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Four- and Eight-Channel Desynn Graphical Recorders

By

F. R. J. SPEARMAN, A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.S.

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1952

TWO SHILLINGS NET

Four- and Eight-Channel Desynn Graphical Recorders

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Summary.—A 4-channel recorder, providing continuous traces against time on photographic film, has been developed for use with any instruments embodying Desynn transmitters. It is suitable for the measurement of quantities which vary with a maximum frequency of 3 c.p.s. It is made from F.24 camera component parts, and uses the standard magazine and 5-in. wide film. It has been successfully used for flight trials; manufacturing drawings are available. An 8-channel version, of which two or three may be coupled together, is under development.

1. *Introduction.*—The use of multi-channel graphical recorders instead of intermittently recording automatic observers has long been desirable for some flight tests, and to meet this need two instruments using the Desynn transmission system are under development. A 4-channel recorder was developed quickly to meet an immediate need and has already been used for flight trials, while an 8-channel recorder with more refinements is being developed, but has not yet been used for flight trials.

The main application of the recorder is to the dynamic measurement of quantities such as displacement, force, and acceleration, which vary with a maximum frequency of up to 3 c.p.s. The instrument is suitable for investigation of such problems as longitudinal stability, and the 4-channel recorder has been used for drag measurements.

The main advantages are:

(i) The greatly reduced time required for computation of results.

(ii) Increased general accuracy of recording, as compared with the dial instrument-frame camera method, not due to increased accuracy of the instrument but due to the record being continuous instead of consisting of a series of points.

(iii) The simplicity of the instrument which makes its reliability high.

(iv) The simplicity of installation since all connections between the recorder and pick-ups are electrical, and the recorder operates directly from a 24-volts d.c. supply.

2. *Description.*—2.1. *General.*—The 4- and 8-channel recorders are essentially similar in that the Desynn transmission system is used and a graphical record is obtained without any lens system on a film which passes at constant speed a narrow slit at right-angles to its direction of motion.

The recorder consists essentially of an F.24 camera body, gearbox, electric motor with flexible shaft, and magazine; the cone and lens assembly are removed and blanked off, the gear box is modified to give continuous film feed, and the register glass is replaced by polished metal masking plates over which the film rubs and incorporated in which is the transverse slit a few thousandths of an inch wide. Filament lamps are fitted to floodlight the inside of the light-tight body and

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4 or 8 Desynn repeaters are mounted inside the body so that the pointers attached to the repeater spindles are just above and clear of the slit. The rotating pointers cast shadows on the strip of film 5 in. wide which is illuminated through the narrow slit so giving, in conjunction with the film travel, four or eight continuous graphical records. An external impulse generator gives a time marking on the film either by means of flag solenoids or a flashing neon lamp.

2.2. *Four-channel Recorder.*—The main features are:

2.21. Four Desynn repeaters are mounted in the body together with two flags olenoids, one to mark each edge of the film.

2.22. The coupling ratio between the Desynn repeater and the recording head is unity, and each Desynn repeater is fitted with a four-vaned cross, which is made as light as possible to prevent adding too much inertia to the repeater magnet. Each of the four non-overlapping records is thus in four sections, so giving a record width equivalent to the full film width ; traces in adjacent sections are duplicated at the edge to assist transfer between sections, and different sections are identified by different trace widths. Continuous rotation of the recording head is permissible.

2.23. The recording scale varies by as much as 2 to 1 since the angular travel of each vane is ± 45 deg. Experiments with involute vanes to maintain linearity have been made but inertia is thereby increased.

2.24. The timing is from an external impulse generator which operates the flag solenoids. The film has only one speed, *viz.* one inch per second.

2.25. The slit is 4/1000-in. wide and a number of short slits at right-angles to the main slit have been made to give calibration lines along the film. The masking plate is decreased locally to 20 thousandths thick so as to minimise the distance between vane and film and thus give a sharp recording edge.

2.26. Photographs of the 4-channel recorder, together with a typical record, are appended.

2.3. *Eight-Channel Recorder.*—The main features are:

2.31. Eight Desynn repeaters are mounted in the body but no event recorders, *i.e.*, on-off signals, are fitted.

2.32. The Desynn repeaters and recording head have a coupling ratio of 1/9 through a spur gear. The angular movement of the recording head is thus limited to ± 20 deg, over which range the recording scale is linear within 3 per cent and the mass, spring and damping forces added by the recording head are almost negligible due to the low value of coupling ratio. Provided that the resulting record gives the required accuracy, this system has advantages, and the trace is not sectional as in the 4-channel recorder. It is hoped to take up any backlash in the gears by fitting a light spring between the recording head and frame. This spring also prevents possible wander of the repeater when the current is off.

2.33. One master unit and up to three slave units are driven by a single motor and gear box with a wide range of film speeds, through rigidly coupled shafts which can easily be disconnected. By this means a large number of channels can be coupled together and provision is made for a common time base to be applied to all film widths.

2.34. Two records are obtained over one strip of film about 1-in. wide, one trace being a double line. The Desynn repeaters are mounted so that they can be tilted to give the minimum distance between film and recording head, and so that mechanical interference between the two heads does not take place. It is possible but unlikely that interference between the two records will make analysis difficult.

2.35. The timing is by neon lamp which gives a dark line across the full width of the strip. An external time base, preferably with a number of different frequencies available, is necessary.

2.36. To assist calibration and analysis a graticule of film with a number of pin-point holes forms the slit and gives a series of fine parallel lines along the direction of motion of the film. With the transverse timing marks the record is thus obtained on the equivalent of squared paper.

3. *Performance Limitations.*—3.1. *General.*—The performance is limited by two factors, the characteristics of the Desynn repeater, usually quoted in terms of its undamped natural frequency and damping ratio, and the consideration that the performance of the signal-generating instrument must not be affected by the coupling to it of the Desynn transmitter.

3.2. *Desynn Repeaters.*—There are two types of Desynn repeater, the standard and the rapid response. Each of these may be coupled to any one of the three transmitters, toroidal, micro and miniature. Tests of each repeater with each transmitter to determine their characteristics are in hand using the 4-channel recorder and ' master Desynn '. Rough results are tabulated below.

Type	*Code No.*	*Undamped Natural Frequency*	*Damping Ratio*
Standard	4 DE	9	0·1
Rapid Response ..	15 DE	12	0·25

The amplitude, therefore, may be expected to be accurate within 5 per cent for up to 1·5 c.p.s. for the standard repeater and up to 3 c.p.s. for the rapid response repeater. Phase relationship between signals of differing frequency is satisfactory for these low frequencies so that the record is not distorted.

3.3. *Signal Generating Instruments.*—Only certain types of signal-generating instruments have sufficient power for operation of a Desynn transmitter whilst maintaining their own accuracy. Displacement, where the power is large, can be easily and accurately measured since the coupling is rigid. Force, converted to displacement by a spring, and other quantities such as acceleration, and air speed, can also be measured, but a Desynn repeater cannot yet be satisfactorily coupled to an instrument, such as the free gyroscope, where the power is very small.

3.4. *Accuracy.*—The accuracy depends on so many factors that it is difficult to quote a specific figure. It is considered that the accuracy during use of the 4-channel recorder was 2 per cent at its very worst, as obtained during an accelerometer calibration, and that the average error was considerably less.

4. *Conclusions.*—4.1. The prototype 8-channel is unlikely to be available for flight tests for at least six months so that the only recorder of this type available for general use for probably the next year will be the 4-channel. By fitting these with rapid response Desynns a satisfactory instrument can be supplied which will meet most requirements and record accurately up to 3 c.p.s. Intensive further development of the 4-channel recorder will not, however, take place.

4.2. Desynn recorders are limited in application by the limitations of the Desynn transmission system. Both the standard (4 DE) Desynn repeater, and the rapid response (15 DE) Desynn repeater require to be tested on the 4-channel recorder to obtain dynamic performance data with the three types of transmitters toroidal, micro and miniature. The application is also limited to signal generating instruments which can operate the Desynn transmitter. For the 8-channel recorder Messrs. S. Smith & Sons are supplying complete geared repeater units. The performance of the 8-channel recorder can only be satisfactory if these units are satisfactory.

4.3. While the use of F.24 camera parts is desirable in many ways since it makes use of useful existing parts, particularly the standard magazine, and for this reason is advocated, it is felt that, if at a later date the instrument were constructed by a firm in quantities of over 100, the question of the desirability of using F.24 camera parts should be reconsidered.

APPENDIX

General Data on 4-Channel Desynn Graphical Recorder

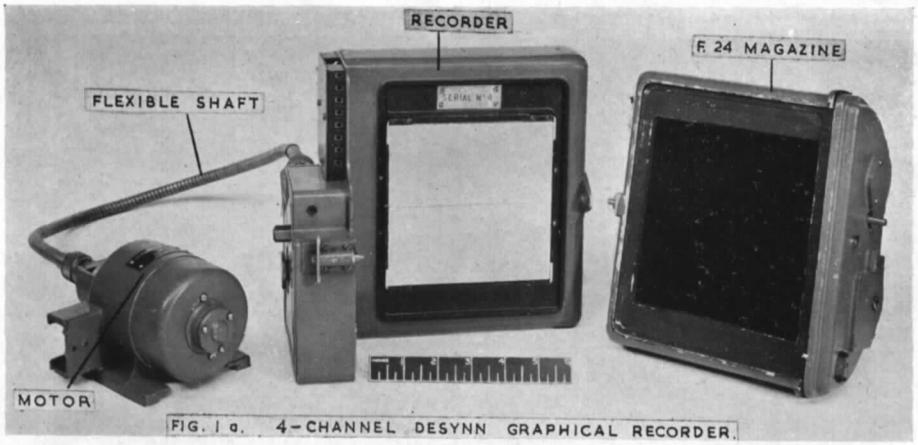
Overall approximate size of recorder with magazine fitted but without motor, 7 × 7 × 9 in.

Total weight of recorder	16 lb
Weights of component parts:—	
Recorder	6 lb 5 oz
Magazine (unloaded)	5 lb 7 oz
Motor with flexible shaft	4 lb 5 oz

Approximate steady power consumption, 1·5 amps at 24 volts d.c. (with momentary peak of about 5 amps when d.c. motor is started).

Frequency range for accurate recording with rapid response (15 DE) Desynn repeaters, 0 to 3 c.p.s.

Normal film speed	1 in/sec (approx.)
Capacity of magazine	50 ft (approx.)
Duration of recording per magazine	10 mins (approx.).



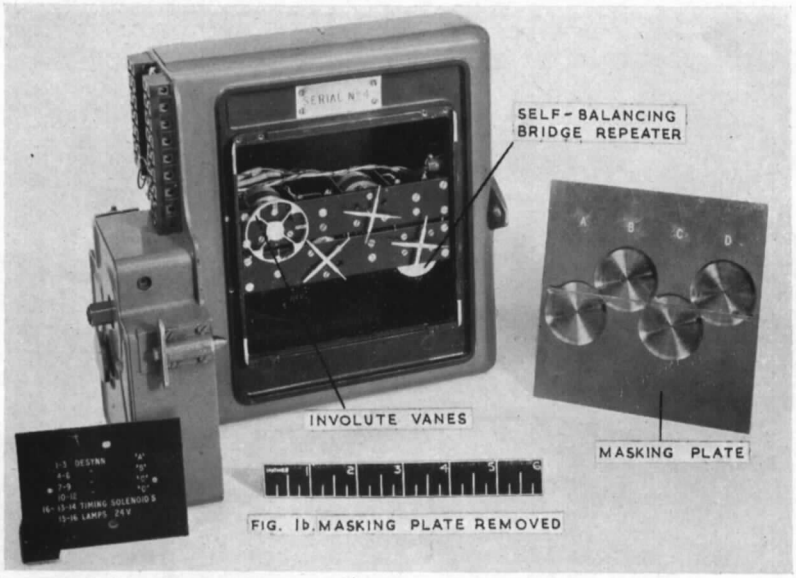


FIG. 1. Four-channel Desynn graphical recorder.

(51499) Wt. 15/680 K.5 4/52 Hw.

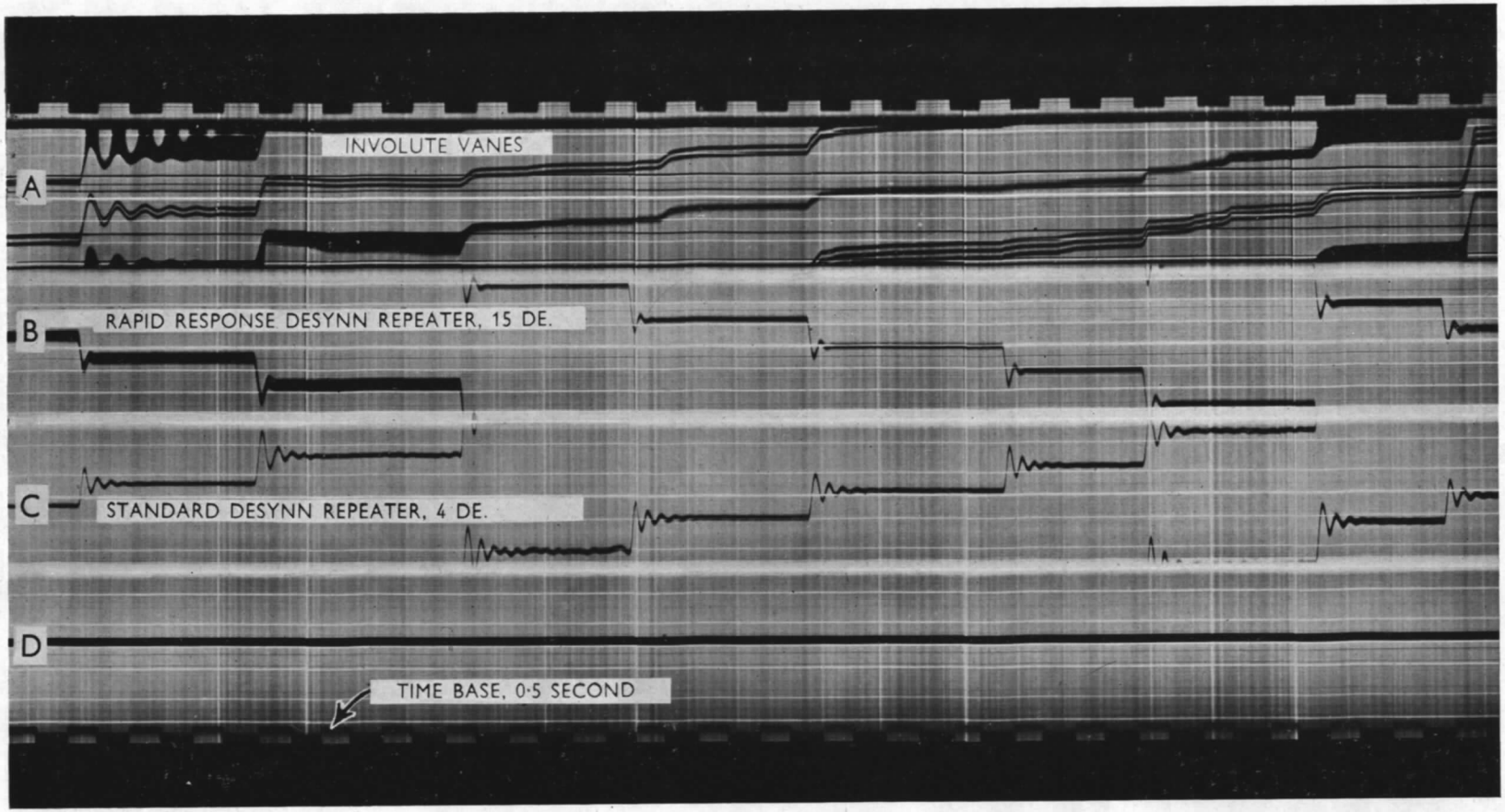


FIG. 2. Sample record obtained with 4-channel recorder.

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