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METHOD OF QUICKLY DETERMINING THE APPROXIMATE PHOSPHORUS CONTENT OF A STEEL SPECIMEN

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FIG. 2

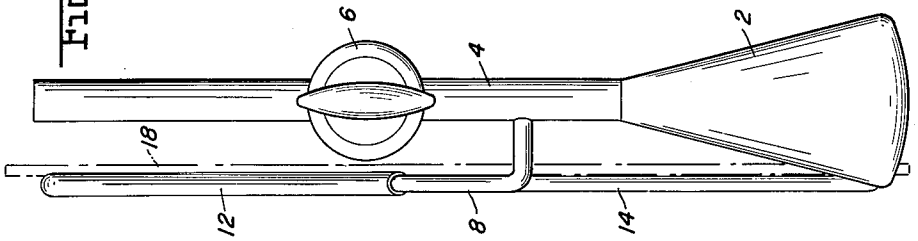
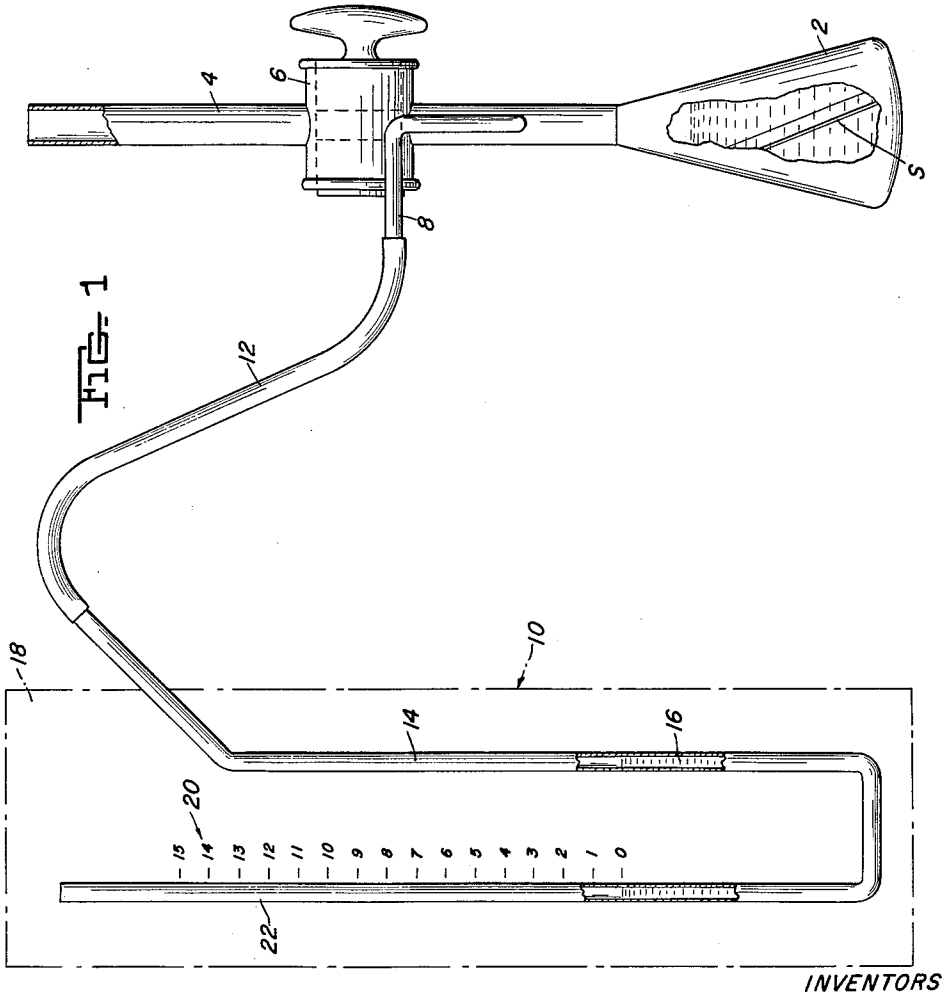


FIG. 1



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METHOD OF QUICKLY DETERMINING THE APPROXIMATE PHOSPHORUS CONTENT OF A STEEL SPECIMEN

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The present invention relates generally to the testing of steel and more particularly has for its primary object the provision of a method for quickly determining the approximate phosphorus content of annealed strip steel.

The method of the present invention is especially suited for testing box annealed or continuous annealed steel strip which is being processed for tin plating. Therefore, the invention will be described in connection with such steel strip, but it is to be understood that the invention is not limited to such application.

In order to successfully withstand the deformations involved in the fabrication and use of containers made of tin plate, the tin plate stock must be produced with a particular stiffness suitable for its ultimate use. The amount of phosphorus in the tin plate steel stock is determinative as to the degree of stiffness the finished tin plate will have. Ordinarily, tin plate is made from low, intermediate or high phosphorus content steel stock, depending on the stiffness required. The low phosphorus steel stock contains residual to .015% maximum phosphorus; the intermediate grade contains .03/.05% or .07/.09% phosphorus; and the high phosphorus grade of tin plate contains .12/.15% phosphorus. In usual practice during processing of tin plate low phosphorus stock is box annealed or continuous annealed; intermediate phosphorus stock is box annealed only; and high phosphorus stock is continuous annealed only.

During the processing of steel strip for tin plate the identity of the strip as to phosphorus content is sometimes in doubt as a result of identification being inadvertently removed from the coil of strip being processed. Up to the time of our invention, when this happened it was necessary to remove the coil of material from the processing line until a sample thereof could be analyzed in the chemical laboratory so that identity and phosphorus content of the material could be re-established. The quantitative analysis procedure in the chemical laboratory was excessively time consuming at best and resulted in considerable time loss before the material in question could be further processed.

The present invention proposes a method whereby the approximate phosphorus content of a sample of tin plate steel strip stock may be quickly determined with such accuracy as to establish whether the steel has a low, intermediate, or high phosphorus content.

The invention will be fully appreciated from the following detailed disclosure and the appended claim when read in connection with the accompanying figures in which:

FIGURE 1 is a front elevational view of an apparatus for carrying out the method of the invention; and

FIGURE 2 is a side elevation of FIGURE 1.

Referring more particularly to the drawing reference numeral **2** designates a glass flask having an elongated neck **4** with a stopcock **6** therein. A vent tube **8** projects from the neck **4** and is connected to a manometer **10** by means of a tube **12**. The manometer **10** includes an open end, generally U shape glass tube **14** containing a colored liquid **16**. The tube **14** is secured to a panel **18** having a linear scale **20** imprinted thereon. The scale **20** may consist of ½ inch graduations along and adjacent to the outer leg **22** of the tube **14**.

In practicing the method of the invention, the flask **2** is filled with a solution of 1–1 hydrochloric acid. A clean sample S of predetermined size of the strip to be tested is then immersed into the solution through the neck **4**. We have found a standard sample size of 5/16 inch wide by 2½ inches long to be suitable for this purpose. The reaction between the hydrochloric solution and the sample of strip causes gas to be evolved which is initially permitted to pass out into the atmosphere through open stopcock 6 for a period of approximately four minutes. The stopcock **6** is then closed so that the gas flow is restricted to the manometer **10** via the vent **8** and tube **12**. The flow of gas from the flask to the manometer causes the colored liquid to rise in the outer leg **22** of the tube **14**. Readings are then taken from the scale **20** at one minute intervals for four minutes and then added together to obtain a "test reading." For any given sample the increase in the amount of gas evolved as a result of the reaction between the sample and the hydrochloric acid is directly proportional to the length of time the sample is immersed in the acid. Also, more gas will be evolved in a given time from a high phosphorus steel than from a low phosphorus steel. Therefore, readings are taken over a standard four minute period in order to insure that the reaction is proceeding at a normal uniform rate. If, for any reason, the four readings taken during the four minute period do not indicate a uniform rate of gas evolution the stopcock **6** is reopened for a brief interval of time to permit the gas to be vented to the atmosphere and thus allow the liquid **16** of the manometer **10** to drop to the zero reading of the scale **20**. Then the stopcock is closed again and the test is repeated. The following is a typical example of readings obtained at one minute intervals over a period of four minutes in the testing of a box annealed intermediate phosphorus content steel sample:

Phosphorus content:	Reading on scale 20
0%	2.5 (after 1 minute)
0%	5.0 (after 2 minutes)
0%	7.5 (after 3 minutes)
0%	10.0 (after 4 minutes)
.07/.09%	10.0 "test reading"

Testing of a number of samples of tin plate steel strip stock of known phosphorus content has resulted in the establishment of the following listed "test readings" as typical for tin plate steel strip stock in various phosphorus content categories:

Box annealed strip

Phosphorus content:	"Test reading" [1]
.015% maximum	Up to 3.0
.03/.05%	4.0 to 5.0
.07/.09%	9.0 to 11.0

[1] Test reading is the reading taken after the fourth minute.

Continuous annealed strip

Phosphorus content:	"Test reading" [1]
.015% maximum	9.0 to 10.0
.12 to .15%	30.0 to 40.0

[1] Test reading is the reading taken after the fourth minute.

It will be noted that samples of continuous annealed strip cause more gas to be evolved when immersed in the hydrochloric acid than a sample of box annealed strip having the same phosphorus content. This is due to the fact that continuous annealed steel strip has a smaller grain size than the box annealed strip and it is theorized that the presence of a greater number of grain boundaries in the microstructure of the continuous annealed strip causes the material to be more susceptible to attack by the hydrochloric acid solution.

It will be obvious that, if desired, the method of the invention can also be used to distinguish between box annealed strip and continuous annealed strip if the phosphorus content of the material is known.

While one embodiment of our invention has been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claim.

We claim:

A method of quickly determining the approximate phosphorus content of annealed steel comprising the steps of obtaining a sample of predetermined size of said steel, immersing said sample in a hydrochloric acid solution, allowing the gas evolved by the reaction between the sample and the acid solution to escape for a predetermined time, and then restricting the flow of said gas to a pressure-responsive indicator and taking a series of readings from said indicator at predetermined intervals.

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