

PRESSURE GAUGES

**THE ACTIVITIES AND PRODUCTS OF THE FIRM OF J. C. ECKARDT
A.G. BAD CANNSTADT STUTTGART.**

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BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

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THE ACTIVITIES AND PRODUCTS OF THE FIRM OF J.C. ECKARDT

AG. BAD CANNSTADT STUTTGART.

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J.C. ECKARDT A.G.
BAD CANNSTADT
STUTTGART

1. PARTICULARS OF TARGET

Location - Bad Cannstadt (suburb of Stuttgart) in continuation of Löwenstrasse off Heilbronner Str.

Type Pressure gauge, Pressure, Temperature and Flow recorder Factory.

Condition of target. Essentially intact. Minor damage by fire had been repaired.

2. SUMMARY

The firm's Bad Cannstadt factory specialised in the manufacture of commercial pressure gauges of the bourdon tube and diaphragm type for boilers, and industrial plant generally. In addition three main types of flowmeters for industrial use were manufactured, all of which worked on the fundamental principle of measuring the differential pressure across a sharp edged circular orifice in the pipe line. Capillary type dial reading thermometers of the mercury bulb and ether-ether vapour types were made and a form of industrial bimetallic thermometer for use chiefly in bakeries and similar ovens was produced. This last was not of the bimetallic strip type but was the form in which the difference between the expansion of the steel shroud and an Invar rod was arranged to operate a pointer via a suitable linkage.

Many models of the pressure gauges, flowmeters and thermometers were of the chart recording type in which mechanical linkages were arranged to move the recording pen over a chart driven by clock work.

The most notable feature was the application of the Patin self balancing bridge electrical circuit to remote transmissions for these instruments. The firm had developed a large size transmitter and indicator for this purpose for universal application under licence from Patin.

The firm operated a second factory at Sonneberg

in Thuringia at which all their aircraft instruments were made. The most interesting of these was the electrical transmitting oil and fuel pressure and temperature gauge of the Patin self balancing bridge type Fl. Nos. 20571-1 and 20682, made under licence from Patin.

Technical details of the firms pressure and flow gauges were obtained together with details of the fine potentiometers employed in the Patin transmission. A brief description of the Patin self balancing bridge circuit is given in Appendix 1.

3. PERSONNEL

The Director of the Bad Cannstadt works is Mr. Friedrich Gross. Gross had a general knowledge of the items and technical details of what was made at the firm's Sonneberg factory.

Gross and Hans Lechner, an engineer occupying a supervisory post, were the principal contacts. Lechner speaks English well.

The firm employed about 700 men at Bad Cannstadt, including a drawing office staff of 10 and about 50 apprentices who were accommodated in a well equipped training school.

4. FIRMS PRODUCTS

At Sonneberg the firm made aircraft instruments including the following:-

- Bourdon tube pressure gauges of the conventional type
- Air Speed Indicators of the conventional type
- Electrical Transmitting oil and fuel pressure and temperature gauges of the Patin self balancing bridge type under licence from Patin.
- Patin type Master and Repeater Compasses.

Questioned about altitude recorders of the Fuess type with moulded cover and curved transparent plastic window covering the drum clock, which had been seen bearing the firm's name, Gross said that they had not made these since 1939 when Fuess of Berlin took over full production.

At Bad Cannstadt the firm produced the following industrial instruments:-

Pressure gauges of the bourdon tube and diaphragm types
Flowmeters of the orifice plate type with indicators of the differential pressure gauge and ring balance types.
Capillary type dial reading thermometers of the mercury bulb and ether-ether vapour type.
Bimetal thermometers of the type in which the difference between the expansion of the steel shroud and an Invar rod was arranged to operate a pointer via a suitable linkage.

Many models of pressure gauges, flowmeters and thermometers were fitted with chart recording gear driven by clockwork.

The firm had also produced a standard transmitter unit on the Patin self balancing bridge circuit principle which could be fitted to many of these recording instruments to give a remote indication operated electrically.

5. POTENTIOMETER WINDING TECHNIQUE

The distinguishing feature of both the Patin electrical transmitting thermometers and pressure gauges and the Patin compass is the fineness and precision of the small potentiometers and brushes employed.

Gross gave the following details of the production and testing of these resistors.

Originally the resistors were hand wound, but at Sonneberg machines had been installed for winding both the strip and ring types. The firm had adopted the self balancing bridge circuit for application to their industrial recording instruments and since the number produced (about 40 per month) was not large enough to warrant the use of machinery at Bad Cannstadt, hand winding was retained there. The operatives were intensively trained by Patin in the first place and the process required great skill, but the production time was now only 40 minutes for the hand winding of a small potentiometer 9 m.m. in diameter and covering 270°.

For the aircraft instrument resistors they had formerly used Platinum Iridium alloy wire, but latterly used 70% Pt. 30% Ag. (Platinum Silver Alloy) for both brushes and resistor. Diameter of wire was 0.06 m.m. For these materials, the brush pressure was 0.6 to 0.8 gms. and a simple spring balance with the tolerance marked on it was used to test this factor.

The firm was not allowed to use Pt. Ag. alloy wire for industrial instruments and here they used special Constantan alloy known as "Potentiometer Constantan" supplied by C.J. Vogel, Berlin, Köpenick. The wire was enamelled and was 0.06 to 0.08 m.m. in diameter.

There were 380 windings in a space of 12 m.m. and a tolerance was $270^\circ \pm 0.5\%$ on the angular length and 500 ohms. ± 20 ohms. on resistance. Contact pressure for this wire and brush material was higher than with platinum-silver as the contact resistance was higher. A contact pressure of 1.0 g.m. was therefore used.

6. INDUSTRIAL INSTRUMENTS

6.1 Flowmeters Veeder type counter wheels for some types of recording instrument were obtained from Irion and Vosseler of Schweningen.

I.G. Farben Industrie were good customers for industrial flowmeters which were of three types, as follows:- all measured the differential pressure across an orifice in the pipe line.

(a) The Diaphragm Type

The pressures were fed to opposite sides of a corrugated diaphragm and the movement transmitted via a linkage to a pointer. The noteworthy feature of these was the formation of the diaphragm chamber which consisted of two castings joined by a flange. Two diaphragms corrugated to match the moving diaphragm in the centre were covered on their backs with small brass wire hooks which were keyed into a cement filling between the diaphragms and the inner curved surfaces of the casting. A metal corrugated lining was thus formed for the moving diaphragm chamber

the corrugations of which matched those of the moving diaphragm exactly, and supported the moving diaphragm over its whole area under overload pressures from either side.

(b) Ring Balance Type (High pressure)

A Steel tubular ring of about 270 angular degrees is supported on a knife edge and the lowest part (about 180°) is filled with mercury. The differential pressures are fed to the open ends of the ring through coiled spring tubes and the mercury is thereby displaced one way or the other which unbalances the ring and causes it to turn about the knife edge. The movement is recorded by a suitable linkage and pointer system. (Drum charts and Patin transmission were fitted on a sample examined).

(c) Ring Balance Type (Low pressure)

The principle is the same as described above except that the ring is of square section and is made in sheet steel or brass of continuous form with a partition at one point. The ring is half filled with water instead of mercury.

6.2 Pressure Gauges

The firm had no experience of Beryllium Copper alloy bourdon tubes; their experience was limited to Brass, Phosphor Bronze and Steel which they used as follows:-

Brass up to pressure of 5-6 atmospheres.

P. Bronze up to pressures of 50
atmospheres

Steel up to pressures of 600 atmospheres
(in special circumstances with hardened
Steel Bourdons up to 1200 atmospheres.
The steel was 0.3 to 0.6% Carbon steel.

The firm generally worked to an overall accuracy tolerance of 1.5% on pressure gauges and a mean overload of 100% (less for the lower pressure ranges).

They furnished Certificates of accuracy by the .Physikalisch Technische Reich Anstalt Berlin on request by customers.

7. PRODUCTION METHODS

Apart from their adoption and application of fine potentiometers for D.C. electrical transmissions the firm's production methods appeared to be conventional and even conservative.

The hand forming of bourdon tubes was observed by filling the tubing with sand, clamping one end in a split mandrel and rotating round the mandrel with a tommy bar.

Commercial instrument dials were produced by a photo lithographic process and printed on metal using a rubber roller transfer from the stone to the dial plate. Some dials were touched up by hand painting.

The firm's apprenticeship scheme which trained boys between the ages of 14 and 17, and the facilities afforded for their education and the standard of practical work expected from them were impressive.

8. CONCLUSIONS

The standard products of the firm are based on well known principles and methods of production. The chief features of interest are:-

(i) The application of the self balancing bridge circuit to industrial instruments and the production of a standard transmitter and indicator movement of this type.

(ii) The extent to which chart recording methods had been applied to industrial instruments such as pressure gauges and flowmeters.

APPENDIX 1.

The Patin self Balancing bridge circuit

The Patin self balancing bridge circuit is a simple electrical D.C. transmission system, the practicability of which depends upon the development of wire wound potentiometers and brushes of such fineness and small friction that they can be operated by a moving coil electrical indicator without appreciable loss of accuracy.

The supply voltage is applied to the ends of a fine wire wound potentiometer housed in the transmitter unit which is connected in parallel with a second similar potentiometer housed in the indicator. The brush of the first potentiometer is moved by the prime mover in the system (e.g. a metal bellows in the case of a pressure gauge or a bimetal strip in the case of a thermometer).

A connection is taken from the brush of the transmitter potentiometer to the moving coil of the indicator which may be of the conventional permanent magnet moving coil galvanometer type. The indicator accordingly deflects in response to the signal received. The moving coil however, carries a brush which wipes over the second potentiometer. In deflecting therefore, the indicator moves its brush to a position on the second potentiometer at which there is no potential difference between the brush on the indicator moving coil and that operated by the transmitter. The moving coil therefore comes to rest at the balance point and the magnitude of its deflection is a measure of the initial movement of the transmitter brush.

In the case of the aircraft dashboard instruments employing this principle gearing was fitted to the moving coil spindle of a conventional 90° moving coil movement in order to produce a pointer movement of 180° .