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GRAIN DRYING CONTROL GAUGE

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2 Sheets-Sheet 1

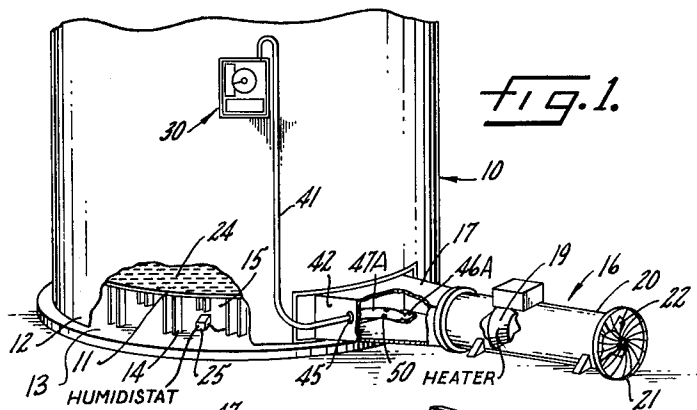


fig. 1.

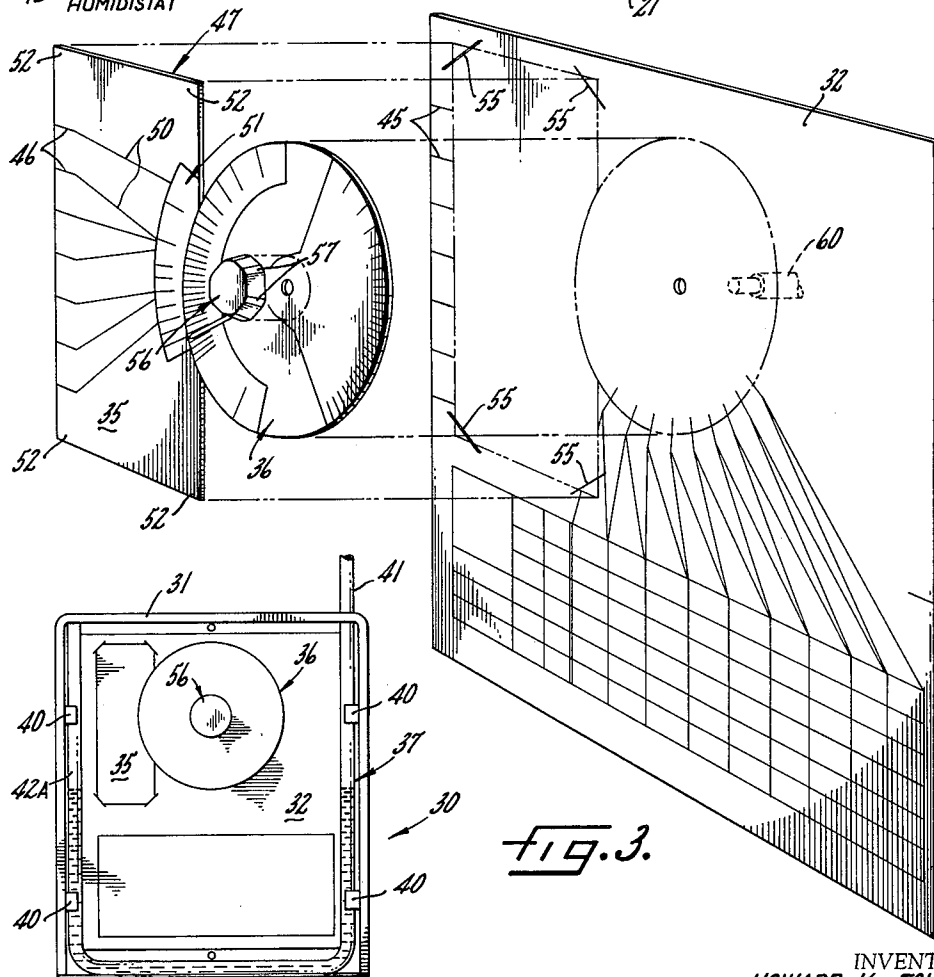


fig. 2.

fig. 3.

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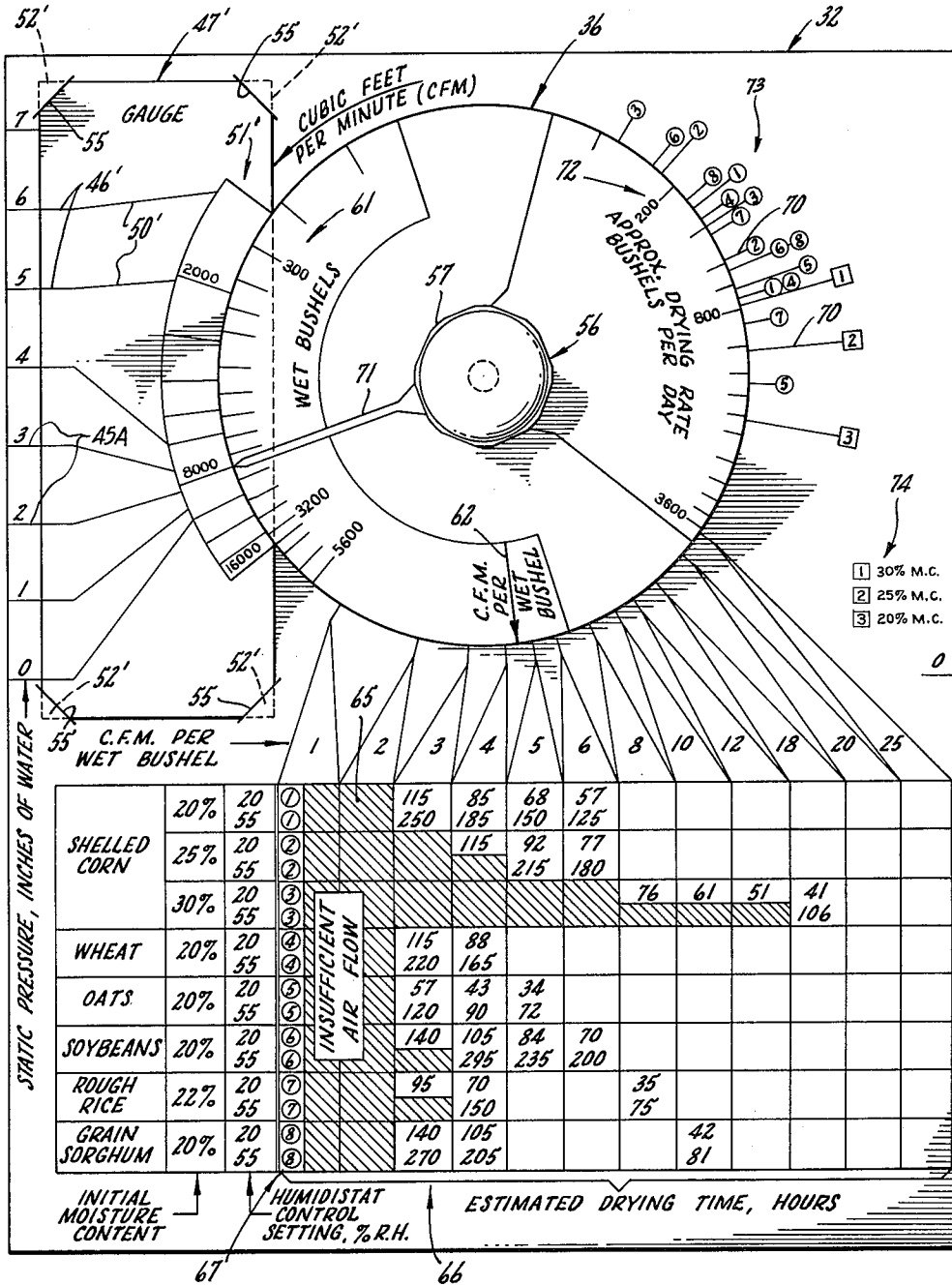


Fig. 4.

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GRAIN DRYING CONTROL GAUGE

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6 Claims. (Cl. 34-48)

The present invention relates to apparatus for drying grain and the like.

Grain can be dried by means of a grain bin and a conduit leading into the grain bin at the lower end thereof whereby air of constant humidity (or below a given humidity) can be forced through the grain. One arrangement for carrying out such a process is shown in the U.S. patent to Barre 2,855,697. It has been found that there are a large number of variables which determine the rate of grain drying in such a process and also a large number of variables which determine the total time required to dry the grain. Consequently, one object of the present invention is to provide means whereby the operator of the grain drying apparatus is notified of the time required to complete the drying of the grain.

Another object of the present invention is to provide grain drying apparatus incorporating means for notifying the operator of the rate of grain drying which normally takes place from the bottom of the bin upwardly.

Still another object of the present invention is to provide improved grain drying apparatus.

Related objects and advantages will become apparent as the description proceeds.

In accordance with the present invention, there is provided grain drying apparatus including a grain bin, an air conduit leading to the grain bin and means for forcing air of relatively constant humidity to the grain bin through the conduit. There is further provided means for measuring and indicating the static pressure within the air conduit. The thus indicated static pressure is converted by the present apparatus into information such as rate of volume flow of air through the grain bin, rate of grain drying, and time required to complete drying of the grain.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims.

FIG. 1 is a perspective view of grain drying apparatus embodying the present invention.

FIG. 2 is a fragmentary detailed view of a gauge forming a part of the structure of FIG. 1.

FIG. 3 is an exploded perspective view of a portion of the structure illustrated in FIG. 2.

FIG. 4 is an assembled front elevation of the structure illustrated in FIG. 3 showing, however, an alternative insert card.

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawing and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Referring now more particularly to the drawings, there is illustrated a grain bin 10. The grain bin is relatively airtight except at its upper end (not shown) and includes a bottom 11 fixed within the bin and spaced upwardly from the lower edge 12 of the bin so as to define a plenum chamber 15. The bottom 11 may be supported in the

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illustrated position by suitable upright members 14 which may rest on a concrete slab 13.

Fixed to the side of the grain bin so as to open into the plenum 15 is a conduit 16 having a flaring portion 17 which connects the grain bin and a cylindrical portion 20 of the conduit. At the entrance end 21 of the conduit, there is mounted a blower 22 which functions to move air through the conduit 16 and the plenum chamber 15 and upwardly through the bottom 11 and grain 24 supported on the bottom 11. The bottom 11 should be perforated so as to permit the passage of such air and preferably has an open area as compared to the total area of approximately 7%-10%. It should be understood, however, that the grain bin 10 is substantially airtight as is the conduit 16 and the connection of the grain bin and conduit. Thus, the only access of air to the grain bin is the entrance 21 of the conduit and the upper end of the grain bin.

Within the conduit 16 and particularly the cylindrical portion 20 of the conduit, there is mounted a heater 19 which may be electric or may use gas as its fuel. One example of an electric heater is incorporated in the commercially available grain drier Farm Fans Model E-324 Electricron manufactured by Farm Fans, Inc., of Indianapolis, Indiana. One example of a suitable gas heater is illustrated in the above mentioned patent to Barre although this example places the heater upstream of the blower. A further example of a suitable gas heater is the conventional and commercially available grain drier Farm Fans Model DH-21 also manufactured by said Farm Fans, Inc.

The apparatus of FIG. 1 is provided with suitable means for controlling the moisture of the air entering the grain from the conduit 16. This means might include a humidistat 25 located within the plenum chamber 15 and arranged to control the heater 19 and to turn it on whenever the humidity of the air moving through the plenum chamber rises above a predetermined value. It can be appreciated that the operation of the heater will cause the air moving through the conduit to be heated and to cause its relative humidity to drop. The humidistat is arranged to shut off the heater when the humidity of the air within the plenum chamber drops below a given level whereby the relative humidity of the air moving into the grain is maintained below a predetermined value. A suitable humidistat control means for the heater forms a part of the above conventional commercially available embodiments (of heater and blower structures) and also forms a part of the disclosure of the above mentioned Barre patent. Consequently, the details of the control means will not be further described herein.

Fixed to the wall of the grain bin is a gauge 30. In general, this gauge includes a rectangular housing 31 (FIG. 2), a card 32 mounted within the housing 31, an insert card 35 mounted upon the card 32 and a rotatable indicator dial 36 rotatably mounted upon the housing. The gauge further includes a U-shaped manometer tube 37 fixed within the housing by means of suitable spring clips 40 extending from the walls of the housing. The manometer tube 37 is connected to the conduit 16 by means of a closed tube 41 which leads to the side 42 of the tapered portion 17 of the conduit 16. In order to prevent leakage through the side wall 42, the tube 41 has a rubber stopper 45 thereabout. The tube 41 extends through the wall 42 and projects upstream to a crimped closed end 46A. In the portion 47A of the tube which projects upstream, there are sidewardly opening bores 50, for example four such bores, which sense the static pressure within the portion 17 of the conduit 16. This pressure is transmitted through the tube 41 to the U-

shaped tube 37 causing the level of the liquid in the leg 42A to vary and to indicate static pressure in inches of water.

Referring more particularly to FIGS. 3 and 4, it will be noted that the card 32 has horizontal equally spaced indicating lines 45 thereon, these lines being spaced .606 inch apart. (The liquid in the manometer can be any liquid but preferably in the present embodiment is oil having a specific gravity of .826. Thus 1 inch of water/.826 $\times$ $\frac{1}{2}$ =.606 inch.) Lines 45A lead into further indicating lines 46 and 46' shown on the alternative insert cards 47 and 47'. The lines 46 and 46' are also horizontal and equally spaced and lead into sloping lines 50 and 50' which terminate at a cubic foot per minute scale 51 or 51' formed on the insert cards. Thus, the operator of the grain bin can read directly the static pressure within the conduit 17 as well as the rate of volume flow of air through the grain. The insert cards 47 and 47' can be mounted upon the card 32 by insertion of the corners 52 or 52' into diagonal slits 55 in the card 32. The card 47, for example, is used for one size of blower 22 and is so marked while the card 47' is used for another size of blower and is so marked, the two cards having different arrangements of scales thereon.

The indicator dial 36 has fixed thereto a handle 56 which preferably has ridges 57 facilitating twisting of the dial. The indicator dial and handle are rotatably mounted upon the housing 31 and card 32 by means of a dowel 60 which is fixed to the handle 56 and the dial 36 and is rotatably mounted upon the housing 31.

On the indicator dial 36 is a scale 61 indicating the amount of wet bushels in the bin. This value may be determined in a conventional manner by forcing a graduated stick or rod down through the grain from the top of the bin until resistance abruptly ceases and the rod moves freely. It should be understood that the lower portion of the bin houses the dry grain while the upper portion of the bin houses the grain which is still wet. By lining up the correct value of wet bushels on the scale 61 with the indicated reading of the scale 51 or 51', the further indicator 62 is rotated to a particular value of c.f.m. per wet bushel, i.e., below the dial 36. In the example shown in FIG. 4, the indicator is pointing at approximately 4.5 c.f.m. per wet bushel. Depending upon the type of grain being dried, the time required to dry the grain may be determined by moving vertically downward from the designated c.f.m. per wet bushel.

Assuming, for example, that in the present situation shelled corn of 20% initial moisture content is being dried, and further assuming that the humidistat control is set at 20% humidity, the amount of time required to dry the grain is between 85 and 68 hours. Since the indicator 62 is pointing at approximately 4.5 c.f.m. per weight bushel or approximately halfway between the 4 and 5 readings, the time can be interpolated at approximately 76 hours. It should be noted that a large part 65 of the scale 66 is blacked out so as to indicate "insufficient air flow" which means that there is insufficient amount of air flowing to dry the grain within the grain bin. Such a situation can be avoided by not placing too great a quantity of the grain in the bin at one time. In other words, by placing a small amount of grain in the bin and by drying that grain prior to placing a further amount of grain in the bin, the operator can stay out of the area 65 of the chart.

The indicator dial 36 also has thereon a scale 72 giving approximate drying rate in bushels per day. By use of the column 67, the correct indicator line of all the lines 70 can be selected. The operator then rotates the dial 36 until the pointer 71 which is fixed to or formed on the dial points to the manometer indicated reading of the scale 51 or 51'. The proper line 70, as designated by the column 67, then indicates the correct drying rate in bushels per day on the scale 72. Although not indicated (for clarity) in the column 67 and ad-

jacent the lines 70, the encircled numerals are color coded so that in moving from the column 67 to the numerals 73, the proper line 70 is selected. For example, the two encircled numerals 1 in column 67 have different colored backgrounds each of which corresponds to the background of a respective encircled 1 in the group 73. The group 74 of numerals corresponds to the numerals with a square around them in group 73.

From the above description, it can be appreciated that the present invention provides grain drying apparatus incorporating means for notifying the operator not only of the rate of grain drying but also of the time required to complete the drying of the grain. It will also be clear that the present apparatus performs its intended function in a highly efficient yet inexpensive manner.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention and the scope of the claims are also desired to be protected.

The invention claimed is:

1. In grain drying apparatus including a grain bin, a conduit leading into said grain bin, means for forcing air under pressure into said grain bin through said conduit, and means for maintaining the relative humidity of the air moving through said conduit below a given level; the improvement which comprises a manometer, a pressure sensing device operatively connected to said manometer and received in said conduit and having an opening therein transverse to the direction of said conduit for measuring the pressure in said conduit, an element fixedly mounted adjacent said manometer, first calibrations on said element immediately adjacent said manometer and converting the reading thereof into volume rate of flow of air through said conduit, an indicator disc rotatably mounted with relation to said element, further calibrations on said element adjacent said indicator disc and setting forth drying time required, said indicator disc having a wet volume scale and a pointer thereon and fixed with relation thereto, said pointer indicating drying time from said further calibrations when said wet volume scale is positioned with the actual wet volume at the sensed volume rate of flow of air.

2. In grain drying apparatus including a grain bin, a conduit leading into said grain bin, means for forcing air into said grain bin through said conduit, and means for maintaining the relative humidity of the air moving through said conduit below a given level; the improvement which comprises a manometer, a pressure sensing device operatively connected to said manometer and received in said conduit and having an opening therein transverse to the direction of said conduit for measuring the pressure in said conduit, first calibrations adjacent said manometer converting the reading thereof into volume rate of flow of air through said conduit, an indicator disc rotatably mounted adjacent said manometer, further calibrations adjacent said indicator disc setting forth drying time required, said indicator disc having two pointers thereon and fixed with relation thereto, said indicator disc having a wet volume scale and a drying rate scale thereon and fixed with relation thereto, one pointer indicating drying time from said further calibrations when said wet volume scale is positioned with the actual wet volume at the sensed volume rate of flow of air, said drying rate scale indicating drying rate when the other of said pointers is positioned at the sensed volume rate of flow of air.

3. In grain drying apparatus including a grain bin, a conduit leading into said grain bin, means for forcing air under pressure into said grain bin through said conduits, means for maintaining the relative humidity of the air moving through said conduit below a given level, the improvement which comprises a manometer, a pressure

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sensing device operatively connected to said manometer and received in said conduit and having an opening therein transverse to the direction of said conduit for measuring the pressure in said conduit, a first flat element fixedly mounted adjacent said manometer, a plurality of second flat elements selectively removably mountable on said first flat element, first calibrations on each of said second elements positioned to be adjacent said manometer when the respective second element is mounted on said first element and converting the reading of said manometer into volume rate of flow of air through said conduit, an indicator disc rotatably mounted with relation to said element, further calibrations on said first element adjacent said indicator disc and setting forth drying time required, said indicator disc having a wet volume scale and a pointer thereon and fixed with relation thereto, said pointer indicating drying time from said further calibrations when said wet volume scale is positioned with the actual wet volume at the sensed volume rate of flow of air.

4. A grain drying control gauge comprising an upright U-shaped tube, liquid received in said tube, one leg of said tube being open at its upper end, a pressure sensing probe crimped at one end and having holes in its side for sensing pressure, tubing connecting the upper end of the other leg of said tube with said probe, a vertical base, said tube being mounted on said base and extending along the bottom and sideward edges thereof, first calibrations on said base adjacent said one leg converting the liquid level thereof into volume rate of flow of air, an indicator disc rotatably mounted centrally of said base, further calibrations on said base adjacent said indicator disc setting forth drying time required, said indicator disc having a wet volume scale and a pointer thereon, said pointer indicating drying time from said further calibrations when said wet volume scale is positioned with the actual wet volume at the sensed volume rate of flow of air.

5. A grain drying control gauge comprising an upright U-shaped tube, liquid received in said tube, one leg of said tube being open at its upper end, the other leg of said tube being adapted for sensing pressure, a vertical base, said tube being mounted on said base and extending along the bottom and sideward edges thereof, a plurality of equal sized cards selectively removably mounted on

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said base, first calibrations on each of said cards positioned to be adjacent said one leg when said card is mounted on said base and converting the liquid level of said manometer into volume rate of flow of air through said conduit, an indicator disc rotatably mounted centrally of said base, further calibrations on said base adjacent said indicator disc setting forth drying time required, said indicator disc having a wet volume scale and a pointer thereon, said pointer indicating drying time from said further calibrations when said wet volume scale is positioned with the actual wet volume at the sensed volume rate of flow of air.

6. A grain drying control gauge comprising an upright U-shaped tube, liquid received in said tube, one leg of said tube being open at its upper end, the other leg of said tube being adapted for sensing pressure, a vertical base, said tube being mounted on said base along the bottom and sideward edges thereof, first calibrations on said base adjacent said one leg converting the liquid level thereof into volume rate of flow of air, an indicator disc rotatably mounted centrally of said base adjacent said one leg, further calibrations on said base adjacent said indicator disc setting forth drying time required, said indicator disc having two pointers thereon and fixed with relation thereto, said indicator disc having a wet volume scale and a drying rate scale thereon and fixed with relation thereto, one pointer indicating drying time from said further calibrations when said wet volume scale is positioned with the actual wet volume at the sensed volume rate of flow of air, said drying rate scale indicating drying rate when the other of said pointers is positioned at the sensed volume rate of flow of air.

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