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(54) IMPROVEMENTS IN OR RELATING TO EVALUATION OF PRINTED SHEETS

(71) We, HEIDELBERGER DRUCKMASCHINEN AKTIENGESELLSCHAFT, a body corporate organised under the laws of the Federal Republic of Germany, of Alte Eppelheimer Strasse 15—21, Postfach 102940, 69 Heidelberg, Federal Republic of Germany, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the evaluation of printed sheets.

In many cases the printer's value judgement is no longer adequate for evaluating the quality of printed work, more particularly in reproducing colour pictures.

It is only the introduction of measurable quantities, and the correlation among themselves of a plurality of parameters which can be measured individually, in mathematically formulable relationships, which makes an objective evaluation possible. Differences of opinion between printers, reproducers and final clients can be avoided by prescribing agreed tolerances, and lastly printing can be conducted with optimum economy.

Numerous methods of metrological quality evaluation exist.

Those methods for the evaluation of a printed sheet which use so-called print test strips printed at the same time outside the actual image surface (such as the test strips of FOGRA, GATF, UGRA, BRUNNER et al) have been found to approximate to practical conditions and to be thoroughly satisfactory. The strips generally contain test fields for full density, point screens for different degrees of surface cover, and also line screens, often also full surface test fields for the metrological detection of the colour intensification in superimposed printing of consecutive colours. The optical densities of the individual test fields are tested by means of densitometers, and are brought into mutual relationship if desired. The evaluation is generally made by recourse to tables, slide rules, nomograms, or other calculating aids. Pre-programmed pocket calculators are also used for this purpose.

The disadvantage of these methods is that test field after test field of the control strip, or also of a plurality of control strips arranged consecutively in the direction of travel of a sheet, must be tested individually — i.e., in chronological sequence, field-by-field. In addition colour filters of densitometers must be changed for each test field colour. The test values must be recorded. Even when making use of calculating means, the work of evaluation is time-wasting and strenuous, and errors may be made. In particular, the current supervision of printing progress requires skill and powers of concentration in the evaluator. It is of course obvious, and presumably also known, to accommodate a plurality of densitometers juxtaposed laterally and offset in a common bracket in order to reduce the number of test operations. However, no particularly advantageous arrangement of densitometers is known for achieving maximum information from only a few test operations.

According to the present invention there is provided apparatus for the densitometric evaluation of a printed sheet with a printed print-monitoring strip, the apparatus comprising a common bracket, densitometers at selected mutual intervals, forming gaps therebetween for exclusive full tone density measurement and densitometers insertable in all of or freely selected gaps for measuring full tone and/or screen tone values for mathematical correlation into quality-assessing parameters.

Apparatus in accordance with the invention can in particular be used in colour printing to provide comprehensive information on the quality of printed sheets to be evaluated, with only one rapidly-performed test operation, while the cost outlay for the apparatus is an economical proportion to the whole press installation. The necessary print-monitoring strip

also occupies no greater surface of a printed sheet than hitherto, i.e. a single, narrow monitoring strip extending across the sheet width of a colour-printed sheet permits an economical utilization of the printing material.

In accordance with the invention, two categories of information from test values are distinguished.

Deviations of test results from prescribed values of full tone density are generally corrected by modifying the ink quantity to be supplied to the printed sheet. This involves ink quantity modifications which must either be effective across the entire sheet width, or those which are only necessary in specific selected zones. From this follows the requirement that the full tone densities shall be detectable in test fields distributed as uniformly as possible across the sheet width. Only in this way is it possible, in the knowledge of all the full tone densities of the tested zones, to give an appropriate correction command, whether it be a modification of the entire ink supply, e.g. by modifying the ink stripe width on a doctor or a modification of the ink supply in the zone deviating from the prescribed density value by modifying in each case a zone adjusting screw position on the printing unit of the relevant colour.

Whereas, for the above-stated reason, full tone density can often be detected for every colour, this is not the case with second category of information. This category is understood to embrace information about printing contrast, screen point increase, and the occurrence of shifting and doubling, i.e. those values which are formed by a mathematical correlation of full tone and/or screen tone values. If the test fields for individual information components of a parameter to be formed by relation are placed closely juxtaposed in the monitoring strip, then even when the full tone density across the sheet width deviates, the final values of the deviations formed by correlation will be largely independent.

The invention makes use of a common bracket, carrying at selected mutual intervals, densitometers for exclusive full tone density measurement arranged with gaps therebetween, and into all of the gaps, or freely selected gaps, additional densitometers are inserted for the measurement of full tone and/or screen tone values required for mathematical correlation to form quality-assessing parameters.

A particularly preferred embodiment has the common bracket with the densitometers slidable axially into a plurality of test positions corresponding to distances of test fields of the monitoring strip, with equal mutual intervals in each case.

Advantageously, the common bracket is adjustable into four test positions in conformity with the four colours of four-colour printing. By lateral displacement of the bracket into, e.g. four positions (three displacements from a basic position) the densitometers for exclusive full tone density measurement which are preferably distributed uniformly across the sheet width can be brought consecutively opposite the full tone surfaces for the four colours arranged in the monitoring strip, whereas the densitometers for measuring the full tone and/or screen tone values necessary for mathematical correlation to form quality-evaluating parameters in one colour consecutively detect the test surfaces (screens of different surface cover, full tone surfaces etc.) required for the correlation of a relevant colour.

An opposite stationary colour filter bar can be associated with all of the densitometers for the exclusive full tone density measurement, upon which no filters are arranged in the region of the gaps between the densitometers.

In this case, it is convenient if particular colour filters are associated with the densitometers for testing the full tone and/or screen tone values required for mathematical correlation to yield quality-evaluating parameters. Such an arrangement makes it possible to execute the stationary filter bar without filters in the region of the gaps, so that a greater freedom can be obtained in the conformation of the print-monitoring strip.

In the case of only four densitometers, for example, for testing the full tone and/or screen tone values necessary for mathematical correlation, the filters of which differ mutually, the values to be formed by the mathematical correlation can be obtained in the same test operation as that necessary to detect the full tone values of the four colours.

In order to permit a freely-chosen placing of the test strip in an image, the bracket with the densitometers is preferably mounted conjointly with the colour filter bar, slidably parallel to the sheet front edge in a guideway and lockably with respect thereto.

Apparatus embodying the present invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings wherein

Figure 1 is a perspective view of the apparatus;

Figure 2 is a highly simplified vertical section through the bracket for one possible densitometer arrangement;

Figure 3 shows an association of densitometers with test strips and colour filter bar for one possible densitometer arrangement; and

Figure 4 shows a section of a print-monitoring strip.

A sheet 2 for evaluation having a printed print-monitoring strip 3 is placed on a test bench 1.

A bracket 4, hereinafter designated the test beam, is positioned above the print-monitoring strip 3 on the sheet 2. (In Figure 1, the print-monitoring strip 3 is masked by the test beam 4). The test beam 4 is slidable along a guide bar 5 and is lockable on the latter in any

desired position by means of a clamping device 6. The test bench 1 contains an electronic evaluator device (not shown or described in detail) which is connected to densitometers 7 and 8 by wires (likewise not shown). Operating elements 9 and displays 10 permit the evaluation of test results; operating elements 11 permit the adjustment of adjusting members for the ink supply on the printing press.

The test beam 4 is equipped with a guide bar 12 which has four catches 13, the interval between which corresponds approximately to a test field division 14 on the print-monitoring strip 3. A test head mounting housing 15 is slidable on the guide bar has a ball catch 16 and by means of the catch 16 the test head mounting housing 15 can be retained in four prescribed test positions 17, 18, 19 and 20. The test head mounting housing 15 can be slid into the corresponding test positions 17 to 20 by a handle 21. The beam 4 has mounting compartments 22 for mounting the densitometers 7 and 8 already referred to, which are removable for the purpose of maintenance and optionally for repositioning into other mounting compartments 22 of the test head mounting housing 15. The interval pitch for the mounting compartment 22 corresponds approximately to four test field divisions 14, or is slightly greater than the latter, if gaps are left in the print monitoring strip 3 between the individual test field blocks 23 and 33.

The pitch of the intervals for the test and mounting compartments preferably corresponds to the zone pitch of the ink adjusting means, not shown, so that an association of the test to the location on the machine is obtained.

Fitted to the guide bar 12 is a colour filter bar 19, which therefore does not participate in displacement of the test head mounting housing 15 relative to the guide bar 12. Its position with reference to the printed sheet accordingly remains unchanged throughout the test operations.

The densitometers 7 serve exclusively for full tone testing of all four colours. They are inserted into every second mounting compartment 22 and are opposite the colour filters 27 in the test position 17, with the test head mounting housing 15 locked in the extreme right hand notch. In the test position in which the test head mounting housing 15 is locked in the second notch from the right, the densitometers 7 stand opposite the filters 28, in the test position 19 with the test head mounting housing 15 in the third notch from the right the densitometers 7 are opposite the filters 29, and in the test postion 20 the densitometers 7 are opposite the filters 30, when the test head mounting housing 15 is locked in the fourth notch from the right.

In Figure 3, the colour filters for the colour red are designated by the reference numeral 27, the colour filters for the colour green by the reference numeral 28, the colour filters of the colour blue by the reference numeral 29, and the brightness filter by the reference numeral 30.

The corresponding printing colours C (Cyanogen), M (Magenta), Y (Yellow) and S (Black) on the print-monitoring strip 3 are associated with the different colour filters 27 to 29 and with the brightness filter 30.

The densitometers 8 have their own incorporated colour filter 31. In Figure 3, the red colour filter 31, for example, is shown being used for testing in a test field block 33 of the monitoring strip for the colour cyanogen.

Whereas the test field blocks 23 contain consecutively the test surfaces 32 for the full tone densities in the colours cyanogen, magenta, yellow and black, the test field blocks 33 exhibit consecutively a test field 34 with a surface cover of 80% (referred to the screen film, i.e. not to the actual state) a full tone surface 35, a test field 36 with 39% surface cover in the film, and lastly a test field 37 with 7% surface cover in the film. Such a test field block is shown greatly enlarged in Figure 4.

When tested consecutively, these test fields 34 to 37 of the test field blocks 33 yield, for example, the print contrasts for the three screens in accordance with the known formula

$$K = \frac{D_V - D_R}{D_V}$$

with K = contrast, D_V = full tone density and D_R = screen tone density in the print.

By comparing the theoretical surface cover in the film with the optically effective surface cover in the print, which is likewise calculated from known relationships, screen dot increases for surface covers 7%, 39% and 80% can be ascertained, which is generally effected in evaluation electronics (not shown) which detects all the test values, stores them, performs appropriate mathematical correlations for the values obtained by the densitometers 8, and holds them in readiness for indication in the display 10 when summoned. Thus, for example, transmission characteristics are known sufficiently accurately to act as a measure of the quality of the printing process.

The same test is performed simultaneously for the other colours in the remaining test field blocks 33.

For a sheet approximately one metre wide, thirty-two zones have to be adjusted for example, on the ink duct (not shown) of the printing press. The test beam 4 then exhibits thirty-two marking compartments 22, whilst in every second, for example a densitometer 7 for full tone density measurement may be inserted, i.e. sixteen altogether. The densitometers 7 permit the detection of full tone density across the entire sheet width. Another four densitometers 8, which are inserted into any of the mounting compartments 18 left free

between the densitometers 7, yield quality statements in the four colours, depending upon the conformation of the print-monitoring strip 3 through contrast, dot increase, shifting, and doubling etc.

By a lateral displacement of the sheet 2, instead of the test head mounting housing 15, test field blocks 33 of a different composition can be brought beneath the densitometers 8, from those in the basic position. This means that using an additional test step, still more information can be obtained than is described hereinbefore.

WHAT WE CLAIM IS:—

1. Apparatus for the densitometric evaluation of a printed sheet with a printed print-monitoring strip, the apparatus comprising a common bracket, carrying densitometers at selected mutual intervals, forming gaps therebetween, for exclusive full tone density measurement and densitometers insertable in all of or freely selected gaps for measuring full tone and/or screen tone values for mathematical correlation into quality-assessing parameters.

2. Apparatus according to claim 1 wherein the common bracket with the densitometers is axially-slidable into a plurality of test positions corresponding to the widths of test fields of a monitoring strip with equal respective mutual intervals.

3. Apparatus according to claim 1 or claim 2 wherein the common bracket is adjustable to four test positions corresponding to the four colours of a four-colour printing process.

4. Apparatus according to any one of claims 1 to 3, wherein all the densitometers for the exclusive full-tone density measurement have an opposite stationary colour filter bar associated therewith upon which no filters are arranged in the region of the gaps between the densitometers.

5. Apparatus according to any one of claims 1 to 4, wherein particular colour filters are associated with the densitometers which serve for testing full tone and/or screen tone values necessary for mathematical correlation.

6. Apparatus according to any one of claims 1 to 5, wherein the bracket on which the densitometers are mounted carries a colour filter bar, the bracket and bar being together movable parallel to the sheet front edge in a guideway and being lockable with respect to the guideway.

7. Apparatus for the densitometric evaluation of a printed sheet, the apparatus being substantially as herein described with reference to the accompanying drawings.

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