Reprinted from the *Journal of Scientific Instruments*, Vol. 29, pp. 176–178, June 1952

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A printing recorder for use in conjunction with scaling units

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[*Paper received* 31 *October*, 1951]

The machine prints on a 6 in wide continuous paper roll the counts registered by the counter and neons of one or two scaling units, together with an angle, recorded as degrees and minutes. Closure of an external contact triggers a relay-controlled sequence of operations of printing and moving on the paper, counting by the scaling units being interrupted momentarily while printing takes place.

INTRODUCTION

The printing recorder was designed to work with an automatic X-ray counter spectrometer for recording intensities of diffracted X-rays too weak to be satisfactorily measured with a ratemeter and graphical recorder, and also for making measurements of integrated reflexions from crystals. Provision is made for the simultaneous recording of counts registered by two independent scaling units such as may be required when the primary X-ray beam is monitored, or for certain special diffraction techniques. The Bragg angle of reflexion by the specimen under examination is recorded in degrees and minutes. Pins mounted on the worm shaft driving the spectrometer scanning arm close the contact that operates the printer. The angular interval traversed between each printing can be varied from 2½–30 min of the Bragg angle.

Though intended to be employed on X-ray studies the machine can be used as it stands in any work requiring the routine recording of counts registered by scaling units. For making measurements continuously over long periods, or for working in places where radiation precludes the presence of a human operator, such a machine has an obvious application. The counting procedure used with the X-ray spectrometer corresponds to the "constant time" method in radiometric assay work. The machine has facilities to enable other counting techniques to be used without difficulty.

ARRANGEMENT OF COMPONENTS

The complete machine is shown in Fig. 1. The various components of the machine are housed together in a standard radio chassis for mounting in a Post Office rack. The front panel dimensions are 19 × 8¾ in and the chassis is 14 in deep.

For ease of adjustment and servicing all components are readily removed from the chassis. The relay unit *A* is plugged in position, and connexion between the chassis and the neon

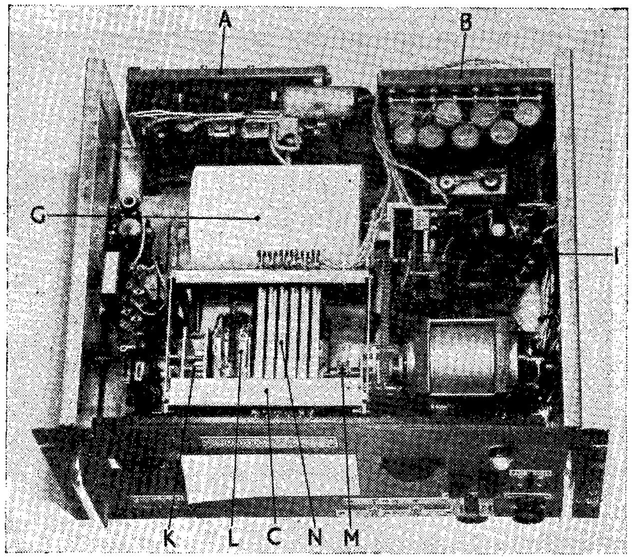

Fig. 1. Complete printing recorder

printer driving unit *B* is by flexible cable. When these two units have been taken out the printing mechanism *C* can slide back on runners and then be lifted out if required; it is also connected to the chassis by a flexible cable. The front panel carries push-buttons for manually operating the printer or moving on the paper. The printing machine works on 24 V d.c. which is obtained from an external battery supply.

PRINTING MECHANISM

Fig. 2 shows the printing mechanism removed from the chassis. The rubber-faced printing bar *D* is operated by the four solenoids *F*. The paper leaves the roll *G* (Fig. 1), is guided under the counters, etc., then rises up over the drum *H* and finally leaves the printer by a slot in the chassis

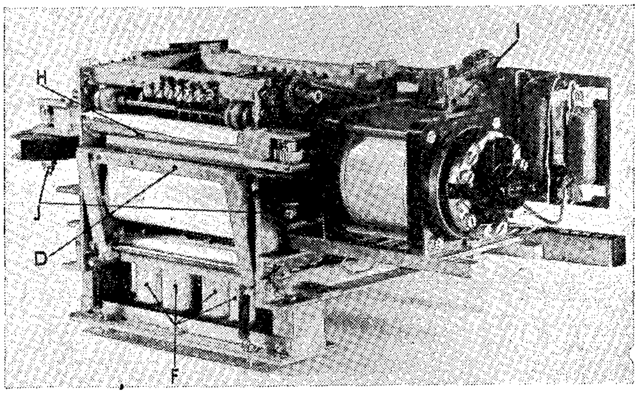

Fig. 2. Printing mechanism

front panel. Typewriter ribbon passes between the paper and the numbers to be printed. The drum *H* is driven from the impulse motor *I* by a Meccano sprocket chain, after each printing the paper being moved onwards $\frac{3}{8}$ in. The typewriter ribbon spools are mounted on shafts which can either idle against slight friction or be positively driven, depending upon the setting of the nuts *J*. With one nut loose and the other nut tight the ribbon will wind regularly in one direction, the correct tension being maintained. The nuts *J* are accessible from the front panel, so that the direction of ribbon travel is easily reversed. It can be wound back and forth several times before it need be renewed.

PRINTING ELECTROMECHANICAL COUNTERS

Two forms of printing electromechanical counter have been constructed and installed in the machine. The first (*K*, Figs. 1 and 3) uses a standard numbering machine, made by Ticket Issuing Machines Ltd., in conjunction with an impulse motor. Extra slots were milled in the ratchet wheel of the motor so that it would revolve $\frac{1}{8}$ of a revolution at a time. A 5 to 4 reduction gear train connects the motor with the printer so that the units wheel of the latter revolves the required $\frac{1}{10}$ of a revolution at each count. This printing counter is quite simple to construct, but is rather bulky on account of the size of the impulse motor. The speed is about 7 counts/sec. This can be increased by passing a heavier current through the motor but at the expense of greater wear of the moving parts.

The second printing counter (*L*, Figs. 1 and 3), is a modified Post Office counter. The Post Office counter wheels were combined in pairs with small embossed wheels of about the

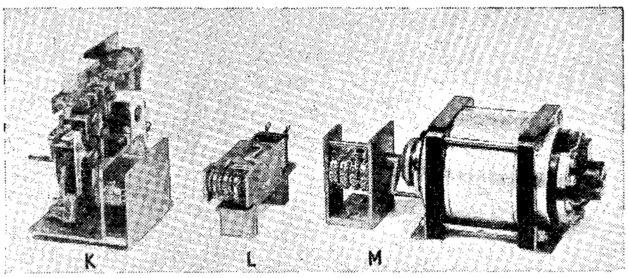

Fig. 3. Printing electromechanical counters and angle printers

same diameter (kindly supplied by Ticket Issuing Machines Ltd.) to make a very compact printer. The speed is about 9 counts/sec using the original light returning spring and standard operating current. Increase in operating current and strength of the spring would enable higher counting speed to be obtained, but again at the expense of increased wear. The modified Post Office counter is faster, smaller, and requires a smaller operating power than the impulse motor driven counter, but the machining of the small parts of the former requires skill and patience.

ANGLE PRINTERS

The angle printers shown at *M* in Figs. 1 and 3 were constructed with the aid of counter components from aircraft drift indicators. The counter wheels were drilled radially in the positions of the numbers. Standard monotype, of face 0·22 in, were turned down from a rectangular to a cylindrical section over part of their length, then cut off across the cylindrical portion to leave a short pin for insertion into the radial holes. After insertion the pins were tacked in position with solder. The use of a special jig facilitated the rapid turning and shortening of a large number of type to closely similar dimensions.

The four digit counter made in this way reads tens, units, and sixtieths, and hence is suitable for either time or angle recording. The counter is driven directly by a 3 in magslip transmitter which has sufficient power to operate it with negligible lag at the speeds employed.

NEON INTERPOLATION PRINTING UNITS

The neon interpolation printing units are shown in Fig. 4 and their location within this printing mechanism is seen at *N* in Fig. 1. Six units have been installed in the machine. Each unit is driven by one half of a double triode contained in the amplifier unit (*B*, Fig. 1). The triodes are controlled by the scale-of-2 circuits in the scaling units. The voltage at one anode of each scale-of-2 circuit is tapped through a high resistance (to avoid impairing scaler resolving time) and is led by a cable to the amplifier unit. At the back of the amplifier unit is an easily accessible distribution panel enabling any amplifier grid to be connected to any scale-of-2 in either scaling unit. A suitable bias voltage is applied to the grid of each amplifier through a high resistance from a dry battery attached to the unit. Heater and h.t. voltage

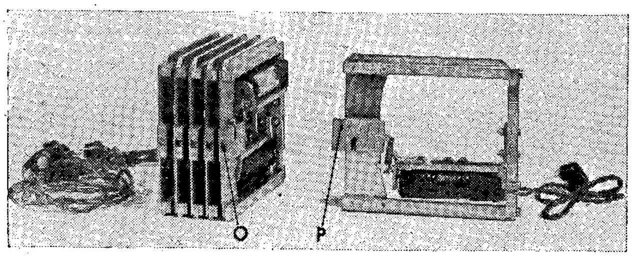

Fig. 4. Neon interpolation printing units

(110 V d.c.) are derived from an external source. The 5 kΩ printer solenoids, together with a $0\cdot5\ \mu$F capacitor to limit surges, form the anode loads of the amplifiers.

The design of the interpolation printers themselves was evolved out of considerable experimentation. Standard type of face $0\cdot150$ in can slide in a rectangular channel *O* in the brass block *P* (Fig. 4). When the solenoid is energized an arm attached to the solenoid armature bears upon a pin sliding in the channel and pushes the type forward till they project about $\frac{1}{16}$ in out of the block *P*. With the solenoid not energized, the type are held retracted by a light spring engaging a small groove in the type. When the solenoid is energized and printing takes place, the printing bar pushes back the type and opens the solenoid armature, the resistance offered by the type during this action being quite sufficient to produce a satisfactory impression. This resistance is mostly overcome in a small fraction of the total travel. Hence this design has the advantage that the maximum pressure applied to the type, and so the strength of the impression, is not dependent upon precise positioning of each printer. The six printing units pack side-by-side, as shown in Fig. 4, the solenoids lying alternately above and below the centre line to facilitate close packing. The printers slide in grooves and are locked in position by screws which also provide positional adjustment.

Apart from the cutting of the small groove mentioned above, the type does not need to be altered in shape or size from the standard form and can be changed in a very short time by loosening the retaining spring. As an example, if the six printers are connected to the six stages of a single scale-of-64 scaling unit, then they are arranged to print 01, 02, 04, 08, 16 and 32.

THE CONTROL MECHANISM

The sequence of operations of printing, etc., is controlled by the relay unit *A* (Fig. 1), which consists of a bank of five relays. One relay has a small mercury-in-glass switch attached to its armature to carry the heavy d.c. current taken by the solenoids which operate the printing bar. The sequence is triggered by the closure of an external contact or by a push-button switch mounted on the front panel. The following operations take place:

(1) Bias voltage on neon printer amplifiers is changed so that these can register the state of the scaler scale-of-2 circuits.
(2) Counting is stopped by operating scaler external "count on/off" control.
(3) Machine prints.
(4) Counting by the scaler is re-started.
(5) Neon printer amplifier bias is returned to its original level.
(6) Paper is moved forward.

Operations (1) to (4) take place in about $\frac{1}{3}$ sec, a period negligible compared with usual counting intervals. Correct timing is arranged by making use of natural delays in relay operation together with some extra delays introduced by shunting relay solenoids with a large capacitance and a variable resistance in series.

PERFORMANCE

All moving parts of the printer mechanism are robustly constructed and are not likely to fail mechanically. The only relay contact carrying a heavy current is of the mercury-in-glass type. One paper roll and one typewriter ribbon spool will suffice for many thousand operations. No trouble has been encountered with the motion of the paper. As originally set up, the neon printing units were kept continuously operating and those printers recording the earlier scaling unit stages had to perform some tens of thousands of movements, which they did without failure. But as this continuous activity is unnecessary, the only requirement being that the neon printers record the count on the scaling unit at the time of printing, provision was made for rendering them inoperative during the counting interval (i.e. operations (1) and (5) in the sequence described above). With the latter arrangement the life of the neon printers should be very long.

The most likely components to fail are the impulse motors, but either the whole motor, or just the parts that have worn out, can be readily replaced as these are of standard design.

The modified Post Office counter should have a life comparable with that of the unmodified counter, increase of robustness of the wheels tending to counteract the effect of increased inertia.

ACKNOWLEDGEMENTS

The interest of Sir Lawrence Bragg and Dr. W. H Taylor in this work is gratefully acknowledged. Thanks are due to Mr. J. Fuller and Mr. F. Marks of the Cavendish Laboratory Main Workshop for undertaking the modification of the Post Office counter, and to Mr. A. Barker of the Cambridge University Engineering Laboratory who superintended the construction of the angle printer. Help with general construction and assembly work was given by Mr. C. E. Chapman and Mr. G. Abbs of the Crystallographic Laboratory Workshop, Cavendish Laboratory. Financial support was provided by a grant from the British Electrical and Allied Industries Research Association.

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