Sept. 18, 1923. 1,468,075

A. H. PFUND

DETERMINING THE HIDING POWER OF PAINTS AND PIGMENTS

Filed Nov. 21, 1919

Fig. 1,

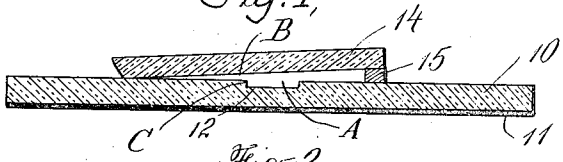


Fig. 2,

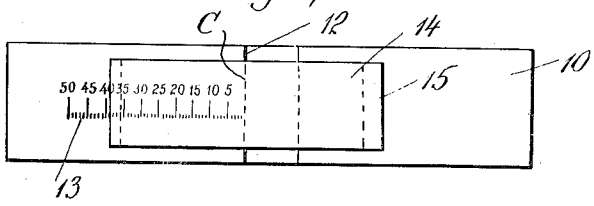


Fig. 3,

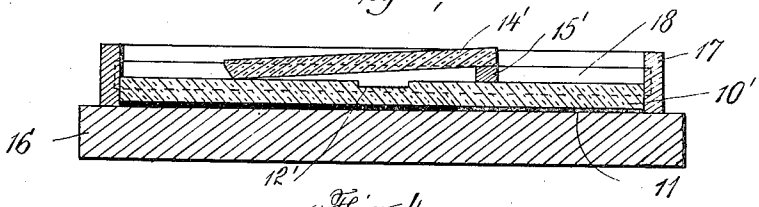


Fig. 4.

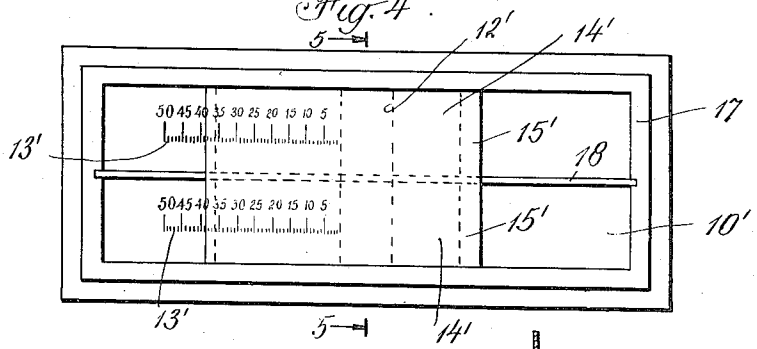


Fig. 5,

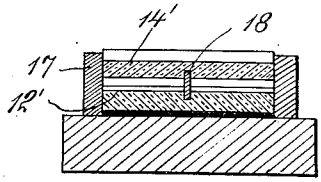
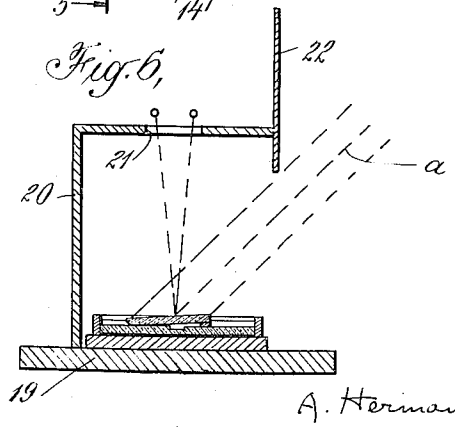


Fig. 6,



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UNITED STATES PATENT OFFICE.

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DETERMINING THE HIDING POWER OF PAINTS AND PIGMENTS.

Application filed November 21, 1919. Serial No. 339,718.

To all whom it may concern:

Be it known, that I, AUGUST HERMAN PFUND, a citizen of the United States, residing at Baltimore, in the county of Baltimore City, State of Maryland, have invented certain new and useful Improvements in Determining the Hiding Power of Paints and Pigments; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in determining the hiding power of paints and pigments, and has for its objects the provision of an improved method of obtaining a measure of the hiding power of a paint or pigment as well as the provision of appropriate apparatus for carrying out this method.

The hiding power of a paint may be defined as that property of a paint which enables it to obliterate beyond recognition any background upon which it may be spread. In order to compare the hiding power of two white pigments, the almost universal custom has heretofore been to rub down equal masses of the two samples with the same amount of linseed oil and ultra-marine blue. The resultant pastes are spread side by side and the sample which has the paler tint is supposed to contain the pigment of greater hiding power. The idea is that the particles of white pigment hide the dark particles and hence give a light tint to the paste. As the result of investigations conducted in accordance with the present invention, it appears that the criterion, upon which the aforementioned tests have heretofore been based, is incorrect.

One of the objects of the invention is to provide a method which will yield numerical values of the true hiding power of white paints and pigments. The basic idea underlying the invention may be expressed thus: Granting that an infinitely thick layer of a paint will "hide" a given background completely, it is sought to find the thinnest layer which will hide the back-ground as effectively as does the infinitely thick layer. Obviously, the thinner the layer of paint required, the greater is the hiding power of the paint. For white paints, the severest test met with in practice is a white wall with black lettering. In such a case, it is desired to obliterate the lettering by covering the entire surface with successive coats of paints. These conditions are simulated by the method and apparatus of the present invention.

In its general aspect, the method of the invention involves spreading upon an appropriate back-ground two juxtaposed layers or portions of the paint or pigment, the thickness of one of these layers being greater than required to completely hide the back-ground. By progressively varying the thickness of the other or second layer of the paint or pigment until the hiding power of the second layer is substantially equivalent to that of the first layer, there is obtained a measure of the hiding power of the paint or pigment in terms of the thickness of this second layer of the paint or pigment when its hiding power is substantially equivalent to that of the first layer.

The novel features of the invention which I believe to be patentably characteristic thereof are set forth in the appended claims. These features, together with the construction and mode of operation of apparatus embodying the same, will be better understood from the following description taken in conjunction with the accompanying drawing, in which:

Fig. 1 is a diagrammatic elevation of a simple device for carrying out the method of the invention;

Fig. 2 is a plan view of the device of Fig. 1;

Figs. 3 and 4 are elevation and plan views respectively of a form of apparatus I have found well adapted for the practice of the invention.

Fig. 5 is a sectional elevation on the section line 5—5 of Fig. 4; and

Fig. 6 is a diagrammatic view of a screen which I have found useful in conjunction with the apparatus illustrated in the preceding figures.

Referring first to Fig. 1 of the drawing, there is diagrammatically represented a plate 10 of glass whose upper surface is optically flat. The lower surface of the glass plate 10 is coated with black baking enamel 11, which yields the desired black back-ground for working with white paint and pigments. A transverse groove 12 is cut in the upper surface of the glass plate 10 and an appropriate scale 13 is etched on the upper surface of the glass plate, as shown in Fig. 2 of the drawing. I have

used, with advantage, a plate of glass 14 x 5 x 0.6 centimeters having a transverse groove 2 mm. deep and 1 centimeter wide.

Resting upon the plate 10 is a glass plate 14, whose lower surface is likewise optically flat. A strip of thin steel 15 is attached to one end of the plate 14, so that a wedge-shaped layer of paint may be formed between the adjacent surfaces of the glass plates 10 and 14. I have successfully used for the plate 14 a piece of glass 7 x 3.5 x 0.6 cm. having a strip of steel 0.45 mm. thick attached to one end thereof.

The wedge-shaped layer of paint between the glass plates 10 and 14 terminates abruptly at the "infinitely thick" layer or portion A, contained in the groove 12, and, so long as the hiding of the juxtaposed layer or portion B of the wedge-shaped layer of paint is not complete, the line of demarcation between these two layers will be visible. By sliding the plate 14 to the left, as viewed in Figs. 1 and 2 of the drawing, it finally becomes impossible to see the edge or line of demarcation between the juxtaposed layers A and B of the paint. From a knowledge of the angle of the wedge and the reading on the scale 13, it is possible to calculate the thickness of this critical layer lying immediately above the edge C, this edge C being the line of division between the "infinitely thick" layer of paint A and the juxtaposed wedge-shaped layer of paint B.

Now, in advancing the plate 14 until the line of demarcation can no longer be seen, we have overdone it, so to speak. To correct this, we must reverse the motion of the plate 14 until the edge C can just be distinguished over its entire length. The mean value of the readings, corresponding respectively, to the disappearance and the appearance of the edge C yields the desired result. Since the fading away and reappearance of the edge C is so gradual, due to the fact that the least perceptible increment of intensity which the human eye can detect is 1 to 2% (Fedner's law), it is clear that no high degree of precision is attainable by this method. By taking ten pairs of readings, it has been found that the average deviation from the mean is about 3 to 4%.

In Figs. 3, 4 and 5 of the accompanying drawing, I have illustrated a practical form of the device which I had used with success. In this modification of the invention, the base plate 10′ of glass or other appropriate transparent material is mounted on a block 16 which may advantageously be of wood. The plate 10′ is surrounded by a rectangular frame 17, which prevents the paint or pigment from slopping over. The base plate 10′ has a recess 12′, which is adapted to contain the "infinitely thick" layer of the paint or pigment. The movable plate 14′, of glass or other appropriate transparent material, slides within the frame 17, transversely of the recess 12′. The plate 14′ has a thin strip of metal 15′ attached to one end thereof so as to provide the desired wedge-shaped space between the adjacent surfaces or faces of the plates 10′ and 14′. An appropriate background 11 is formed on the lower face of the base plate 10′.

The device shown in Figs. 3, 4 and 5 is of the duplex type, so that two lots of paint or pigment may be tested at the same time and thus their respective hiding powers conveniently compared. To this end, a transverse strip 18 is fitted in appropriate grooves in the plates 10′ and 14′, and is arranged substantially midway of the width of these plates. Two scales 13′ are provided for the two testing sides of this duplex device.

A suitable viewing device has been found of assistance since the reflection of the observer's face in the upper plate 14 is annoying. A suitable arrangement for this purpose is diagrammatically illustrated in Fig. 6 of the drawing. As indicated in Fig. 6, strong daylight illuminates the apparatus from the observer's right (or left), the light rays being represented in this figure by the dotted lines *a*. The viewing device comprises an appropriate base 19 upon which is mounted a housing 20 having its inner walls blackened. The housing 20 is provided with an appropriate opening 21 through which the superposed plates 10 and 14 may be seen. At its back, the viewing device is provided with a vertical blackened shield 22. I have successfully employed for the housing 20 a box-like chamber of about 30 cm. in height.

For convenience, I call the device or instrument for determining or measuring the hiding power of a paint or pigment, as hereinbefore described, a "cryptometer" from the two Greek words for "conceal" and "measure."

The instrument may, if desired, be developed to yield results of high precision. I will herein refer to two methods by which this result may be accomplished, although it will be understood that I do not thereby intend to limit the invention to these particular methods of securing high precision. If we call the hiding complete when the brightness of the variable layer is 99% of that of the infinitely thick layer, then, by means of a photo-electric cell, which measures the light from the two layers in contact at the edge C, it is possible to locate the desired point very accurately. Again, by making, preliminarily, a study of the variation of brightness of the paint or pigment with increasing thickness, a formula can be established connecting these two quantities. Then, by finding a position of the movable plate 14 where the brightness is, say, one-half that of the infinitely thick layer, it is possible to calculate the thickness yielding

99% of the brightness of the infinitely thick layer. For most purposes, high precision is not necessary, and for this reason, the use of the cryptometer, in the form and manner herein illustrated and described, is not only sufficiently accurate but is extremely simple in its construction and operation.

A sharp distinction must be made between the hiding power of a pigment and that of a paint. Not only are these quantities expressed in different units but they are not necessarily related in the sense that a pigment of great hiding power necessarily produces a paint of correspondingly great hiding power. Taking up first the hiding power of pigments, let us consider an intimate mixture of x grs. of a white pigment and y grs. of colorless (or very pale) linseed oil. This mixture is tested in the cryptometer and the critical thickness producing complete hiding is found. Let

t=thickness of critical layer (in cms.).

b=numbers of grs. of pigment in a disc of 1 cm² base and thickness t.

Then, if b grs. pigment hide 1 sq. cm., we find the number of sq. cm. A covered and hidden by one gram of pigment from the relation:

$$b:1::1:A \text{ or } \frac{1}{b}=A$$

Since the hiding power is better the thinner the layer, that is, the smaller b is, we may define the hiding power of a pigment as the reciprocal of the number of grs. of pigment, mixed with colorless linseed oil to painting consistency, which are necessary to hide a black, non-absorb-end area 1 cm². This is numerically equal to the number of sq. cm. covered and hidden by 1 gr. of pigment. Hiding powers of pigments will, therefore, be expressed in terms of cm² per gr. Investigations have shown that the hiding power of the pigment is effected by the relative amount of oil present:—the thinner the mixture, the greater the hiding power. This means that the hiding power is not only a function of the number of white particles, but also of their separation. In order to reduce all mixtures to a standard condition, the term "painting consistency" is specified in the foregoing definition.

Turning next to the hiding-powers of paints, we choose, as a measure, the number of sq. ft. which one gallon of paint will cover and hide. While the retention of the metric system might, at first thought, seem advisable, practice dictates the selection of the English system of units. The actual measurements and calculations are very simple. The paint is measured up in the cryptometer and, from a knowledge of the critical thickness, the number of square feet per gallon is calculated at once. As a matter of fact the cryptometer may, of course, be made so that one may read the result directly off a separate scale etched on the lower plate.

The results obtained for characteristic pigments and paints are summarized in the following table:

Pigment.	Painting consistency: grs. pigment / grs. oil.	Hiding power pigment.	Hiding power paint.
1. Sublimed white lead	7:3	26 cm²/gr.	172 sq. ft./gal.
2. Basic carbonate white lead	7:3	36	243
3. Lithopone	4:3	51	190
4. Titanox	3:4	58	132
5. Zinc oxide (leaded)	1:1	59	194
6. Zinc oxide (pure)	3:4	57	145
7. Zinc oxide plus trace of lampblack	3:4	190	486

Concerning the pigments themselves, the results obtained speak for themselves. The one point, however, to which attention must be called, is that involving a comparison of pigments 6 and 7. The only difference between these two pigments is that 6 is white while 7 is pearl-grey. If these same pigments are compared by rubbing them down with oil and ultra-marine blue, the grey sample will show the darker tint, hence it will be considered as having a smaller hiding-power than the white sample. As a matter of fact, the hiding-power of the grey sample is more than three times as great as that of the white. It is therefore clear that, since the rub-down test yields results which are so violently at variance with those obtained with the cryptometer, the former method should be discarded.

The results on paints are interesting. While the hiding-powers of zinc pigments are larger than those of the white leads, the reverse is true of the paints. (Compare samples 2 and 6). The reason is obvious when the "oil-absorption" of the pigments is considered. One pound of zinc-oxide mixed with one pound of linseed-oil yields a mixture of proper painting consistency, while a similar mixture of white-lead in oil is entirely too "runny" for painting purposes. More lead must be added to give the correct "body" or thickening to the paint. Such a paint has the greater hiding-power but it has gained its superiority in consequence of the excess of lead pigment which has been added.

It is clear that if a surface of lighter tint (say, white-pine) is to be hidden, the number of square feet per gallon will be considerably larger than where a dark background is to be covered. The cryptometer must necessarily leave out of consideration the absorption of the paint in the pores of the wood. However, this instrument may be adapted to take care of lighter backgrounds, by removing the black paint from the lower surface of the base plate 10. If

this plate be rested on the actual surface to be painted, it is again possible to determine in advance just how many gallons are required to paint a given area.

From the foregoing discussion, it will be evident that the invention provides a method and an instrument which yield numerical values of the hiding-powers of paints and pigments. Both the method and the instrument are simple in operation, and can be utilized with convenience. The results obtained from the practice of the invention are, moreover, accurate and reliable, and enable accurate and reliable predictions to be made of the behavior of various paints and pigments in actual painting practice.

I claim:—

1. The method of obtaining a measure of the hiding power of a paint or pigment which comprises spreading upon an appropriate background two juxtaposed layers of the paint or pigment, one of said layers being of greater thickness than required to completely hide the background and the other layer being of adjustable thickness, progressively varying the thickness of said adjustable layer of the paint or pigment until the hiding power of this layer is substantially equivalent to that of the other layer, and indicating the hiding power of the paint or pigment in terms of the thickness of said second layer when its hiding power is substantially equivalent to that of the other layer.

2. The method of obtaining a measure of the hiding power of a paint or pigment which comprises forming a wedge-shaped layer of the paint or pigment in juxtaposition to a layer of the paint or pigment of relatively great thickness, varying the thickness of the juxtaposed edge of said wedge-shaped layer until the line of demarcation between said two juxtaposed layers is just perceptible, varying the thickness of the juxtaposed edge of said wedge-shaped layer until the line of demarcation between said two juxtaposed layers just disappears, and obtaining a measure of the hiding power of the paint or pigment from the mean thickness of the juxtaposed edge of said wedge-shaped layer after each of the aforementioned procedures.

3. The method of obtaining a measure of the hiding power of a paint or pigment which comprises spreading above an appropriate background two juxtaposed layers of the paint or pigment, one layer being of greater thickness than required to completely hide the background and the other layer being of adjustable thickness, progressively increasing and decreasing the thickness of said adjustable layer until the hiding power of the juxtaposed edge of the variable layer is substantially equivalent to the hiding power of the other layer, and obtaining a measure of the hiding power of the paint or pigment from the mean thickness of the juxtaposed edge of the adjustable layer after increasing and decreasing the thickness of this layer until the hiding power of the juxtaposed edge of the variable layer is substantially equivalent to that of the other layer.

4. A device of the character described, comprising a pair of relatively movable, superposed, transparent plates having a wedge-shaped space and a recess therebetween, and an appropriate background on the face of one of said plates.

5. A device of the character described, comprising a transparent base plate having an appropriate background on one of its faces and a recess in its other face, a second transparent plate operatively positioned on the recessed surface of said base plate and movable with respect thereto, and means providing a wedge-shaped space between the adjustable faces of said plates.

6. A device of the character described, comprising an appropriate background, means for maintaining a relatively deep layer of paint or pigment above the background, means for maintaining a layer of paint or pigment of adjustable thickness above the background in juxtaposition to said relatively deep layer, means for adjusting the thickness of said second layer of paint or pigment, and means for obtaining a measure of the thickness of said second layer of paint or pigment in any of its aforementioned adjustments.

7. A device of the character described, comprising a glass base plate having a black, opaque background on one of its faces and a transverse recess on its other face, a second glass plate operatively positioned on the recessed surface of said base plate and movable transversely of the recess, and means providing a wedge-shaped space between the adjacent faces of said plates so that the thickness of said space in the vicinity of the recess may be varied by the movement of the second plate transversely of the recess.

In testimony whereof I affix my signature.

AUGUST HERMAN PFUND.