talc, calcium carbonate, and aluminum hydroxide are given as examples.

As for the amount of pigments to be added, 300 parts or less, preferably 150 parts or less per 100 parts of PVA in terms of solid matter is prepared. Namely, in case more than 300 parts of pigments are added, it is liable not to obtain significant dissolution effect on the fluting in web-offset printing, which is desired by this invention.

In addition, as for the amount of PVA aqueous solution to be preferably applied to the base paper shall be $0.5 - 3 \text{ g/m}^2$ by weight per side surface after being dried. When coating is made, it is preferable to make such coating on both surfaces approximately equal. Namely, if the coating amount on both surfaces is less than 1 g/m^2 , it is difficult to obtain such effects that the dissolution or alleviation of the fluting in web-offset printing desired by this invention. On the other hand, if the coating amount on one surface exceeds 3 g/m^2 , the effect will be saturated. The coating amount of more than that will disadvantageously cause various problems on runnability or printability, which is not desirable.

Moreover, the reason why PVA with high saponification degree is selectively used as the PVA in this invention is that once such PVA is applied to the base paper and dried to be a film state, even

if it comes into contact with water, it will not dissolve easily so that the film state will be maintained as it is. Although the reason for this is not entirely clarified, we presume it as follows: that is to say, the base paper to which the said PVA is applied, is finished as a coated paper by further applying aqueous pigment compositions in the process which follows. During the process, the PVA film will come into contact with a lot of water. In this case, if the PVA film has a strong waterproof property, the film state will be sustained and will be finished as a coated paper. If such a coated paper is used in web-offset printing, when it is processed by high temperature heat processing in the printing process, the moisture contained in the base paper will evaporate by the high temperature. In accordance with this, the base paper begins to shrink. On the other hand, since the PVA film formed on the base paper has the property of spreading, which is opposite to the property of shrinking, when it is heated, the both will offset each other so that the thermal shrinkage of the coated paper is suppressed as a whole. As a result, the drying shrinkage of the coated paper caused from the heat will be decreased, and accordingly, it is presumed that the fluting in web-offset printing will be alleviated.

Consequently, at the time of applying the PVA to the base paper and drying it, it is important that the PVA coat (film) should be formed on the surface of the base paper. Whether or not the PVA film is formed can be judged by measuring the air permeability of the base paper or the coated paper. By its very nature, if the film formation is low, the air permeability comes to low, and if the film formation is high, the air permeability comes to high (the measurement value is high). Thus, judgement can be made easily.

By the way, it is conventionally known that PVA is applied

to the surface of a base paper (one example is described in Japanese Patent Application laid-open publication No. Sho.55-62294), for the purpose of adding blister resistance to a base paper of the coated paper for web-offset printing. According to this reference an attempt
5 was made to manufacture the coated paper for the web-offset printing by adding surface active agent to the PVA before coating the base paper in order to improve the blister resistance that is one of the problems to be solved for the coated paper used for the web-offset printing. That is, the summary of the said reference
10 is to let the PVA penetrate into inside of the base paper layer by using it in combination with the surface active agent and heighten the strength between the layers. In the mean time, since it aims at improving the blister resistant property by restraining the formation of film on the surface of the base paper (the air
15 permeability is accelerated by lowering the air resistance), the technical philosophy thereof is completely opposite from that of the present invention.

Now, referring to another Japanese Patent Application laid-open publication No. Sho.54-11314, it proposes to obtain a base paper
20 having an excellent blister resistance by applying PVA to the base paper so as to make the Z axis strength of the base paper higher than a certain value in the meantime the air permeability of the base paper is kept lower than a certain level. Namely, according to this reference, the air permeability of the base paper is 100
25 seconds or below. Since blisters will be generated by air permeability of several hundred seconds, the base paper according to the publication is obviously different from that, which exceeds 3,000 seconds, defined in the invention.

In short, both of the aforementioned references intend to
30 improve the blister resistance in the web-offset printing by

applying PVA to the base paper not only in order to heighten the interlayer strength but also to lower the air permeability as much as possible. On the other hand, in this invention, the air permeability is heightened by coating the base paper with PVA and
5 forming a PVA film on the surface of that, i.e. the surface of the base paper is coated with a resin film composed of such as PVA to obtain the air permeability of high degree. As a result, the fluting in web-offset printing that could not be solved hitherto is brought to be removed significantly so that it is considered
10 that the present invention is based on novel and distinguished technical concept which was not existed conventionally.

Next, reference is made as to the constitution of the pulp that composes the coated paper used for the web-offset printing. According to the present invention, there are no particular
15 limitations on the pulp to be used. For example, bleached hard wood kraft pulp(LBKP), bleached needle-leaved wood kraft pulp (NBKP), high yield pulp, used paper pulp or the like will be suitably selected and used. In addition to this, there are no particular limitations on the paper making method for a base paper so that
20 both the acidic method and the alkaline method are adopted to make the base paper. It is possible to pre-coat the base paper by using a coater such as ordinary size press, roll coater and blade coater.

In this invention, there are no particular limitations on the aqueous pigment compositions which contains mainly pigment and
25 binder. However, one or more kinds of usual pigment for coated paper, such as clay, kaolin, aluminum hydroxide, calcium carbonate, titanium dioxide, barium sulfate, zinc oxide, satin white, calcium sulfate, talc and plastic pigment can be suitably selected for use.

Furthermore, according to the present invention, the binders,
30 for example, a conjugate diene-based copolymer latex such as

styrene-butadiene copolymer and methyl methacrylate-butadiene copolymer, etc., an acrylic polymer latex such as a polymer or copolymer of acrylic acid ester and/or methacrylic acid ester, a vinyl based polymer latex like ethylene-acetic acid vinyl copolymer, etc., and an alkali soluble or alkali non-soluble polymer and copolymer latexes made by denaturing the above-mentioned various copolymers with a functional-group containing monomer such as a carboxyl group, etc., can be suitably selected for use. In addition to the above, the following can be used as binders: such starches as cationized starch, oxidized starch, thermo-chemically modified starch, denatured enzyme starch, etherified starch, esterified starch, cold water soluble starch, etc., such cellulose as carboxymethyl cellulose, hydroxy methyl cellulose, etc., and a water-soluble synthetic resin based binder such as polyvinyl alcohol, olefin-maleic anhydride resin, etc., can be suitably selected for use.

Further, various additives including dispersant, a water resisting agent, rheology modifier, a coloring agent, a fluorescent whitening agent, etc. are added to the water-base pigment composition if necessary.

When coating on the base paper, the aqueous pigment composition is applied to the base paper in a single or multi-layers by means of the on- or off- machine coaters used in the coated paper manufacturing industry, such as a blade coater, air knife coater, roll coater, reverse roll coater, bar coater, curtain coater, die slot coater, gravure coater, champflex coater, size press coater, etc. The solid content of the pigment composition to be applied is generally 40 - 75 weight % but a 45 - 70 weight % range is desirable considering the runnability. The amount of coating applied to the base paper is about 5 - 20 g/m² per side in

dry weight in general.

The coated paper for printing thus obtained is usually passed through calender rolls and wound up to finish as product. Regarding to the calender finishing method, various types of calendars
5 consisting of metal rolls or metal drums and elastic rolls including, for example, super calender, gloss calender, soft compact calender, etc., are used in the form of an on- or off-machine type.

Brief Description of the Drawings

10 The attached drawings illustrate the irregularity of the surface of the imaged area of the coated paper after printing by using the light laser type displacement sensor (LB-1000 / Keyence Corporation) so as to measure the displacement of the above mentioned flutings in web-offset printing, and by using the
15 waveform data observation software (WAVE SHOT / Keyence Corporation) to make it into graphs. It concretely shows that the more the surface is uneven, the worse the fluting in web-offset printing is. Each of Figs. 1, 2 and 3 corresponds to respective graphs of the coated paper of embodiments 1, 2, and 3 according
20 to the present invention. Each of Fig. 4 and Fig. 5 shows the graphs of the surface of the coated paper surface obtained by comparative examples 1 and 2. A scale expresses 200 μ m in the longitudinal direction and a scale in the lateral direction expresses 6.9 mm, respectively, in the graphs.

25

Description of the Preferred Embodiments

The present invention will be described more in detail in conjunction with a set of examples and comparative examples. However, it is understood that the present invention is not limited
30 thereto. The term "part(s)" and "%" in the description mean

"part(s) by weight" and "% by weight" unless otherwise specified.

In addition, the method of evaluations is as shown below:

[Measuring method of Drying-Contractile Force R]

5 A sample coated paper whose moisture is previously adjusted
pursuant to JIS P8111 (moisture adjustment is made under the
condition of room temperature of 20°C, relative humidity of 65%)
is cut off to obtain a span of 2mm wide in the machine direction
with a length of 2cm in the cross direction. Then, thus obtained
10 coated paper is set to a Thermo Mechanical Analyzer [TMA / SS6000:
manufactured by Seiko Electronics Industries Co., Ltd.]. As PID
Control Values of the terminal probe at the analyzer, P (Proportion)
= 100, I (Integration) = 1, D (Differential) = 100 are used. The
contractile force "R" is obtained by the steps of expanding the
15 span at the rate of 0.01 μm / minute under the condition that the
initial load of 5 gf is added, raising the temperature from 20°C
at a heating speed of 200°C/ minute to the predetermined temperature
of 300°C, maintained at the predetermined temperature of 300 °C for
2 minutes, then measuring the contractile force generated by
20 thermal drying of 1.5 minutes after the commencement of the raise
of the temperature.

[Evaluation of the Fluting in Web-offset Printing]

25 Printing was conducted by using the web-offset printing
machine manufactured by Komori Printing Machine Co., Ltd. Then,
the fluting in web-offset printing generated thereby was visually
evaluated.

[Evaluation Standards]

30 © : The generation of fluting in web-offset printing was hardly

observed.

○ : The generation of fluting in web-offset printing was slightly observed.

△ : The generation of fluting in web-offset printing was observed.

5 × : The generation of fluting in web-offset printing was clearly and severely observed.

Example 1

To a pulp slurry consisting of LBKP 70 parts (freeness 410
10 cc/ csf) and NBKP 30 parts (freeness 480 cc/ csf), precipitated calcium carbonate was added as a filler so as to obtain the paper ash of 10%. Then, as a sizing agent to be added to the pulp slurry, 0.04 parts of AKD sizing agent (trade name: SKS-293F / Arakawa Chemicals Co., Ltd.) and 0.5 parts of aluminum sulfate were added,
15 respectively. In this way, the pulp slurry was prepared to obtain a base paper. To this base paper, PVA having 6% concentration (trade name: PVA-124, saponification degree: 98.5%, polymerization degree: 2,400/ KURARAY) was applied with a size press coater, and after drying, the base paper for coated paper was obtained. In
20 this case, the coating amount of PVA solution was 2.8 g/m² per side surface after the coated material was dried. Further, the basis weight of the base paper thus obtained was 52 g/m².

[Preparation of Coating Composition]

25 Slurry of pigment was prepared using a Cowless dissolver by means of dispersing the pigments consisting of 15 parts of ground calcium carbonate (trade name: FMT-90/ Fimatic Corporation), 20 parts of precipitated calcium carbonate (trade name: TP-221GS/ Okutama Industries Co., Ltd.), 40 parts of fine kaolin (trade name:
30 Amazon 88/ CADAM Corporation) and 25 parts of a kaolin in general

use (trade name: HT/ Engelhard Corporation). Next, 10 parts of styrene-butadiene copolymer latex as solid matter (trade name: SN307/ Sumika A & L Co., Ltd.), 3 parts of oxidized starch as solid matter (trade name: ACE A / Oji Corn Starch Co., Ltd.) and other
5 agents were added to the pigment slurry so that the coating material having the solid matter concentration of 63% was finally prepared.

[Manufacture of the coated paper]

The above mentioned coating material was coated on both sides
10 of the aforementioned base paper for coating with a blade coater to be 11 g/m² per side surface after being dried.

The coated paper obtained in this manner was passed through the super calender consisting of metal rolls and cotton rolls to obtain the coated paper for printing. The drying contractile force
15 R and the evaluation of the fluting in web-offset printing of the coated paper thus obtained are shown in Table 1.

Example 2

Example 1 was repeated to produce a sheet of coated paper
20 except that the coating amount of the PVA solution per side surface after being dried was changed to 1.5 g/m². The drying contractile force R and the evaluation of the fluting in web-offset printing of the coated paper thus obtained are shown in Table 1.

25 Example 3

Example 1 was repeated to produce a sheet of coated paper except that the PVA solution used in Example 1 was replaced by the liquid mixture consisting of 50 parts of kaolin (trade name: UW-90/ Engelhard Corporation) and 50 parts of PVA (trade name: PVA 124/
30 KURARAY) having concentration of 11% as solid matter. The drying

contractile force R and the evaluation of the fluting in web-offset printing of the coated paper thus obtained are shown in Table 1.

Example 4

5 Example 1 was repeated to produce a sheet of coated paper except that PVA-124 used in Example 1 was replaced by PVA (trade name: PVA-224: saponification degree: 88%, polymerization degree: 2,400/ KURARAY). The drying contractile force R and the evaluation of the fluting in web-offset printing of the coated paper thus
10 obtained are shown in Table 1.

Comparative example 1

 Example 1 was repeated to produce a sheet of coated paper except that no size press was used. The drying contractile force
15 R and the evaluation of the fluting in web-offset printing of the coated paper thus obtained are shown in Table 1.

Comparative example 2

 Example 1 was repeated to produce a sheet of coated paper
20 except that the size press solution used in Example 1 was replaced with oxidized starch (trade name: Ace A/ Oji Corn Starch Co., Ltd.) having the concentration of 10%. The drying contractile force R and the evaluation of the fluting in web-offset printing of the coated paper thus obtained are shown in Table 1.

25

Comparative example 3

 Example 1 was repeated to produce a sheet of coated paper except that the amount of size press treatment was changed to 0.8 g/m² (total of both side surfaces.) The drying contractile force
30 R and the evaluation of the fluting in web-offset printing of the

coated paper thus obtained are shown in Table 1.

[Table 1]

			Air permeability of product		Air permeability of base paper	
	Drying contractile force (gf)	Evaluation of Fluting in web-offset printing	J. Tappi-No.5(B) (Sec.) Oken Air-Permeability	Tappi-T536 hm85 High pressure Gurley (Sec.)	JIS-P8117 Low pressure Gurley (Sec.)	Mis-registration
Example 1	18	◎	700,000	80,000	18,000	0.24
Example 2	22	○	300,000	50,000	6,000	0.32
Example 3	13	◎	1,500,000	250,000	60,000	0.18
Example 4	21	○	600,000	70,000	15,000	0.30
Com. ex 1	51	×	5,000	300	20	0.85
Com. ex 2	54	×	20,000	2,000	140	0.92
Com. ex 3	41	△	50,000	10,000	2,000	0.70

5 The surfaces of the coated paper obtained in accordance with the above mentioned Examples 1-3, and Comparative examples 1-2 were made into graphs by using the above mentioned light laser type displacement sensor and waveform observation software. As apparent from Figs. 1-3, the fluting in web-offset printing can be hardly observed in Examples 1-3. On the other hand, apparent from Figs. 4 and 5 which show the evaluation results measured pursuant to Comparative examples 1 and 2, considerably severe fluting in web-offset printing was confirmed.

10 In addition, the coated papers obtained in accordance with the aforementioned Examples 1-4 and Comparative examples 1-3 were now used for gravure rotary printing. The measurement results on the mis-registration were shown in the rightmost column of Table

1. Namely, the evaluation of mis-registration was made as follows:

[Evaluation of Mis-Registration]

Printing was conducted by using gravure rotary printing
5 machine manufactured by Hitachi Seiko Co., Ltd. The total amount
of displacement between yellow (the first color) and black (the
fourth color) of the register-marks on the right edge and the left
edge was given as that of mis-registration.

10 As clearly shown in the measurement results in Table 1, the
coated paper for printing according to the present invention hardly
generates any fluting in web-offset printing and is excellent in
printing finish. In addition to this, when the aforementioned
coated paper is used for gravure printing, mis-registration is
15 hardly occurred so that it can be also used for coated paper for
gravure rotary printing, which is excellent in printing finish.

Claims:

1. A process for manufacturing a coated paper for printing, said process comprising the steps of:

(a) coating a paper web on both sides with an aqueous solution of polyvinyl alcohol to form a coated paper web;

(b) drying the coated paper web to form a base paper having a polyvinyl alcohol coating with a coating weight on a dry basis of 0.5 to 3 g/m² per side of the base paper,

(c) applying a coating composition mainly composed of a pigment and a binder to the base paper, and

(d) drying said paper to form a coating layer on said base paper.

2. The process as defined in claim 1, wherein the polyvinyl alcohol dissolved in said aqueous solution has a saponification degree of not less than 85 mol%.

3. The process as defined in claim 1, wherein said base paper has an air permeability of 3000 seconds or higher according to a measurement pursuant to JIS-P8117.

4. The process as defined in claim 1, wherein said aqueous solution of polyvinyl alcohol comprises an inorganic pigment.

FIG. 1

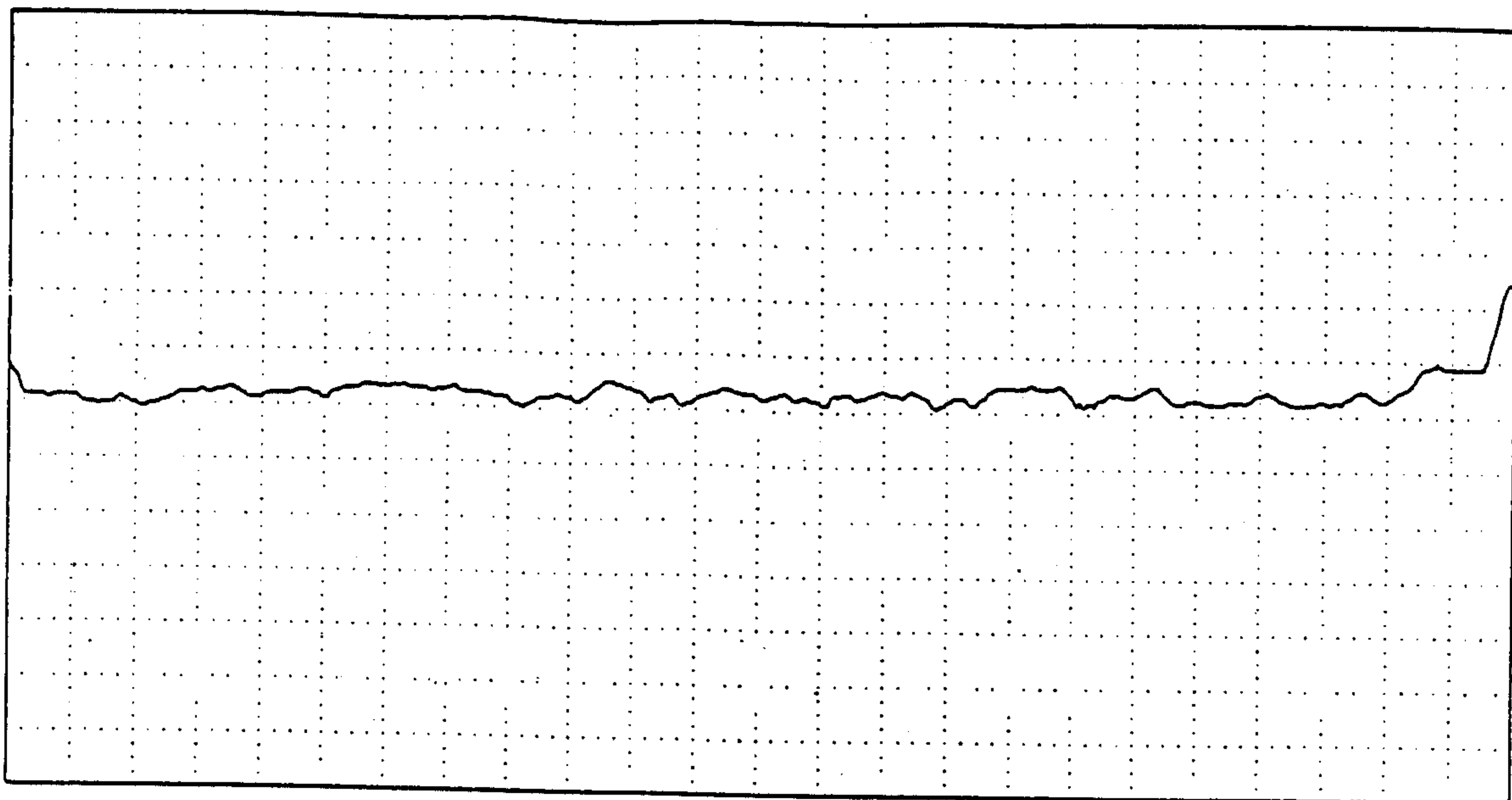


FIG. 2

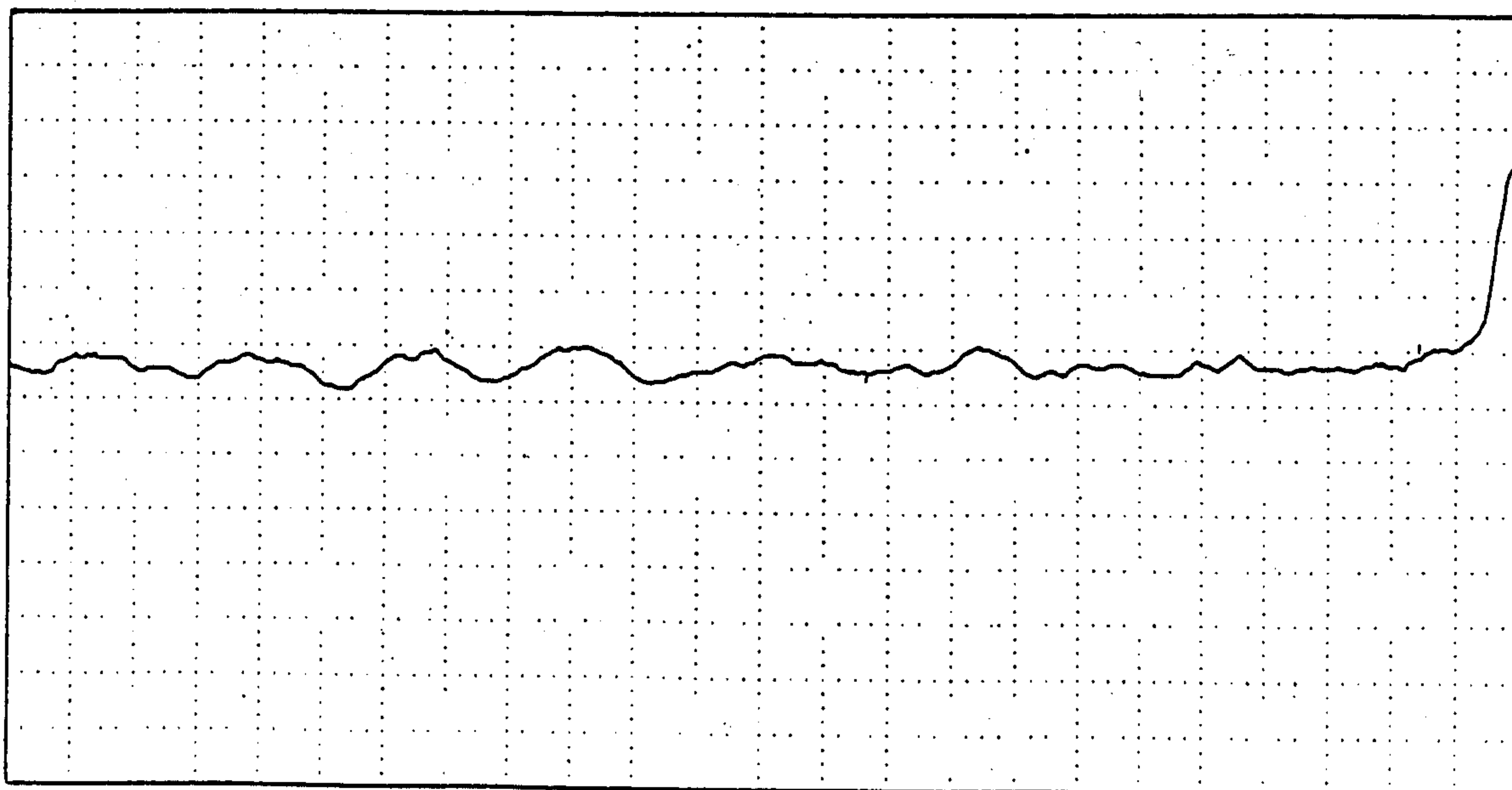


FIG. 3

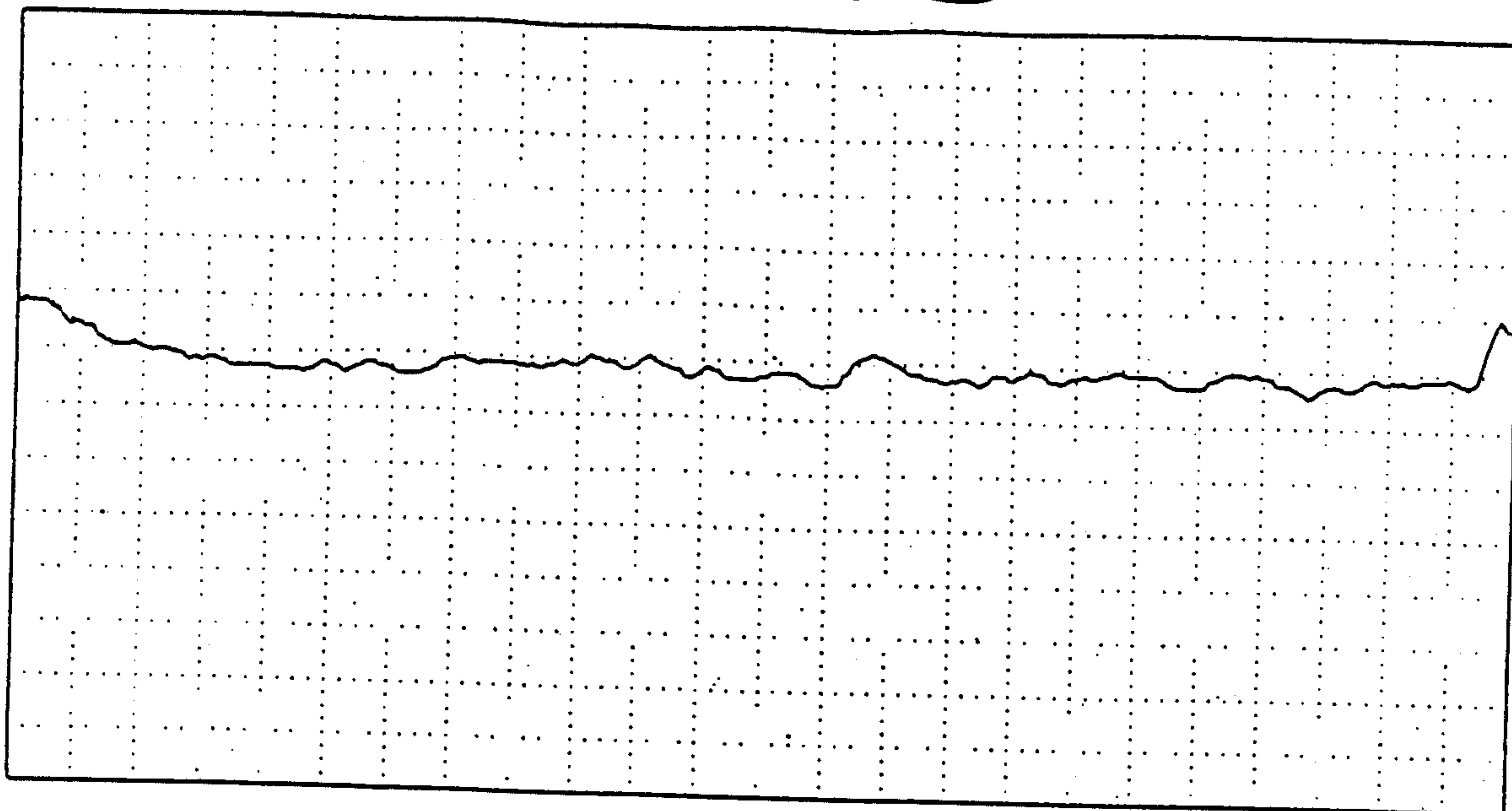


FIG. 4

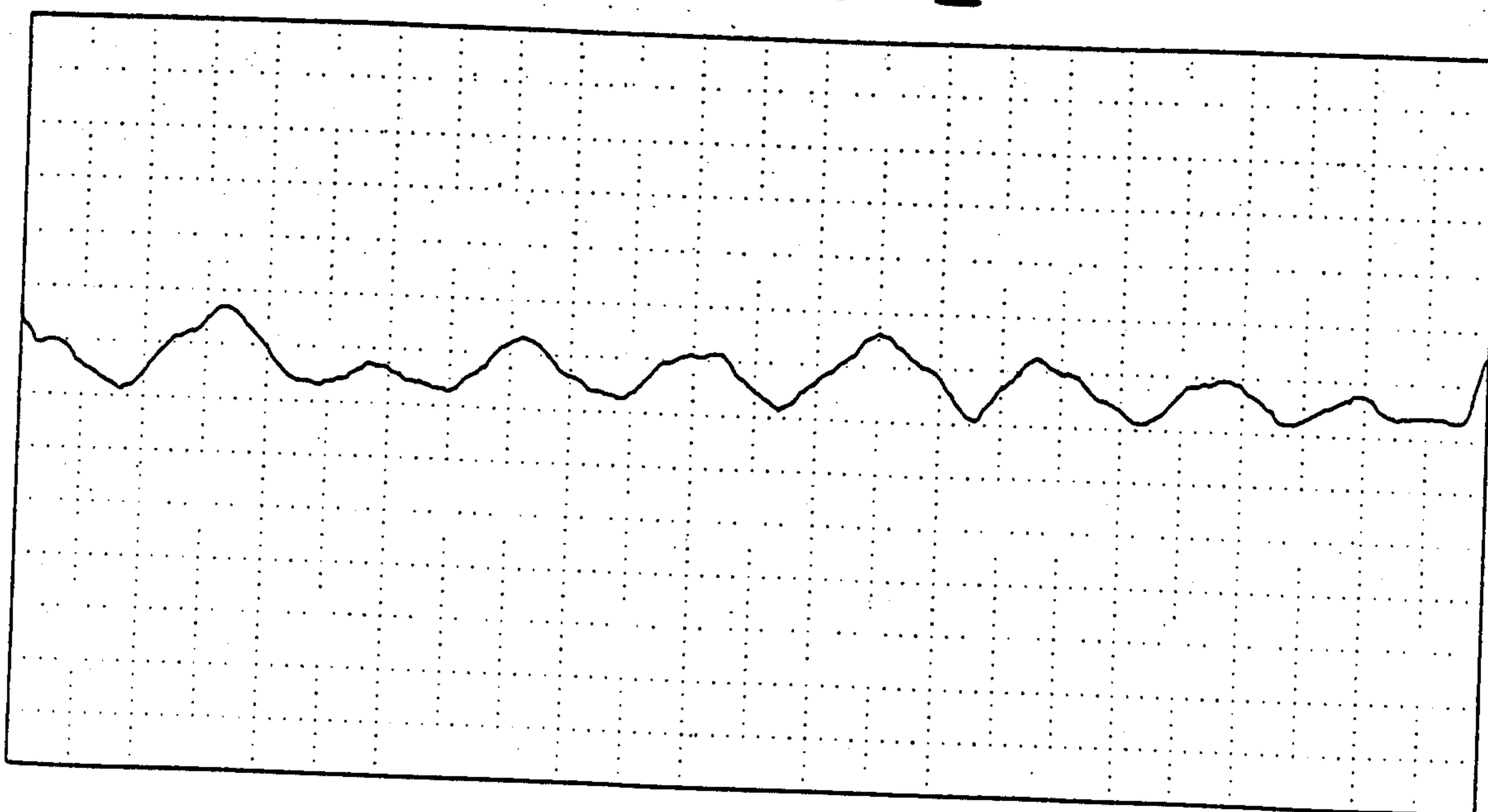


FIG. 5

