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January 21, 1986

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Director, Office of Nuclear Reactor Regulation
Attention: Mr. G. E. Lear, Director
PWR Project Directorate No. 1
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Gentlemen:

Subject: Docket 50-206
Generic Letter 83-28 Item 1.2 - Post Trip Review:
Data and Information Capabilities
San Onofre Nuclear Generating Station
Unit 1

Reference: September 3, 1985 letter from J. A. Zwolinski, NRC,
to K. P. Baskin, SCE, regarding the subject topic

The referenced letter provided the results of the staff's preliminary review of and resulting staff questions concerning the subject item. A discussion was held between NRC staff and SCE to determine if the existing data and information capabilities meet the intent of the staff's criteria for Post-Trip Review. As a result of this discussion, staff reviewers identified the need to review the control room Events Recorder technical manuals and a copy of the recorder strip chart following an actual reactor trip. This information is provided as an enclosure to this letter.

The staff reviewers also requested an explanation of the high speed operation of the Events Recorder strip chart. Our letter of November 28, 1983 indicated that on receipt of a trip signal the Events Recorder automatically enters a high speed mode of operation in which the strip chart is advanced at 3600 times the normal speed for ten seconds. Subsequent review of the strip chart operation has indicated the chart will advance at 3600 times normal speed (3/4 inch/sec versus 3/4 inch/hr) for 24 seconds, which is equivalent to a 24 hour period of normal speed operation.

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Add:

AD - J. KNIGHT (ltr only)
EB (BALLARD)
EICSB (ROSA)
PSB (GAMMILL)
RSB (BERLINGER)
FOB (BENAROYA)

Mr. G. E. Lear

-2-

January 21, 1986

If you have any questions regarding the enclosed information or require additional information on high speed operation of the Events Recorder strip chart, please let me know.

Very truly yours,

M. D. Medford

Enclosure

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EVENTS
10/10/65

4 AM

12 PM

8 PM

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TRIP

BACKUP OPERATIONS

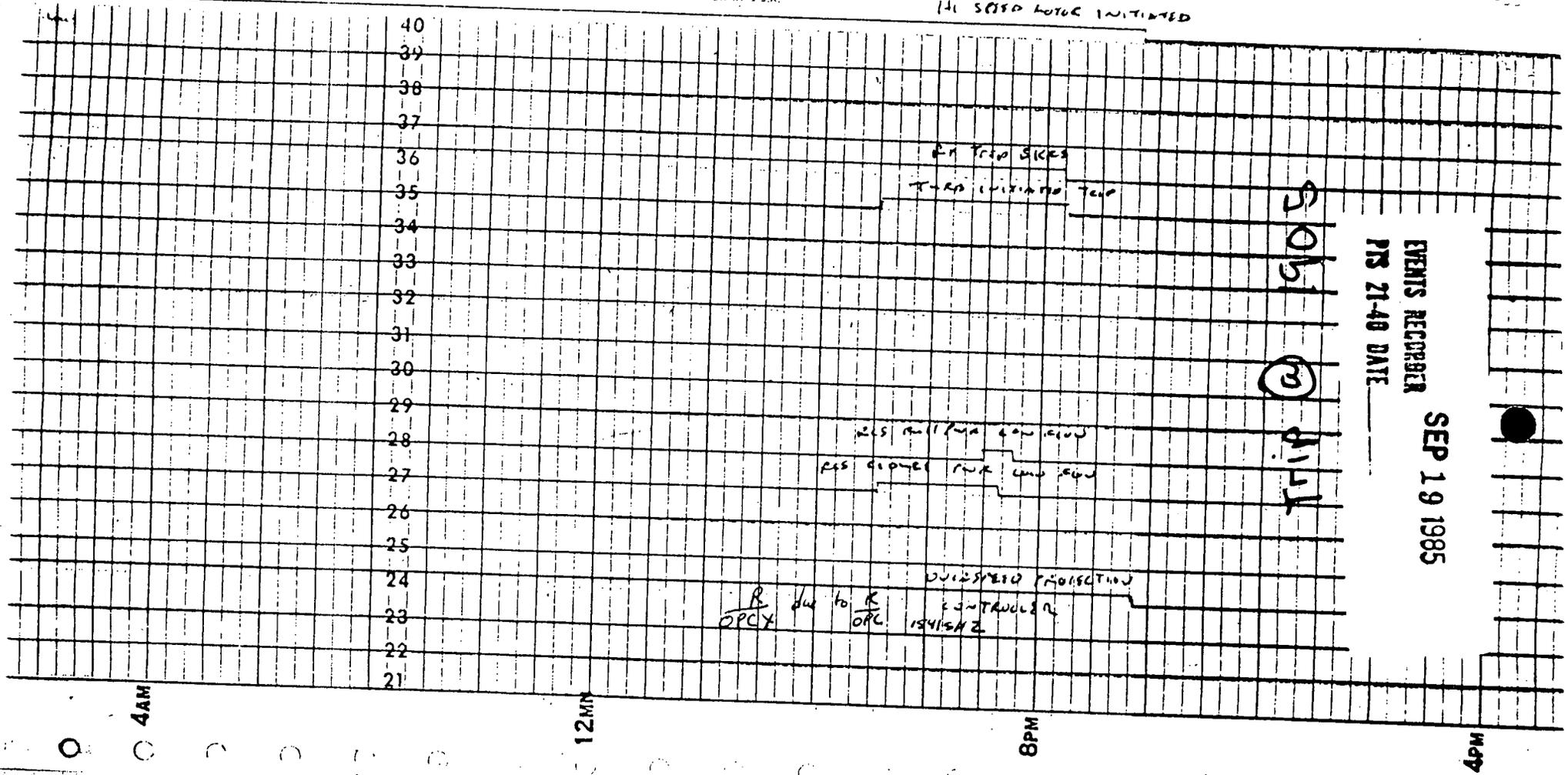
ALEX TAMBIS SUPPLY STORE

1965

TRIP



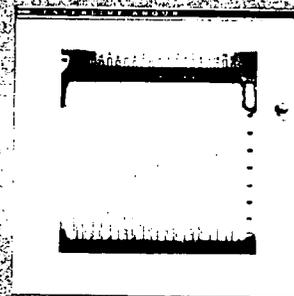
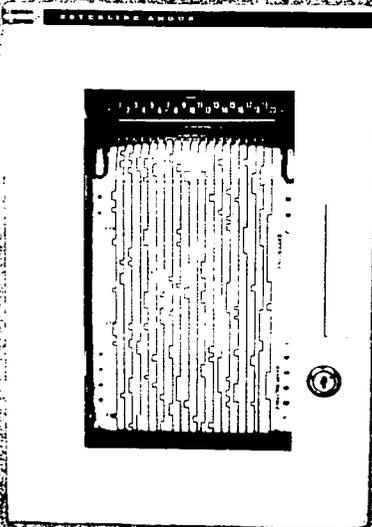
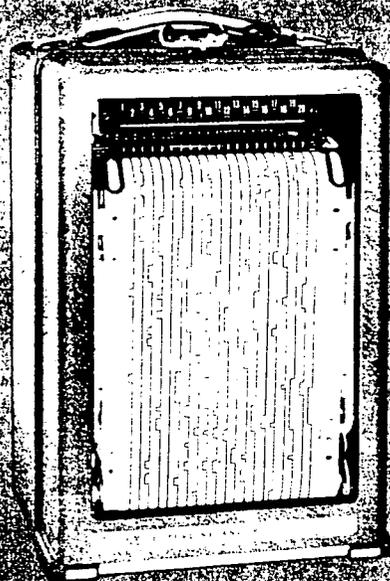
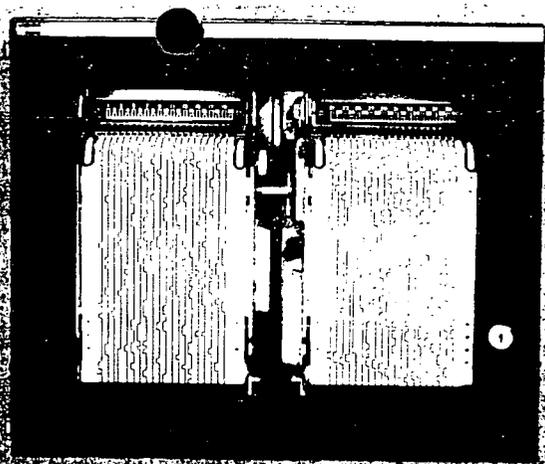
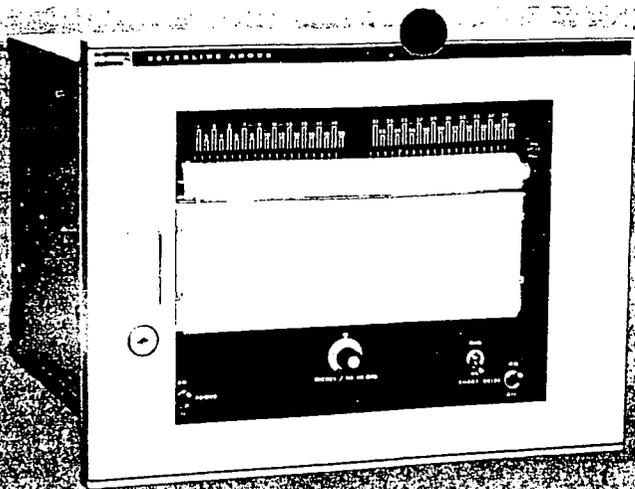
141 SPEED MOTOR INITIATED



EVENTS RECORDER
PTS 21-40 DATE SEP 19 1985

CHART FAST SPEED 3/4 $\frac{\text{inch}}{\text{sec}}$
CHART NORMAL SPEED 3/4 $\frac{\text{inch}}{\text{hour}}$

RUNS FOR 24 SECOND
AND RESETS AFTER
24 hour. run (18 inches)



1. 40-Channel Series "E" (Single Chart). 2. 40-Channel "Twin" Series "A" (Two Charts). 3. Portable Series "A". 4. Flush Series "A". 5. Flush Series "S". 6. Portable Series "S".

EVENT 670 OF DRBS

ESTERLINE ANGUS

Catalog Number Event 670

Inkless and Ink Event Recorders Prove Versatility in Hundreds of Applications

If you want to monitor the active and idle time of machines, the cycling of components in life tests, the operation of circuit breakers, the use of telephone trunks, the sequence of elevator operation, the psychological or physiological reactions of subjects, or if you seek other information where "yes-no" or "on-off" records are important . . . Esterline Angus Inkless or Ink Event Recorders can be an indispensable aid. In fact, they often pay for themselves after only brief service.

These versatile instruments can be activated directly or indirectly by the application of potential, rotary motion, reciprocating motion, temperature, pressure, position, weight, force, presence of an opaque

body, presence of light, or by physical contact.

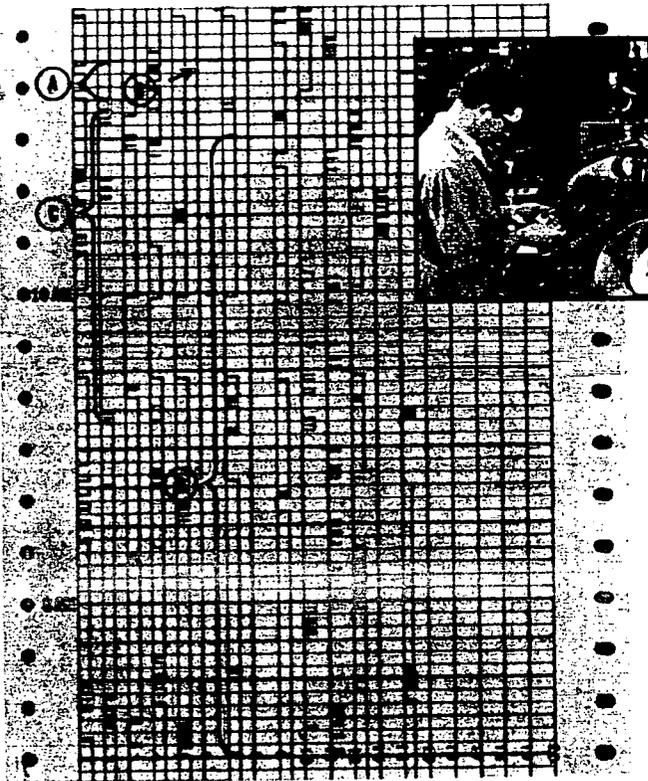
All records are accurately plotted against time. And all records are continuous, as opposed to the hard-to-interpret "skip" writing of other event recorders.

A single instrument case (11 styles are available) accommodates as many as 40 writing elements. Full deflection of the writing element will occur with the application of a voltage pulse lasting only 15 milliseconds.

Writing elements will follow telephone dial pulses and other signals up to 20 "on-off" cycles per second. Rectilinear records are written on 6 or 11-inch charts, and each channel occupies about 1/4 inch.

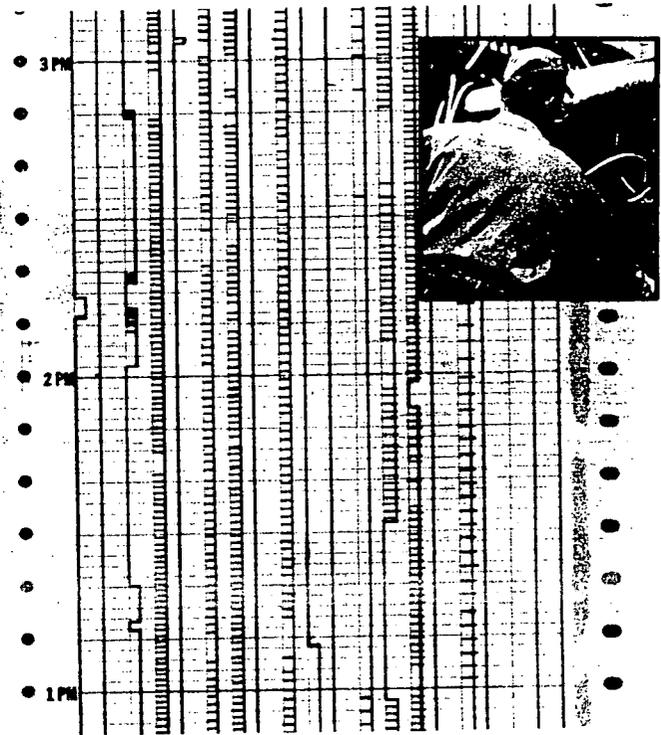
Charts Show Event Recorder Value

SCREW MACHINES

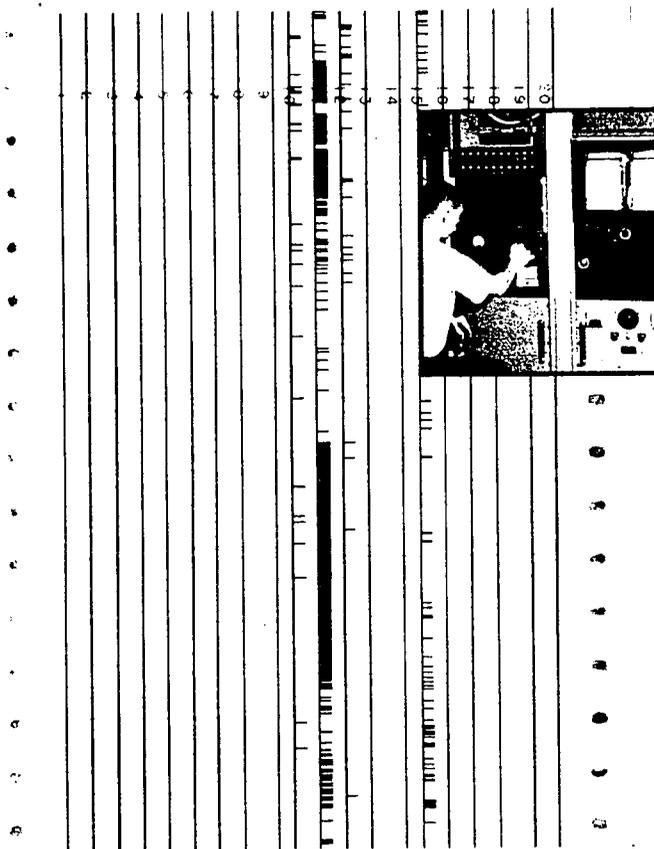


Event Recorders reveal the operation of several screw machines. Letters on the chart indicate: "A"—15 minutes of production, "B"—an idle machine, "C"—downtime for machine repair, "D"—175 minutes of actual production with total elapsed time of 240 minutes, indicating an overall efficiency of 73%.

DIE CASTING MACHINES



This chart shows minute-by-minute production records of die casting machines. When a machine casts a part, the pen monitoring it deflects. After each part is made, the pen returns to normal position. All machines in the plant are monitored.



Testing components is made easier with Esterline Angus Event Recorders, as revealed by this chart of relay tests. Relays 10, 12 and 15 frequently missed, while relay 11 missed almost constantly. No relays are being tested on channels 9, 14, 19 or 20.

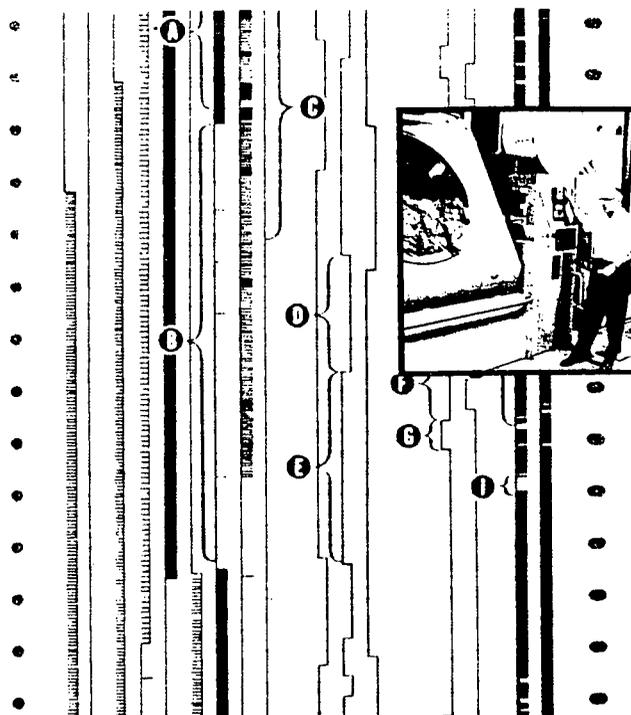


Chart section from Series "A" Event Recorder installed at Mid-West Towel & Linen Service, with 16 channels monitoring operations. Channels 1 through 8 monitor wash machines. (A) Wash machine in operation. (B) Positioning of both sides of wash machine for unloading both sides. Channel 9 monitors city water supply. (C) Indicates water supply coming from company well. Channels 11 through 13 monitor extractors. (D) Extractors in operation. (E) Extractors down time. Channels 19 and 20 monitor shirt pressing units. (H) Pressing units in operation. (I) Pressing units down time.

A Few Other Applications

Electric Utility—monitor sequence of operation of auxiliaries during automatic turbogenerator shutdown. Monitor circuit breaker operation.

Plastics Company—study time cycle of plastic thermoforming machines.

Medical School—record the number and times of injections self-administered by monkeys.

NASA—record sequence of events in missile launch countdowns.

Office Building—determine efficiency of elevator service.

Steel Mill—detect operation of hot strip mill automatic gauge.

Appliance Manufacturer—indicate "on-off" operation of conveyors. Test cycling of timers.

Glass Manufacturer—record sequence in a batch mixing system.

Shipping Company—check number of trucks actually loaded against number invoiced.

Psychopharmacology—record activities of worms in behavior experiments.

Telephone Utility—monitor receiver signal levels and channel switching at a number of stations using data links.

Consulting Engineer—to gather highway traffic delay and capacity data.

Telephone Utility—monitor protective relaying circuits leased to electric utility.

Appliance Manufacturer—test life of color TV sets (records high voltage arc) used on relay switch testing.

Tire Company—record the output of tire building machines.

University Research—record responses and events in behavioral pharmacology experiment investigating narcotic addiction in animals.

Midwest Telephone Company—monitor peg-count and overflow on selected trunk groups, announcement groups and usage on items of common control equipment.

Automobile Manufacturer—record performance of a 13 station transfer machine. Machine downtime, cycle time, unit cycle time, etc.

Grocery Chain—used to obtain raw data on supermarket checkstand operations to establish service levels.

Principle of Operation

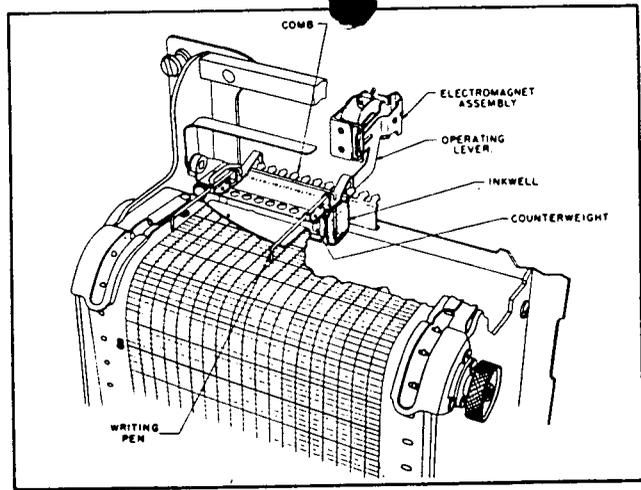
Simplicity is the key to the exceptionally long life and trouble-free service users have come to expect from Esterline Angus Event Recorders.

This simplicity is clearly illustrated in the drawing to the right. Writing elements are deflected by electromagnets which can be rated for operation on practically any AC or DC voltage from 2 to 250.

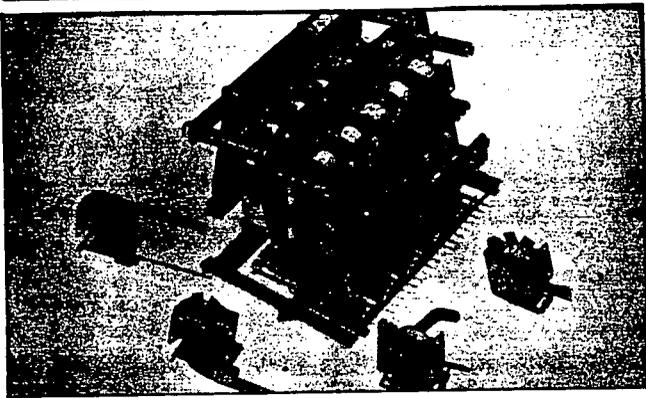
When an electromagnet is energized, its armature moves, causing the operating lever to move. This, in turn, moves the writing pen or inkless writing element $1/10$ inch off of its continuous line.

The pen or inkless writing element remains deflected until the magnet is de-energized. This lateral deflection, coupled with the continuous record of all Esterline Angus Event Recorders, makes charts easier to read than those produced by any other event recorder.

When you analyze an Event Recorder chart, you



know not only that an event has occurred, but also when it occurred, how long it lasted and how frequently it happened.



Shown above are two more reasons for Esterline Angus Event Recorder superiority. In the center is the operating element of a 20-channel Event Recorder. All 20 elements are mounted on a single plate. Completely wired, the entire plate can be easily removed from the recorder. Below the plate are the four styles of coil assemblies. Operating lever shape is different on each assembly.

Writing Methods

Inkless Event Recorders employ electrically heated styluses to produce records on non-wax finish chart paper, which is virtually impervious to external heat, rough handling or discoloration from light.

An independent power supply is required for heating styluses. This circuit can be rated 120 or 240 volts, 50 or 60 Hz. A rheostat adjusts stylus heat to control the width of the recorded line.

All pens on Ink Event Recorders are served from an enclosed ink reservoir which also mechanically supports and aligns the pens. Pen tubes extend into the ink supply through holes in the metal inkwell cover to provide a positive supply of ink regardless of chart speed.

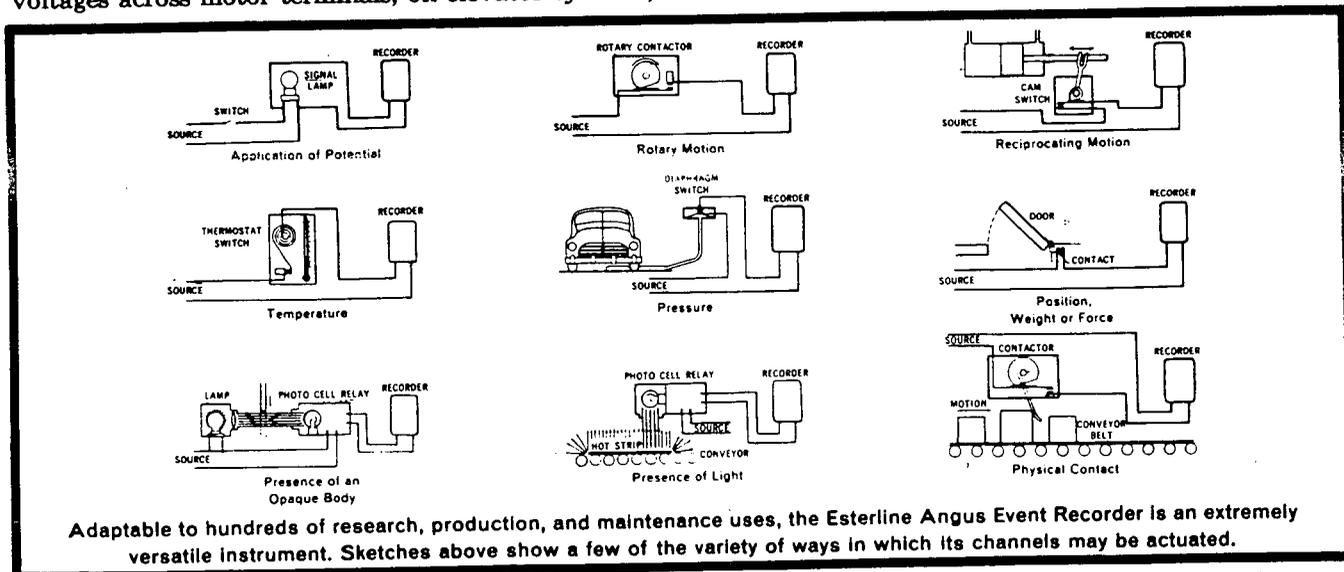
Event Recorders Actuation

A few of many ways Event Recorder electromagnets can be actuated are shown in the drawing below.

The most simple actuation method is the application of voltage directly to the instrument's coils. Scores of applications in which this is possible include signal voltages across motor terminals, on elevator systems,

across indicating lamps, across circuit breakers, across coils of solenoid valves and relays and on railroad interlock systems.

Even where voltages vary over a wide range or where currents are too large to be brought to the recorder, the simple addition of appropriate relays allows normal use of the event recorder.

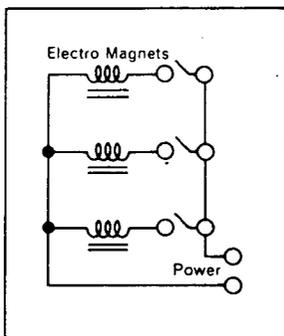


Choose from Three Types of Recorder Wiring

Event Recorder writing elements are deflected by electromagnets, which can be rated for operation on practically any AC or DC voltage from 2 to 250, and which can be so wired that each is electrically independent (separate circuits). A second wiring arrangement has a single common electrical terminal for all electromagnets (common return). In a third wiring arrangement, the writing elements are displaced by closing external circuits (switch type).

Any one of the three wiring types may be used if the power source is AC. When only DC power is available, common return or separate circuit recorders must be employed.

Common Return



Common Return (voltage type) Event Recorders require an external voltage source to actuate the electromagnets. In this type recorder, the common terminal is connected internally to one side of all the coils and is connected externally to one side of a voltage source (preferably the grounded side).

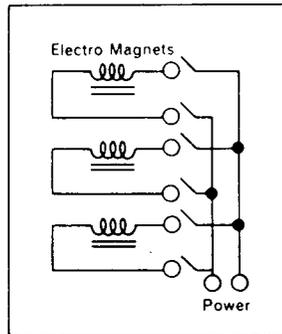
Other terminals of the various coils are wired to the ungrounded terminals of devices on which voltage appears. This includes signal lamps, solenoids and motors.

Voltage is thus made to serve a dual purpose; first, to energize the device being monitored, and second, to actuate the recorder coil which is connected across the device.

Common Return Event Recorders are most often used to study activities such as circuit breaker operation, elevator scheduling, timing cycles of automatically controlled processes and automatic gauging of parts.

Events of a mechanical, rather than an electrical, nature can also be recorded by the common return instruments. This is accomplished by utilizing switches or contactors to interrupt an external voltage source and convert mechanical events into electrical impulses which activate the recorder.

Separate Circuits



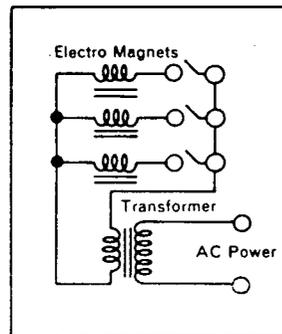
Separate Circuits (voltage type) Event Recorders have a separate pair of terminals for each electromagnet, thus permitting their use in complex systems where wiring, relaying and different electrical values prohibit interconnection between circuits.

This type of recorder is ideal for load studies in a telephone exchange or for studies of elevator scheduling. On portable instruments, separate circuits are often specified to eliminate the need for determining polarity.

To play safe, some users employ separate circuits recorders when they make connections directly across motor terminals. On common return instruments, one terminal of the motor is always connected through one of the instrument's coils to the "common" side of the voltage source.

Although the motor switch is open, a potential with respect to ground may be present on one of the motor terminals. Separate circuits recorders do away with this possibility.

Switch Type



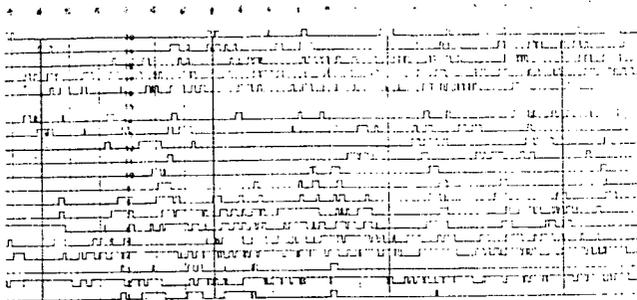
Writing elements in Switch Type Event Recorders are actuated by switches or contactors. A small stepdown transformer—with primary rated 120 or 240 volts, 50 or 60 Hz—is furnished on all Switch Type Event Recorders. It provides 24 volts AC to actuate the electromagnets.

One side of the transformer secondary is connected to one side of all the coils inside the recorder. The other side of the secondary is brought out to a common terminal on the case.

This type of recorder is suitable for use where the power supply is AC and where there is no existing voltage in the circuit to which the electromagnets will be connected.

Use of the switch type recorder, moreover, guarantees low operating voltages which reduce wiring costs and eliminate the hazards very frequently encountered with higher voltages.

You Can Obtain Three Types of Records

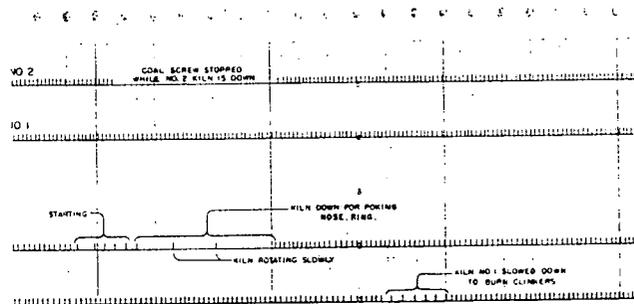
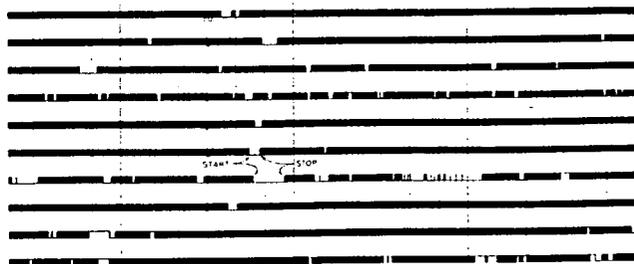


Rectangular Record—A majority of Event Recorder charts look like the one above. The open rectangles reveal the times during which electromagnets were energized; that is, the times during which events occurred. When the events were no longer taking place, the electromagnets were de-energized and the writing elements returned to their base lines. Telephone studies, circuit breaker operation, elevator movements and chemical process supervising often produce records such as these.

Band Record—This type of record (above right) is produced by rapidly opening and closing contactors, usually those connected to reciprocating or rotating machines. Chart speed and method of actuation are chosen so the writing elements produce overlapping marks. The bold band contrasts sharply with the single straight line drawn when the machines were not running.

Impulse Record—When the writing element is energized only momentarily, its return stroke falls on almost the same place as the active stroke. This produces a single cross-wise mark (right). This type of record is valuable for counting objects on a conveyor, vehicles on a highway or billets coming from a furnace.

Combination Record (not illustrated)—Any combination of the three types of records can be obtained in a single recorder simply by making proper selection of actuating devices.

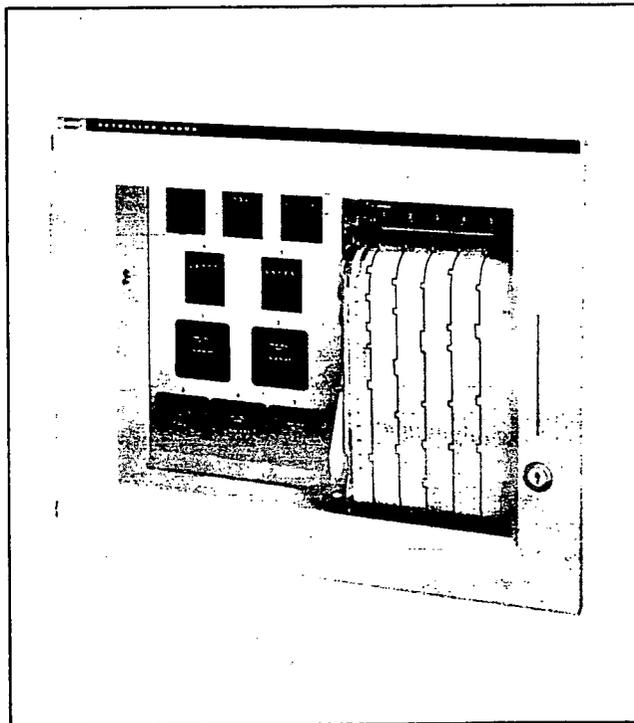


Counters and Totalizers

Counters, totalizers or both can be added in parallel to each electromagnet in either Common Return or Separate Circuits Event Recorders.

Counters are most often employed with Esterline Angus Event Recorders in plants where it is desirable to have a count of events such as the opening and closing of hydraulic presses, plastic molding machines and casting machines.

Time totalizers or hour counters find extensive use in operations such as electric arc welding. They reveal how many productive hours of welding are accomplished in a given period of time.



Mounted in an Esterline Angus twin case, this instrument includes an Event Recorder to the right, plus counters and elapsed time indicators to the left. The five digit reset counters are mounted above the non-reset elapsed time indicators.

Hints Help Achieve Maximum Event Recorder Benefits

Who needs hints to interpret simple "yes-no" or "on-off" records?

Hardly anyone. But these suggestions apply to certain installations which have been called to the attention of Esterline Angus during its long years of Event Recorder production.

For example, a screw machine may continue to operate even though it has run out of stock. Normally, the Event Recorder would show the continued operation.

To eliminate such false recording, two switches are used in series, one connected to the cam shaft and the other connected to the piece of stock being machined. Unless both switches are closed, the writing element is not actuated.

On textile looms, rotary presses or cable machines, shafts will continue to revolve although there is no

production. To avoid false Event Recorder records, cam switches can be attached to idler rolls. Thus, no impulses will be sent to the recorder unless stock is actually moving through the machine.

In arc welding, useful deposition of metal occurs only when two events take place simultaneously: current must be flowing and there must be voltage across the arc.

If the arc is broken while the welding generator is running, there will be voltage, but no current. If the electrode is short-circuited against the work, there will be current, but no voltage.

Two relays solve this problem—one responsive to arc current and the other responsive to arc voltage. Contacts of the two relays are wired in series so the Event Recorder's electromagnet is energized only when both relays are closed.

High Impedance DC Voltage Sensing Event Recorders

Only Esterline Angus offers an Event Recorder which can be bridged onto low power circuits without upsetting their operation in any way. That's because input impedance of this new unit is more than 200,000 ohms.

Operation is rated for voltages between 12 and 55 volts DC with overloads to 300 volts DC. The signal input circuits will accept DC of either polarity.

All input circuits are isolated from each other and from ground. Thus, you can use the unit on either circuits which are isolated or on those that have a common connection.

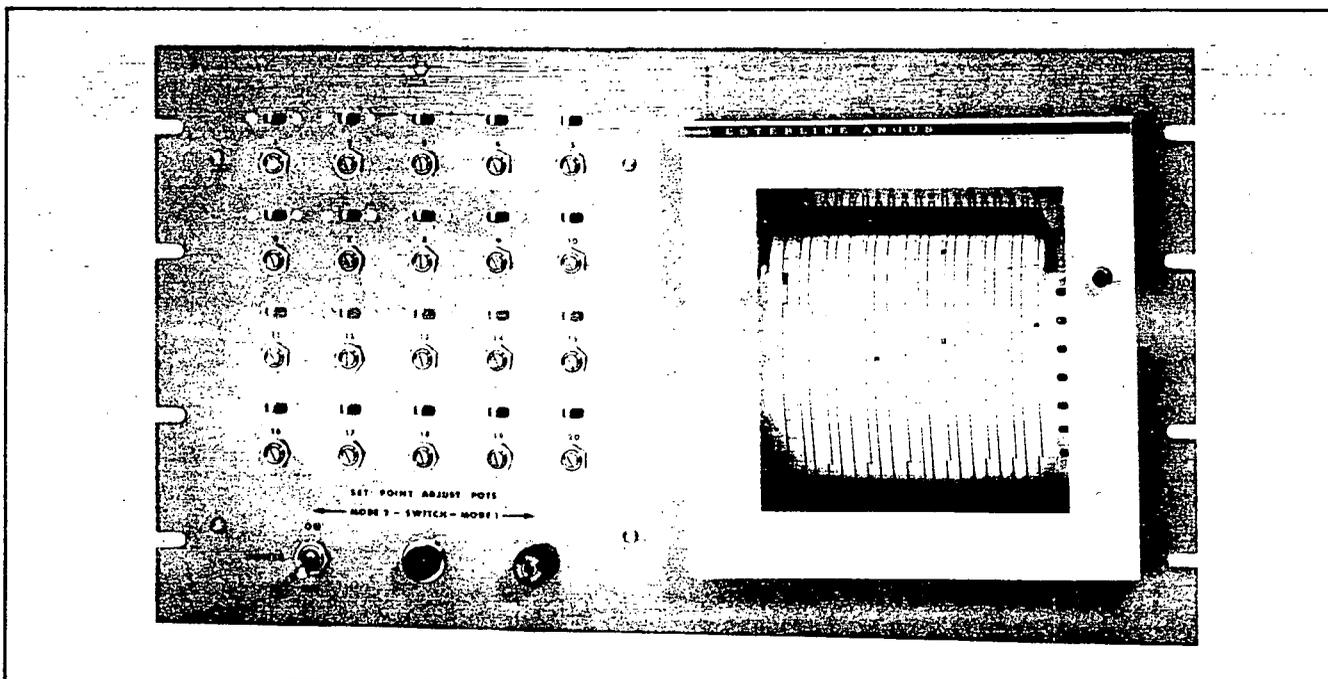
You can order the complete High Impedance Event Recorder unit or you can order a module which can be added to any Esterline Angus Event Recorder with style T coils having separate circuits. You can also order either inkless or ink writing in a variety of case styles and in either Series "A" or Series "S" with separate circuits.

Telephone engineers and other electronic engineers who must deal with low power are already making extensive use of the recently introduced unit.

A switch for each channel provides two modes of operation. One mode causes the pen or stylus to deflect when rated voltage is applied. The other mode causes the pen or stylus to deflect whenever the voltage is below a stated value. In the latter mode, the pen or stylus returns to its "off" position when the signal voltage exceeds a stated value.

Each channel is equipped with a potentiometer for adjusting operating points. Switches, potentiometers, input and output terminals can be housed in a components case which attaches to the rear of a recorder case, in a panel which fits a standard 19" relay rack or in a separate components case.

Standard design of the High Impedance DC Event Recorder requires a source of 120 volts, 60 Hz, 30 volt amperes.



This panel with mode switches and potentiometers to left and Series "S" recorder to right permits a compact installation of the high impedance package in a standard 19" relay rack.

General Specifications

Event Recorders are available in these configurations:

Series "A" Models A620X (Ink) and A620T (Inkless)



Portable



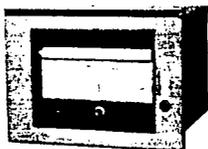
Flush

Cases include portable, flush switchboard, front switchboard and wall mounted. All but portable cases are also furnished in twin mounting to accommodate as many as 40 channels. Details given on page 9.

5, 10, 15 or 20 channels are offered in ink-type recorders; 10 or 20 channels in inkless.

Ink-type recorders may be equipped with hand-wound spring, motor-wound spring, synchronous phantom or Selsyn drives. Synchronous, phantom and Selsyn drives are offered for inkless-type recorders.

Series "E" Models E1140X (Ink) and E1140T (Inkless)



Flush, wall or table mounting cases can be provided. See page 12. 40 channel ink or inkless types are offered.

Twenty-one varieties of synchronous drives are available.

Series "S" Models S620X (Ink) and S620T (Inkless)



Portable (Labgraph)



Flush (Panelgraph)

Cases include a flush configuration with 8" by 8" front and a portable with sloped writing surface. Refer to page 14 for details.

5, 10, 15 or 20 channels are offered in ink-type recorders. Inkless units accommodate 10 or 20 channels.

Seven varieties of synchronous drives may be ordered. Pulse input proportional drives are offered also. Consult page 13.

Electromagnet Specifications

VOLTAGE TYPE—Common or Separate Return

Rated Voltage*	Coil Style	Milli-amperes***	Watts per Circuit	Ohms per Coil (DC) ±10%	Ohms in Series with Coil
Direct Current**					
2 Volts	N	570	1.1	3.5	None
4 Volts	K	286	1.1	14	None
6 Volts	J	231	1.4	26	None
8 Volts	G	131	1.0	61	None
10 Volts	F	99	1.0	101	None
12 Volts	F	119	1.4	101	None
14 Volts	E	90	1.3	156	None
16 Volts	D	67	1.1	238	None
18 Volts	D	76	1.4	238	None
24 Volts	C	65	1.6	372	None
28 Volts	B	42	1.2	666	None
32 Volts	A	29	0.9	1,092	None
48 Volts	T	29	1.4	1,650	None
125 Volts	U	9	1.0	12,500	None
250 Volts	T	26	6.5	1,650	8,000
50-60 Hz AC					
6 Volts	N	447	1.6	3.5	None
12 Volts	K	233	1.7	14	None
24 Volts	G	103	1.5	61	None
120 Volts	T	20	1.5	1,650	None
240 Volts	T	21	4.5	1,650	7,000
SWITCH TYPE—Common Return Only					
50-60 Hz AC					
120 Volts	G	Electrical characteristics of individual coils are the same as listed for voltage type, 24 volt, 50-60 Hz, style G coil, in above table.			
240 Volts	G				

*All electromagnets are guaranteed to operate at voltages 15% above or below rating.

**In permanent installations, it is preferable for the recorder coils to be connected to the negative polarity of the power supply, the switches or relay contacts to be in the positive lead between the power supply and the recorder.

***Recorders with high input impedance can be ordered for DC circuits. The input rating can be as low as 12 V DC or as high as 55 V DC. Signal current at rated voltage will be approximately 1 MA. These high impedance recorders are especially applicable to the study of telephone circuits which cannot carry high instrument burdens.

Special low impedance coils should be used for series operation such as in the secondary of a current transformer. Consult factory giving details of application.

Response Speed—For pens to make full deflection, circuit must be closed or open for at least 15 milliseconds. On repetitive signals, a maximum of 20 "on-off" cycles per second with equal "on" and "off" periods can be accommodated.

Stylus Heating Circuit—On inkless recorders an independent circuit is provided for stylus heating. This circuit can be rated for operation from 120 or 240 volts, 50-60 Hz, 40 VA. A 400 Hz rating may be obtained on special order. A rheostat is provided to adjust stylus heat thereby widening or narrowing the recorded line. Stylus heat must be on 5 seconds before record is made.

Dielectric Test—1,500 volts, 60 Hz, for one minute.

Leads—None furnished. Leads used with switch-type recorder may have resistance up to 35 ohms per circuit (approximately 5,000 feet of No. 18 wire, 2,500 feet one way).

Terminals—Binding Posts not furnished. Screw connections are made to terminal strips for all Series "A" recorders and for "S" portable recorders. Multipin connectors are standard for Series "S" flush recorders and for Series "E" recorders. Multipin connectors can be provided as an option to replace screw connections.

Chart Speed—Charts should be run fast enough to give the desired timing accuracy, yet not so fast as to cause excessive paper consumption and laborious inspection. Where individual strokes are to be counted, the chart speed should be selected so that there are not more than 30 strokes per inch of chart travel. When using the band-type record, speed should be such that there are not less than 80 strokes nor more than about 200 strokes per inch of chart travel.

Charts—Charts for Series "A" and "S" Inkless and Ink Event Recorders are 6 inches wide and accommodate 20 channels of information. The inkless chart is 81 feet long and the ink chart is 103 feet long.

Charts for Series "E" Inkless and Ink Event Recorders are 11 inches wide and accommodate 40 channels of information. The inkless chart is 100 feet long and the ink chart is 120 feet long.

All charts have rectilinear coordinates with each channel approximately 1/4 inch wide.

Series "A" Case Specifications

Terminals Portable or Flush Switchboard	Connections made at back of instrument to screw terminals. If required, for flush mounting, metal covers can be supplied to enclose terminals.
Front Switchboard	Terminals project through panel on which instrument is mounted.
Wall Mounted	Connections can be made by conduit, BX cable or open wiring through two 1" threaded holes in bottom of mounting and wiring compartment.
Mounting Portable	Bottom of case has four holes drilled and tapped for No. 10-24 screws if user desires to fasten recorder to any flat surface.
Flush Switchboard	Case body and mounting flange die cast as single unit. Four No. 12-24 screws provided for mounting on panels of virtually any thickness. Panel cutout size for single recorder is 9 $\frac{3}{8}$ " wide by 14 $\frac{1}{4}$ " high. For twin recorder, cutout size is 17 $\frac{7}{8}$ " wide by 14 $\frac{1}{4}$ " high. Twin recorder fits standard 19" relay racks with no cutout required. Mounting holes of twin recorders are spaced to fit standard relay racks and No. 10-32 screws are provided.
Front Switchboard	Mounting studs provided for rear-of-board connections on metallic or non-metallic panels of any thickness. Mounting ring on case body and three mounting studs are independent of those used for electrical connections.
Wall Mounted	Mounting and wiring compartment attached to back of case body. Compartment fitted with removable steel cover to protect connections. Three lugs are provided for mounting recorder on wall.
Twin Mounted	All but portable units can be provided in a twin arrangement which incorporates two recorders in one case, rigidly synchronizing the records of each recorder and conserving valuable space.
Case Body and Door	High strength, lightweight aluminum alloy die castings, except flush door which is high impact resistant plastic.

Door Glass	Distortion free, supported by gasket and metal clips.
Rubber Door Gasket	Protects interior from dust, fumes and moisture.
Chart Feed Through	Chart can be fed out of case with simple removal of rubber gasket from bottom of case door.
Colors	Esterline gray or charcoal for flush cases. All others textured gray. Any other colors may be specified by customer at small extra cost.
Illumination	Standard for flush case instruments is 120 volt, 60 Hz fluorescent. Incandescent can be provided. Other cases have no internal illumination.
Locks	Flush case: built-in, flush door handle and lock. All other cases: padlocks can be used on eccentric latch.
Multiplier Boxes	Required for ratings of 250 V DC and 240 V, 50-60 Hz. Attach to rear of portable and flush cases and mount separately from front switchboard and wall cases.
Handle (portable only)	Steel reinforced plastic securely fastened to top of case. Lies flat when not in use.

Options

Adapter Panel (single flush only)	Single flush instruments can be mounted in the center of adapter panel for standard relay racks. The drilled and tapped steel panels are 19" wide, 19 $\frac{1}{4}$ " high and $\frac{1}{8}$ " thick. Twin flush instruments are 19" wide and can be readily mounted in standard relay racks. They do not require an adapter.
Carrying Case (portable only)	Protects instrument from damage during transit or storage.
Glare Reducing Glass for Door	Eliminates problem of glare from external light source.
Purging Connection	Permits feeding air into case to maintain positive pressure. Adds protection against entry of dirt laden and/or vapor laden air.

Dimensions and Weight

Case	Height	Width	Depth	Approx. Shipping Weight of Complete Instrument
Portable	14"	8 $\frac{3}{16}$ "	9 $\frac{5}{16}$ "*	34 lbs.
Flush	15 $\frac{23}{32}$ "	10 $\frac{9}{16}$ "	8 $\frac{3}{4}$ "**	38 lbs.
Front	14"	8 $\frac{3}{4}$ "	9 $\frac{1}{4}$ "	34 lbs.
Wall	15 $\frac{1}{16}$ "	8 $\frac{5}{8}$ "	10 $\frac{15}{16}$ "	38 lbs.
Twin flush	15 $\frac{23}{32}$ "	19"	8 $\frac{3}{4}$ "**	70 lbs.
Twin front	14"	17 $\frac{1}{2}$ "	9 $\frac{1}{4}$ "	70 lbs.
Twin wall	15 $\frac{1}{16}$ "	17 $\frac{3}{8}$ "	10 $\frac{5}{8}$ "	80 lbs.
Standard Multiplier case	12 $\frac{1}{4}$ "	5 $\frac{7}{16}$ "	3 $\frac{1}{16}$ "	5 lbs.

*This dimension does not include multiplier. Add 3 $\frac{1}{4}$ " for attached multiplier.

Series "A" Chart Drive Specifications

The variety and quality of Esterline Angus Series "A" chart drives is unmatched in the industry. More than 100 combinations and variations of chart drives may be selected from the five basic chart drive mechanisms to provide speeds in inches or millimeters per unit of time.

Esterline Angus chart drives are mounted on rigid, box-like aluminum frames to maintain alignment of all parts, to reduce friction in the gear train and to provide smooth chart feed.

Change Gears

One pair of change gears is included with each internal chart drive. An almost limitless variety of speeds can be obtained through the use of additional change gears or auxiliary gearing.

Inches or Millimeters Per Second Chart Speeds

When detailed records of rapidly changing phenomena are required, high chart speeds are invaluable. The easiest way to add these speeds to Series "A" Recorders is with an external motor which mounts on the side of standard cases.

Both reset and non-reset motors on inch drives provide $\frac{3}{4}$, $1\frac{1}{2}$ and 3 inches per second speeds. On millimeter speed drives these motors provide $12\frac{1}{2}$, 25, 50 and 100 millimeters per second speeds. The reset (Type R) motor does just what its name implies. It resets to hour speeds so the correct time of day shows on the chart after operating at second speed.

Esterline Angus can also provide an internal high speed synchronous drive (Type 55). It finds greatest use in installations where only second speeds are required or in a twin recorder where there is not room for external motors and hour, minute and second speeds are needed.

Chart Speed Control

The change from hour to minute speeds can be made manually by moving a control lever on the side of the chart drive.

On most chart drives, provision can be made to electrically shift chart speed from inches per hour to inches per minute or second from a remote location.

All electric drives have a stalled induction motor and storage spring for chart reroll. It rerolls 18 inches or 450 millimeters of chart without power.

Hand Wound Spring

Many installations require a recorder which will operate when electric power is off or where electric power is not available. For such installations, the hand wound spring chart drive is ideal.

This drive has four springs connected in series, all of which are wound at one time from the front of the drive by a crank. About 110 turns of the crank completely wind the springs.

One winding of the springs provides eight days of operation at hour speeds or three and one half hours of operation at minute speeds. After eight days of operation at any hour speed, only 65 turns of the crank are required to restore full power.

At any of the standard hour speeds, accuracy is 0.05%, which means the chart drive's maximum gain or loss will be only five minutes during one week (10,080 minutes) of operation. At minute speeds, accuracy is $1\frac{3}{4}$ % or a maximum gain or loss of one minute per hour.

Motor Wound Spring

This chart drive is used where AC power frequency varies or where the chart must continue to operate during a power interruption. It can be ordered with either hour or hour-and-minute speeds.

A small electric motor provides power to wind a helical chart drive spring. A second motor winds a reroll spring which is capable of rerolling 18 inches or 450 millimeters of chart if power to the drive should fail. Both motors are energized about 20 minutes each hour by a cam-operated switch. Operation at any hour speed will continue five hours without power.

Synchronous

Synchronous motor chart drives provide hour-and-minute speeds and operate on frequency-regulated AC power. The chart is propelled by a self-starting synchronous motor which is permanently lubricated.

The reroll mechanism is powered by a stalled induction motor which, through a gear train and small storage spring, automatically adjusts take-up rate to match chart speed.

If desired, a special synchronous motor can be ordered. It multiplies all hour and minute speeds by a factor of 2 or 2.5, making chart speeds up to $\frac{1}{2}$ inch per second or 500 millimeters per minute possible.

Phantom

Phantom chart drives have chart carrying and reroll mechanisms, but no chart driving power. They are ideally suited to applications where the chart is being driven proportional to some quantity other than time, such as the distance traveled by an automobile or the movement of material in a process. They are also used in twin recorders where the chart is advanced by the drive in the other half of the twin.

If a phantom chart drive will meet your needs, carefully consider the driving source before placing your order. When the driving source always exerts a restraining force, even when not in motion, drive 6X or 6EX should be used.

If the driving source exerts no restraining force when the chart is still, drive 6C or 6EC should be used. A drag clutch in these drives prevents the reroll mechanism from pulling the chart through the recorder when the driving source is motionless. Torque required at the coupling shaft to slip the drag clutch varies from $\frac{1}{2}$ to $1\frac{1}{4}$ inch-pounds, dependent upon the type of phantom drive and the ratio of change gears.

If the driving source can reverse rotation, drive 6CC or 6ECC should be used, because each has both drag and back-up clutches which prevent reverse travel of the chart.

Phantom chart drives are furnished with either electric or spring reroll mechanisms.

Selsyn

The Selsyn is an electrical drive in which chart travel is proportional to a quantity other than time. Rotation of the internal Selsyn, which moves the chart, is controlled by a remote Selsyn transmitter.

If the driving source can reverse rotation, the 60C drive should be used. It has a back-up clutch which prevents reverse travel of the chart.

Auxiliary Gearing

Auxiliary gearing can be supplied on inch speed drives to provide chart speeds $\frac{1}{4}$ of standard. Speeds then become $\frac{3}{16}$, $\frac{3}{8}$, $\frac{1}{2}$, $1\frac{1}{2}$ or 3 inches per hour or minute with standard change gears. Auxiliary gearing cannot be supplied for millimeter speed drives.

Series "A" Chart Drive Specifications

Internal Chart Drives

(Inch or millimeter chart speeds may be selected.)

STANDARD CHART SPEEDS

No.	TYPE	Inches Per Hour	Inches Per Minute	Inches Per Second	MM Per Hour	MM Per Minute	MM Per Second
1	Hand-wound Spring, Hour Speeds Only	¼, 1½, 3, 6, 12	—	—	12.5, 25, 50, 100, 200	—	—
2	Hand-wound Spring, Hour and Minute Speeds	¼, 1½, 3, 6, 12	¼, 1½, 3, 6, 12	—	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	—
2A	Hand-wound Spring, Hour and Minute Speeds with Electric Shift	¼, 1½, 3, 6, 12	¼, 1½, 3, 6, 12	—	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	—
4	Synchronous Motor, Hour and Minute Speeds	¼, 1½, 3, 6, 12	¼, 1½, 3, 6, 12	—	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	—
4A	Synchronous Motor, Hour and Minute Speeds with Electric Shift	¼, 1½, 3, 6, 12	¼, 1½, 3, 6, 12	—	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	—
6X	Phantom, Spring Roll, without Clutches	No power unit. One revolution of coupling shaft moves ¼, 1½, 3 or 12 inches of paper under pen point with corresponding gears in place. Furnished complete with coupling.			No power unit. One revolution of coupling shaft moves 12.5, 25, 50, 100 or 200 mm of paper under pen point with corresponding gears in place. Furnished complete with coupling.		
6C	Phantom, Spring Roll, with Drag Clutch						
6CC	Phantom, Spring Roll, with Drag and Back-up Clutches						
6EX	Phantom, Electric Roll, without Clutches						
6EC	Phantom, Electric Roll, with Drag Clutch						
6ECC	Phantom, Electric Roll, with Drag and Back-up Clutches						
51	Motor-wound Spring, Hour Speeds Only	¼, 1½, 3, 6, 12	—	—	12.5, 25, 50, 100, 200	—	—
52	Motor-wound Spring, Hour and Minute Speeds	¼, 1½, 3, 6, 12	¼, 1½, 3, 6, 12	—	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	—
52A	Motor-wound Spring, Hour and Minute Speeds with Electric Shift	¼, 1½, 3, 6, 12	¼, 1½, 3, 6, 12	—	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	—
55	Synchronous Motor, Second Speed Only	—	—	¼, 1½, 3	—	—	12.5, 25, 50
56	Synchronous Motor, Hour and Minute Speeds, USED ONLY WITH 55 DRIVE	¼, 1½, 3, 6, 12	¼, 1½, 3, 6, 12	—	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	—
56A	Synchronous Motor, Hour and Minute Speeds with Electric Shift, USED ONLY WITH 55 DRIVE	¼, 1½, 3, 6, 12	¼, 1½, 3, 6, 12	—	12.5, 25, 50, 100, 200	12.5, 25, 50, 100, 200	—
60	Selsyn	¼, ½ or 1 inch per revolution of Selsyn with ¼, 1½ or 3 inch gears in place.			6.25, 12.5, 25 mm per revolution of Selsyn with 24 and 64 tooth, 39 and 52 tooth and 54 and 36 tooth gears in place.		
60C	Selsyn with Back-up Clutch						

Note: All drives are furnished with one pair of change gears to provide one standard speed. By reversing the set a second standard speed can be obtained (except for 3" or 50 mm gears).

Internal Chart Drive Electrical Ratings

No.	INTERNAL MOTORS				ELECTRIC SPEED SHIFT COILS			
	AC Volts	Frequency Hz	Load of Drive Motor and Roll Motor AC (VA)	DC Volts	AC Volts	Frequency Hz	DC Load Watts	AC Load VA
2A	—	—	—	6, 12, 24, 48	6-120	50, 60	1.4 ^c	2.4 ^c
4	120, 240 ^a	50, 60	26	—	—	—	—	—
4A	120, 240 ^a	50, 60	26	6, 12, 24, 48	120, 240	50, 60	10 ^d	16 ^d
6EX, 6EC, 6ECC	120, 240 ^a	50, 60	15	—	—	—	—	—
51, 52	120, 240 ^b	50, 60	30	—	—	—	—	—
52A	120, 240 ^b	50, 60	30	6, 12, 24, 48	6-120	50, 60	1.4 ^c	2.4 ^c
55, 56	120	60	25	—	—	—	—	—
56A	120	60	26	6, 12, 24, 48	6-120	50, 60	10 ^d	16 ^d
60, 60C	120	50, 60	75	—	—	—	—	—

^a Electric chart drives are normally furnished for one voltage only. At additional cost, 120/240 volt, 50 or 60 Hz chart drives are available. Number 4 drives can also be rated 120/240/480 volt, 60 Hz.

^b Single voltage ratings only are supplied.

^c Both AC and DC speed shift coils are designed for continuous operation.

^d AC speed shift coils are designed for continuous operation. DC speed shift coils should be energized intermittently, not more than five minutes on, followed by equal off period.

External Motor Attachments

External motors attach to right side of recorder (when facing chart). They provide chart speeds 3,600 times

the basic hour speeds of the internal drive up to the maximum speeds indicated in the table.

TYPE	Chart Speeds inches per Second	Chart Speeds mm per Second	MOTOR RATINGS				
			DC Volts	AC Volts	Frequency Hz	DC Load Watts	AC Load VA
N Second Speed Non-reset	¼, 1½, 3 ^a	12.5, 25, 50, 100 ^a	12, 24, 48, 125, 250	120	50, 60	22	60
R Second Speed, with Time Reset	¼, 1½, 3 ^a	12.5, 25, 50, 100 ^a	24, 48, 125, 250	120	50, 60	22	60

^a Speeds above 3 inches per second or 100 mm per second are mechanically possible but not recommended. When combined with No. 51, 52 and 52A internal drives use ¼ inch or 25 mm per second only. If power to any electrically operated internal drive fails, only 18 inches or 450 millimeters of chart will be rerolled.

How to Order

To facilitate rapid handling of your order, please include all information requested below:

1. Series "A", Series "S", or Series "E" inkless or ink and number of channels. Twenty channels standard in "A" and "S" series. If fewer than 20 channels are desired, please indicate 5, 10 or 15 channels ink-type or 10 channels inkless. Forty channels may be ordered in Series "A" twin or Series "E".
2. If inkless-type is ordered, specify stylus heating circuit rating.
3. Case style. If flush case is ordered, specify charcoal or gray color, and electrical rating of lighting which is standard on

"A" and "S" recorders and an option on "E" instruments.

4. Chart drive type, speeds, electrical rating.
5. Electromagnet wiring: common return, separate circuits or switch type.
6. Electromagnet ratings.
7. Carrying case, optional for portable "A" or "S" recorders.
8. Optional, high impedance circuits.
9. Number of charts required.

Esterline Angus Product Representatives

- Albuquerque**
BFA
1238 Ortiz, S.E.
Albuquerque, New Mexico 87108
Telephone: A.C. 505 268-4387
- Atlanta**
Hooker Reid Co., Inc., P.O. Box 11754,
Atlanta, Georgia 30305
Telephone: A.C. 404 237-9385
- Birmingham**
The James Spader Co., P.O. Box 6074,
Birmingham, Alabama 35209
Telephone: A.C. 205 879-1366
- Borger**
Kennedy Engineering Co., P.O. Box 3434
Borger, Texas 79007
Telephone: A.C. 205 879-1366
- Boston**
Esterline Angus, (Branch Office)
P.O. Box 385
Holliston, Massachusetts 01746
Telephone: A.C. 617 235-5343
- Buffalo**
The Robert F. Lamb Co., Inc.,
1865 Kenmore Ave.
Buffalo, New York 14217
Telephone: A.C. 716 874-4900
- Calgary**
Showalter Agencies, Ltd., 2510 4th St., S.W.
Calgary 3, Alberta, Canada
Telephone: A.C. 403 269-6411
- Charleston**
Vynock Engineering Co., P.O. Box 363,
Charleston, West Virginia 25322
Telephone: A.C. 304 722-3525
- Charlotte**
Ranson, Wallace & Co., Inc.,
116½ E. 4th St.,
Charlotte, North Carolina 28202
Telephone: A.C. 704 334-4244
- Chicago**
Esterline Angus (Branch Office)
188 Industrial Way, Suite 22
Elmhurst, Illinois 60126
Telephone: A.C. 312 833-4410
- Cincinnati**
The Beedle Equipment Co., P.O. Box
36061, Cincinnati, Ohio 45236
Telephone: A.C. 513 793-0140
- Cleveland**
Waldrip, Blankenburg & Co.,
7650 Chippewa Road,
Brecksville, Ohio 44141
Telephone: A.C. 216 526-1100
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BFA, Inc.,
P.O. Box 429
Euless, Texas 76039
Telephone: A.C. 817 267-1505
- Denver**
Cliff Beabout Co., 666 Sherman St.,
Denver, Colorado 80203
Telephone: A.C. 303 244-3151
- Des Moines**
Harry E. Ferris Co.,
4005 Plainview Dr.,
Des Moines, Iowa 50311
Telephone: A.C. 515 255-5008
- Detroit**
George R. Peters Associates, P.O. Box
1042, Berkley, Michigan 48072
Telephone: A.C. 313 564-6325
- El Dorado**
L. C. Byrne Co.,
632 Champagnolle
El Dorado, Arkansas 71730
Telephone: A.C. 501 UNION 3-9435
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6001 Gulf Freeway
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Houston, Texas 77023
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- Kansas City**
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Hickman Mills, Missouri 64134
Telephone: A.C. 816 SOUTH 1-6545
- Kingston**
The Robert F. Lamb Co., Inc.,
P.O. Box 661 Uptown Station,
Kingston, New York 12402
Telephone: A.C. 518 338-8833
- Knoxville**
George W. Massey Co., P.O. Box 10102,
Knoxville, Tennessee 37919
Telephone: A.C. 615 577-9553
- Las Cruces**
BFA Corporation, P.O. Box 1237,
Las Cruces, New Mexico 88001
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- Marquette**
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1010 W. Washington Street
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T. R. Bickler Associates, P.O. Box 7245,
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- Minneapolis**
Pinkney & Associates, Inc.,
957 Winnetka Avenue North
Minneapolis, Minnesota 55427
Telephone: A.C. 612 544-3628
- Montreal**
Instro-Test Ltd., 1024 Notre Dame St.
Lachine, Quebec, Canada
Telephone: A.C. 514 637-1231
- New Orleans**
Mid-South Sales Co., P.O. Box 13625,
New Orleans, La. 70125
Telephone: A.C. 504 822-3030
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34-23 Wisse Street
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Telephone: A.C. 201 471-0084
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Orlando, Florida 32805
Telephone: A.C. 305 855-8944
- Philadelphia**
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Rydal West, The Fairway
Jenkintown, Pennsylvania 19046
Telephone: A.C. 215 887-2268
- Phoenix**
BFA, Inc., 503 No. Brown Ave.,
Scottsdale, Arizona 85251
Telephone: A.C. 602 946-4215
- Pittsburgh**
Bollinger & Wirth, P.O. Box 8088
Pittsburgh, Pennsylvania 15216
Telephone: A.C. 412 LOCUST 1-2340
- Portland**
Shaffer & Nelson, Inc., 1001 S.E. Water
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Telephone: A.C. 503 BELMONT 4-7437
- St. Louis**
C. B. Fall Co., 317 N. 11th St., Suite 1003
St. Louis, Missouri 63101
Telephone: A.C. 314 CHESTNUT 1-2433
- Salt Lake City**
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805 West 2500 South
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Telephone: A.C. 315 454-2469
- Toronto**
Ahearn & Soper, Ltd., 844 Caledonia
Rd., Toronto 395, Ontario, Canada
Telephone: A.C. 416 789-4325
- Tulsa**
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Tulsa, Oklahoma 74152
Telephone: A.C. 918 835-9975
- Vancouver**
Ahearn & Soper, Ltd., 1234 Marine Drive,
No. Vancouver, B.C., Canada
Telephone: A.C. 604 988-6822
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NWR Electronics Corporation
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Minnesota 55792
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- Washington, D.C.**
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Recording Instruments

SPECIFICATIONS

INSTALLATION

OPERATION

MAINTENANCE

NOTE: FOR A COMPLETE TECHNICAL DESCRIPTION OF YOUR SPECIFIC INSTRUMENT, SEE THE DATA SHEET WHICH IS SUPPLIED IN A SEPARATE ENVELOPE AT THE BACK OF THIS MANUAL.

ESTERLINE ANGUS

Esterline Angus Division, Esterline Corporation, Box 24000, Indianapolis, Ind., 46224 U.S.A

OPERATING INSTRUCTIONS FOR SERIES "A" RECORDING SYSTEMS

This pictorial section explains how the chart-drive mechanism and its associated writing elements are prepared for operation. Before following these step-by-step procedures, make sure that all items are unpacked and all shipping materials are removed from the instrument.

This includes any cardboard or tie-strings that may be securing writing elements, optional change gears, scaleplates, or chart rollers. For those instruments with front covers hinging at the bottom of the case, remove the cover completely to facilitate the following operations

CHARTING THE DRIVE ALL MODELS

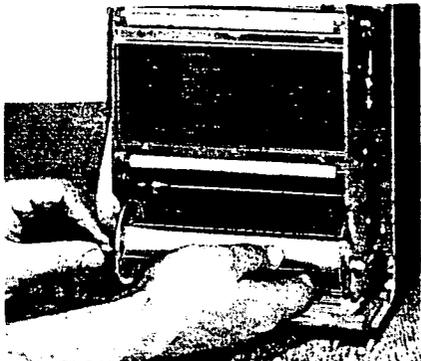


Fig. 1. Press down on either right or left reroll latch near bottom of case and remove reroll roller.



Fig. 2. Remove chart roll arbor by lifting up and pulling forward. Center paper roll on arbor with elongated chart perforations to right.



Fig. 3. Snap ends of arbor with new chart into slots. See that chart roll turns freely.



Fig. 4. Tear or cut end of chart paper to "V" shape. Feed chart into slot marked "Insert End Of Chart Here."

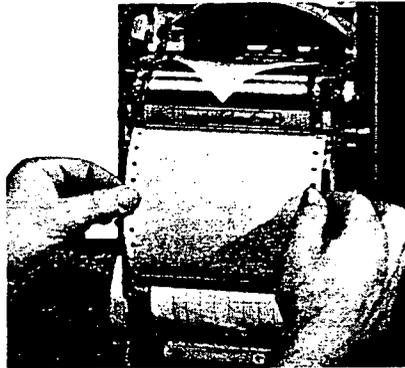


Fig. 5. Push chart into slot until point of paper hangs over top drive roller. (See Fig. 25, Page 3, for inkless recorders with "Tempen.")

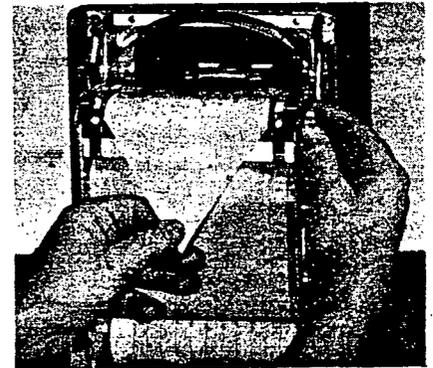


Fig. 6. Carefully pull chart down while turning knurled knob at end of drive roll so roller pins engage chart perforations at edges of paper.

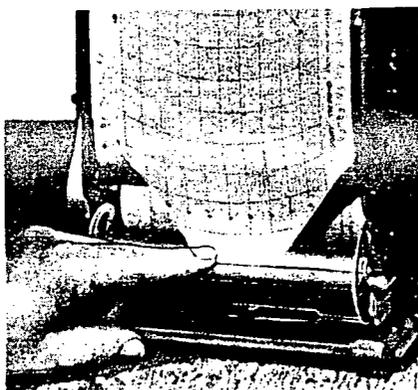


Fig. 7. Snap reroll roller back in place (gear end to left) and insert "V" end of chart into roller slot. It may be necessary to energize electric drives before reroll will take up.

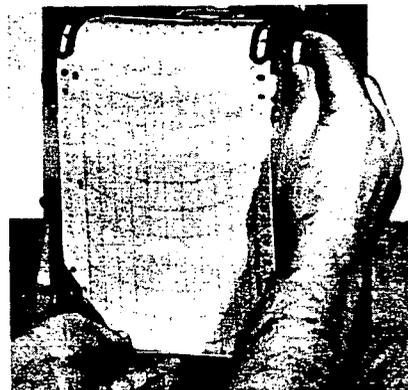


Fig. 8. Turn reroll roller back 1/4 turn to release brake (window-blind action). Advance set knob while permitting reroll to turn forward. See that chart is straight and taut.

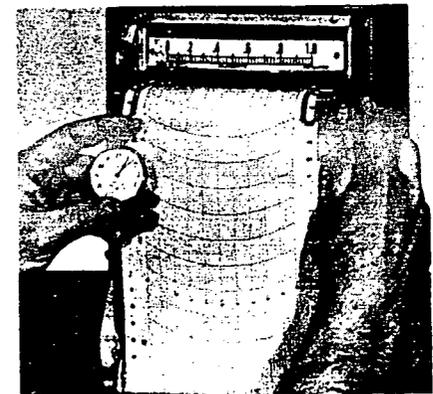


Fig. 9. Turn manual set knob ahead until desired time appears under writing element. For all ink models, pens should be in position prior to this final charting step.

INKING THE INSTRUMENT

(Refer To Specific Model Section)

MODEL A601C ANALOG RECORDERS

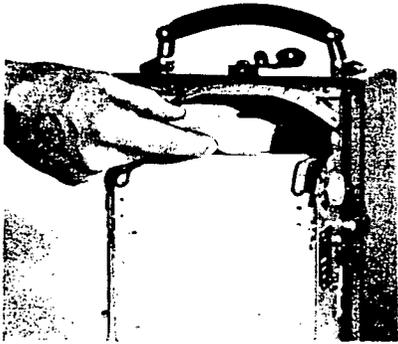


Fig. 10. Swing scaleplate upward, grasp front plastic lip of inkwell, and lift well up and out of instrument.



Fig. 11. Fill inkwell slightly over half full of Esterline Angus ink. Use special inkwell filler supplied. Carefully replace well under spring.

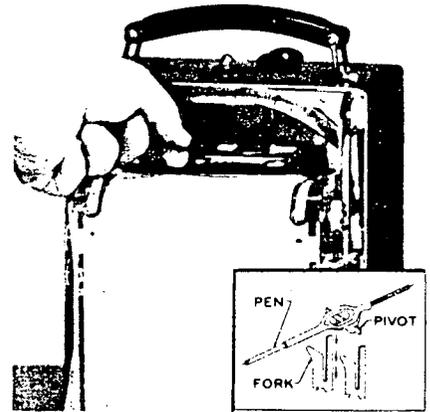


Fig. 12. Seat knife-edge pivot of pen firmly between movement fork assembly with pen tube resting in well. Pen will remain off chart until filled with ink.

MODEL A620X EVENT RECORDERS



Fig. 13. Swing scaleplate upward, press down on metal levers at each end of inkwell and lift well up and out.

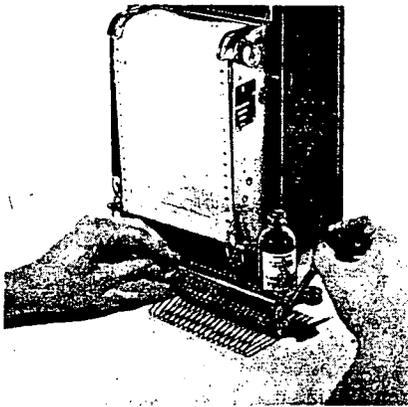


Fig. 14. Fill inkwell slightly over half full of Esterline Angus ink. Use special inkwell filler supplied.

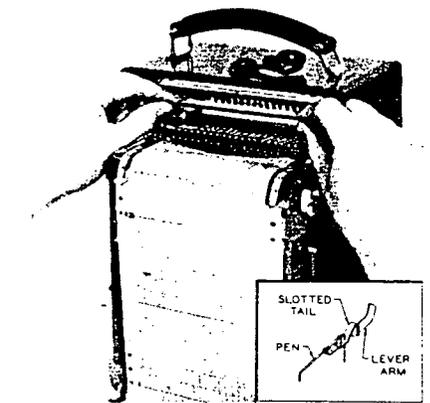


Fig. 15. Replace inkwell and pens without tipping. See that slotted pen tails engage lever arms and assembly seats firmly.

MODEL A602C TWO-CHANNEL RECORDERS

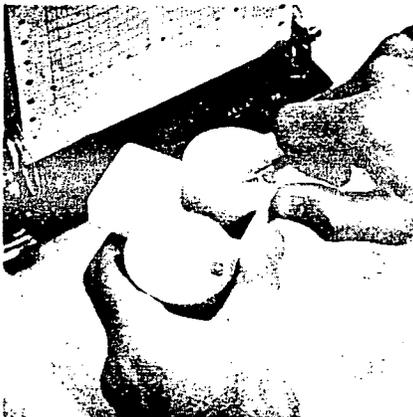


Fig. 16. With razor blade or sharp knife, cut off both projections that seal small openings at top of plastic inkwell. Ink will not spill from containers.

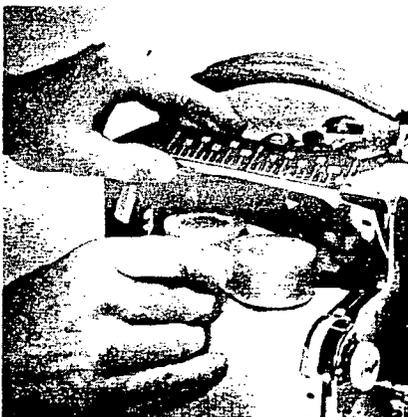


Fig. 17. Swing scaleplate upward (remove from flush cases); grasp lip handle of inkwell, insert front edge under spring retainer, and snap down into instrument.

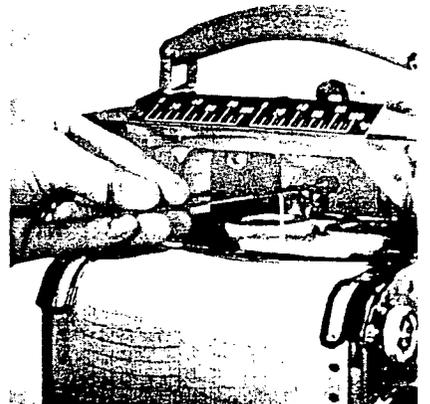


Fig. 18. Seat knife-edge pivot of each pen firmly between movement fork assembly while guiding pen tube into inkwell opening. Pen points will remain off chart until filled with ink.

MODEL A609C ANALOG-EVENT RECORDERS

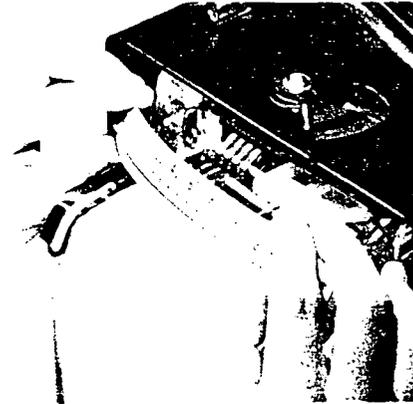


Fig. 19. Grasp scaleplate, bow ends inward, and unsnap from sides. Remove plastic inkwell as in Fig. 10, and metal inkwell as in Fig. 13.

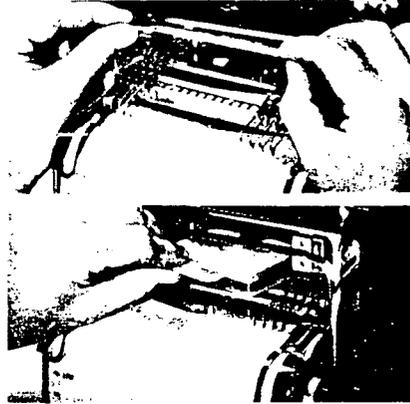


Fig. 20. Fill both inkwells as in Figs. 11 and 14. Snap metal inkwell in place making sure slotted pen tails engage lever arms. Carefully insert plastic inkwell under spring retainer.

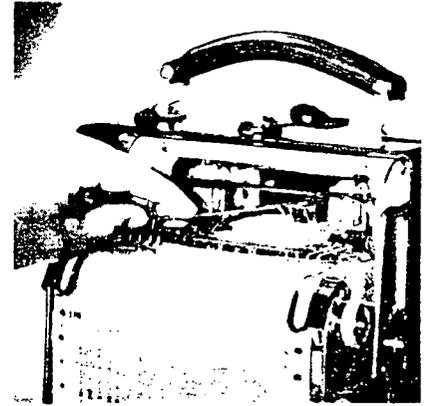


Fig. 21. Seat knife-edge pivot of center pen in movement fork assembly with end of pen in inkwell. Pen point will remain off chart until filled. Snap scaleplate into position.

PRIMING ALL INK MODELS

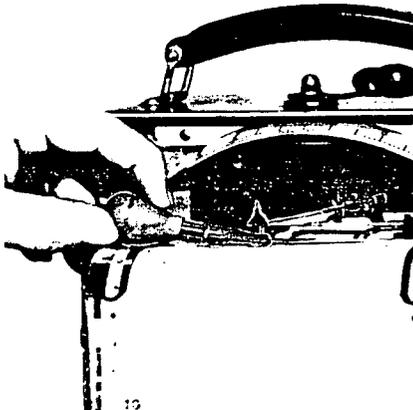


Fig. 22. Compress pen-filler bulb, insert pen point into hole provided in rubber tip, and release bulb slowly until ink appears in glass tube.

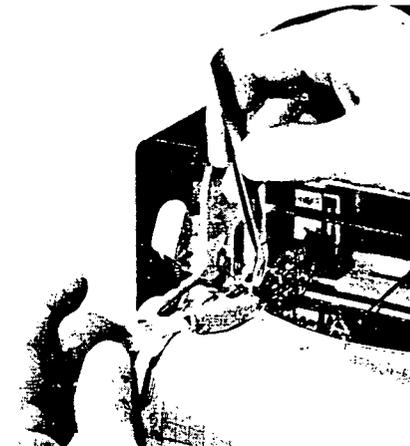


Fig. 23. When priming event or chronograph pens, a pair of tweezers will facilitate insertion of each pen in filler hole. Wash pen filler with water.

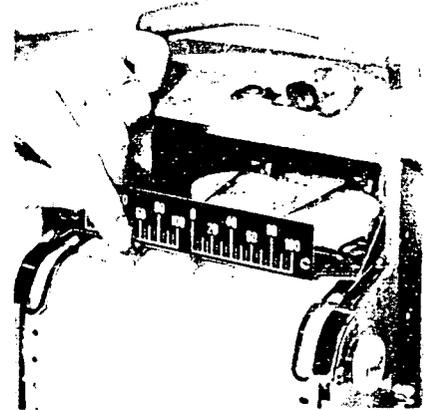


Fig. 24. Return scaleplate to normal viewing position. Make sure pen point is at right angle to chart and check for proper inking.

INKLESS INSTRUMENTS

MODEL A620T EVENT RECORDERS WITH TEMPEN®

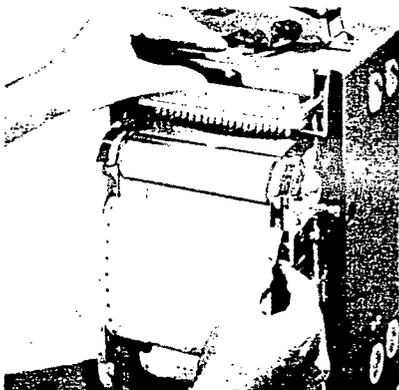


Fig. 25. Lift lip of scale with thumb to raise writing elements. Feed chart over top roller until point of "V" can be reached with fingertips. Proceed as in Fig. 6.

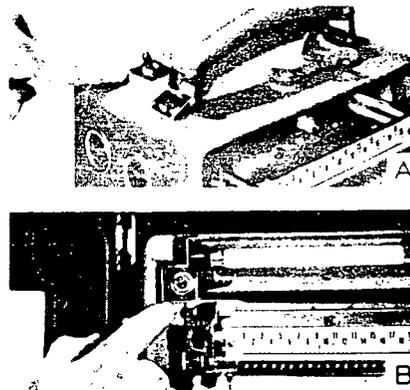


Fig. 26. "STYLUS HEAT" switch is found on top of portable, wall, and front-switchboard cases (A), and inside flush-mounted units (B).

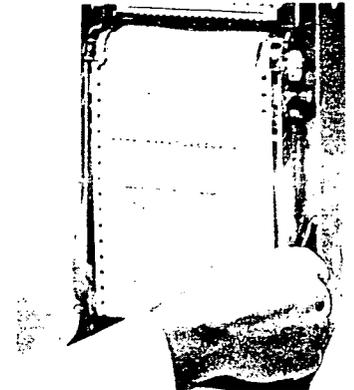


Fig. 27. With screwdriver, see that heat control is properly set. After applying power to drive and stylus circuits, system is ready for use. (See connection diagrams.)

GENERAL OPERATION AND CARE OF CHART DRIVES

(For Additional Information, See Instructions Following This Section.)

The instruction plate on the front of all standard power drives shows the path traveled by the chart, change gears to use for each standard speed, and how to start and stop the drive. Change gears are stored on a clip at the upper left corner of the drive; change gears for special speeds, if any, are stored at the upper right corner. In changing gears, the keyway in the hub must engage the key on the shaft and the knurled nut holding each gear must be tight. **DO NOT PRY GEARS OFF THE SHAFTS.** A straight pull will avoid bending a shaft.

STANDARD SPEEDS AND CHANGE GEARS

Chart Speed Inches Per Hour or Minute	Change Gears		Color of Driver & Driven Change Gears
	No. of Teeth Driver	No. of Teeth Driven	
3/4	18	72	Gold
1-1/2	30	60	Green
3	45	45	Red
6	60	30	Green
12	72	18	Gold

Electric Shift -

Drives equipped with an electric shift to change chart speeds automatically from inches per hour to inches per minute have a separate pair of terminals on the back of the recorder. Voltage and frequency of the electric shift are not always the same as that of the motors.

Coupling Drives -

Every chart drive, except the Selsyn, has a shaft for coupling to an external source or to the phantom drive in a twin recorder. It is not desirable to couple two synchronous drives. If set to the same time of day and operated from the same source, they will stay synchronized. Motor-wound spring drives should not be coupled to each other but may be coupled to a phantom drive in a twin meter or to an external driving source. Two hand-wound spring drives can be coupled to synchronize chart timing. The drives must be in good condition and timed accurately, or they may stop. Coupled drives will operate at both hour and minute feeds.

Couplings -

A phantom coupling is suitable for coupling the power chart drive in a twin instrument to the phantom chart drive. It is made to spring over the coupling ball fittings and eliminate any lost motion or backlash between the two drives. It is not suitable for transmitting heavy torque and it does not take the place of the power couplings, such as those used for external motor drive devices. Excessive torque on a phantom coupling will damage it.

Adjusting Chart Guides -

The chart guides are properly adjusted at the factory and the adjustment normally should not

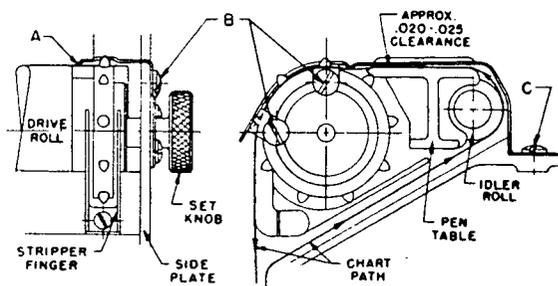


Fig. 28. Adjustment points for chart guides.

be changed. However, if the drive has been subjected to rough handling or been disassembled, readjustment will be necessary. The correct position of the chart guides is evident when there is no tendency of the paper to be depressed into the grooves on the drive roll. The turned down edge "A", Fig. 28, should follow the contour of the drive roll but allow clearance for the chart paper, so that there is no drag on the paper. It may be necessary to loosen screws "B" (2 per guide) in order to facilitate this adjustment. Screw "C" may also be loosened when necessary to provide parallel clearance over the writing table and proper parallel positioning of chart guides with relation to the side plate.

Removing Chart Drives From Twin Cases -

Before attempting to remove a chart drive from a twin case, the coupling must be disconnected by pushing the coupling endwise as far as it will go. If it is pushed to the right, the left-hand chart drive can be removed. Do not pull the drive out at an angle to disconnect from the coupling. This may damage the chart drive and the coupling. A phantom coupling, when properly located, should extend about the same amount over each coupling ball fitting.

Cleaning and Lubrication -

The chart drive can be removed for cleaning and oiling by loosening the four corner mounting screws. The drive can then be pulled forward out of the case. Connections to any electrical features will be disconnected automatically when the drive is removed (except Selsyn, Style 102 and 101MS, which has screw terminals). For specific lubrication information, refer to the instruction section on your particular chart drive.

Driving The Chart From An External Source -

Hand-wound spring, motor-wound spring, synchronous and phantom drives are equipped with internal clutches so the chart can be driven from an external source or by an external motor attachment without damaging the internal mechanism. When the external source can reverse direction, the internal drive must also be equipped with a back-up clutch.

GENERAL INSTRUCTIONS FOR ESTERLINE ANGUS MODEL A620T EVENT RECORDERS WITH TEMPEN[®]

Inkless event recorders are simple to operate and maintain; however, improper connections may result in unsatisfactory operation and permanent damage to vital parts of the instrument. No attempt should be made to put the recorder into operation until instructions in this manual have been studied.

UNPACKING

Since all Esterline Angus instruments are carefully inspected and packed before shipment, carriers are responsible for any damage in transit. Should a packing case appear damaged, make a notation to that effect on the express receipt or freight bill. If the shipment is damaged, notify the carrier at once.

A packing slip listing all enclosed items is included with each shipment. Check off the items as they are unpacked; if anything is missing, go through the packing material carefully before throwing it away. New instruments are shipped complete with one record chart. Two charts are supplied with all twin units, and each flush-styled case will include a set of keys for its built-in lock.

DESCRIPTION

The instrument is designed to graphically record event information from as many as twenty different sources simultaneously, and on a single chart 6" in width. The writing elements, which are electrically-heated styluses, record time and duration of events on separate channels. The chart paper used with this instrument has a non-wax finish and is sensitive to both heat and pressure.

Each stylus is actuated by a small electromagnet, which in turn is connected to the circuit or system being monitored. When the electromagnet is energized, the stylus is displaced approximately 1/10" from a reference line on the chart. When the electromagnet is de-energized, the stylus automatically returns to its original position. Construction of this assembly is shown in drawing #17300 of this manual.

The electromagnet coils are operated by either AC or DC voltages in a number of circuit configurations—depending upon the particular type ordered. Standard configurations are briefly

described in this section under the heading "CONNECTIONS".

The internal stylus-heating circuit is especially designed to produce graphic records without smoke, fumes, or odor. All styluses are connected in series and are heated by a direct-current source. The source consists of a full-wave rectifier circuit regulated by a zener diode and protected against shorts by a transistorized limiter stage. A step-down line transformer supplies power to the heater circuit and its operating voltage and frequency will be specified on the nameplate at the bottom of the instrument case, and on the Data Sheet in this manual.

INSTALLATION

Complete instructions for threading the chart, operating the drive, and servicing the writing elements are given in Section IS 20 of this manual.

For all fixed installations, the instruments should be mounted level and upright in a clean and well lighted location. The recorder should not be subjected to extreme vibration or high temperatures. If excessive dust, steam, moisture, smoke, or corrosive fumes are present, a protective cabinet should be constructed for the unit. The cabinet must be properly vented, however, to maintain a flow of air around the heat-producing styluses.

When installing the instrument on a panel, always refer to mounting dimensions. Series resistances, if used, will either be attached to the instrument case or supplied as a separate unit. All separate boxes will be marked with the recorder serial number, and must be mounted in a vertical position.

CONNECTIONS

The instrument will require external connections to operate the chart drive, heat the styluses, and actuate the event-recording elements. Before making any of these connections, always refer to the wiring diagrams in this manual.

Each stylus and its chart reference line is identified by a number on the front scaleplate. Normally, input connections for the styluses will be numbered on the instrument terminal block to

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correspond with these scaleplate numbers. If 10 styluses are ordered for any one unit, they will be arranged on the left side of the instrument so as to record on only the first 10 lines of the chart.

Unless otherwise ordered, the recorder will be wired internally with a common lead connecting one side of all electromagnet coils. This connection point will be marked "COM" on the terminal block. The other side of each coil will be brought out to a numbered terminal. Rated input potentials are applied between the numbered terminal and the common terminal. The common or grounded side of the external source should always be connected to the common terminal on the recorder. For DC operation, switches or relays that are to actuate the electromagnets should be connected between the positive polarity of the external source and the individual stylus terminals.

When specified, the recorder may be wired so as to have a pair of terminals for each electromagnet. In this circuit configuration, the rated input potential is applied directly across the two terminals. Since the electromagnets are not interconnected, the input circuits may be completely isolated.

If the recorder is designed to operate the styluses by a simple switch or contact action, its terminal block will have individually numbered terminals and a common connection. With this type of recorder, the external switch device merely supplies a conductive path between the common connection and any one of the numbered terminals. These devices trigger or gate an internal source of power which in turn energizes the electromagnets. The internal source consists principally of a step-down transformer; one side of the secondary being connected to each electromagnet coil and the other to the common post on the terminal block. The transformer supplies approximately 24-volts AC to the electromagnet coils. AC input required for this circuit is either 120 or 240 volts, 50 or 60 cps.

CAUTION: For the switch-type recorder, there must be no voltage present in the external circuits connected to the electromagnet terminals.

ADJUSTMENTS

Although all inkless recorders are carefully setup for standard operation before leaving the factory, certain field adjustments are made possible to satisfy unusual applications and individual preferences. In order to properly evaluate results of

these adjustments, however, the chart should be running at an appropriate speed and styluses cycled so that both forward and lateral writing characteristics may be observed.

NOTE: Always turn on stylus heat switch 5 seconds before starting chart drive.

HEAT CONTROL—Temperature of the writing elements is made variable by a rheostat which is connected in series with the stylus-heating circuit. This control is accessible from the front of the instrument; its shaft is slotted and projects through a hole in the lower-right side of the chart-drive mounting plate. (See Fig. 27 in Section IS 20 of this manual).

When the control is rotated in a clockwise direction, temperature of the styluses will increase and the recorded lines on the chart will become darker. To reduce stylus temperature, and consequently lighten the recorded lines, the control is rotated counterclockwise. It is recommended that this control remain in an advanced clockwise position for optimum line perception.

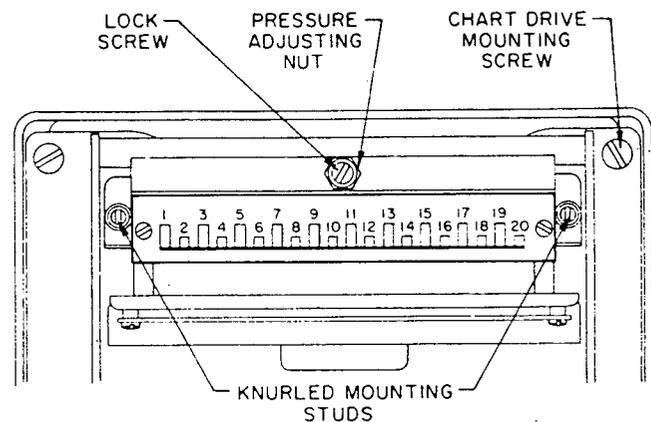


Fig. 1. Top-front of inkless recorder showing adjustment and disassembly points.

STYLUS PRESSURE—Pressure of the styluses on the chart paper is made variable by a pivoted spring tension in the stylus mounting assembly. A 3/8" hex nut, located slightly above and behind the scaleplate, is provided for this adjustment (see Fig. 1). When the nut is turned clockwise, stylus pressure will decrease and the recorded lines will appear wider; when it is turned counterclockwise, pressure will increase and the lines will become narrower. This adjustment is pre-set at the factory and will not normally require field attention - unless either the stylus mounting assembly or the chart drive has been removed from the instrument.

Recommended procedures for adjusting pressure are as follows: Turn on the instrument and set the heat control to minimum (fully counterclockwise). Loosen the lock screw in the center of the pressure adjustment nut. Adjust the nut so

that all styluses are producing fine lines on the chart paper and are properly recording all lateral movements. Advance the heat control 1/4 turn if the recorded lines are not visible. It may also be necessary at this point to remove the scaleplate in order to adjust the nut. If pressure is too light, the styluses will produce wide, blurry lines. If pressure is too heavy, the styluses will tend to drag and not completely respond to lateral movements.

After the required pressure is obtained, tighten the lock screw, advance the heat control for a darker trace, and check operation at the desired chart speed. If individual lateral lines appear to run together at slow chart speeds, increase the speed or reduce the setting of the heat control as required.

TRACKING-Normally, the writing elements will record on their respective chart reference lines; however, if the entire complement of styluses are too far displaced to the right or left, the comb bar, which is used to limit the swing of the electromagnet levers, may be adjusted. In order to make this adjustment, the stylus mounting assembly must be removed from the instrument. (See "DISASSEMBLY" instructions in this section.)

After the stylus assembly is removed, loosen the mounting screws at each end of the comb and pry the bar slightly to the right or left as required. Tighten the comb screws, replace the stylus mounting assembly, and check operation. It may be necessary to perform this procedure more than once if precise alignment is desired.

If only certain styluses fail to track their reference lines, turn off the heating circuit and carefully bend the end of each displaced element until proper alignment is achieved. Should tracking difficulty persist after making the above adjustments, return the instrument to the factory for service.

CAUTION: Avoid direct contact with the heated stylus tips when making adjustments.

RECORD CHARTS

Any portion of a chart may be unwound from the reroll for inspection by pulling straight out on the chart paper. To stop the reroll action and examine the chart at leisure, release the chart suddenly after a desired length has been pulled from the reroll. This will lock the reroll roller in position. To rewind the chart, pull it forward slightly and then let it wind slowly back onto the reroll roller.

Near the end of each record chart a warning notice will be stamped in the center of the paper indicating that only 5 feet of unused chart remain. If a continued record is desired, be sure to watch

for this warning.

To remove the entire rerolled chart, grasp the chart with the left hand, push the reroll latch down on the right side, and pull the chart roll forward and out of the instrument. The chart paper may then be removed from the reroll tube by holding the disk at the gear end of the tube, pulling the plug out of the opposite end, and sliding the chart from the tube. If the chart is too tightly wound, carefully twist the tube counter-clockwise (viewed from gear end) as it is being withdrawn from the chart.

An Esterline Angus "CHART INSPECTOR" is recommended for use when examining completed records. This accessory is a convenient tool for inspecting the record, making notes on the paper, and re-rolling the charts.

Instead of re-rolling the chart on the internal roller in a conventional manner, provisions may be made for feeding used chart out of the bottom of the case. This is accomplished by removing the rubber strip (or section of gasket) at the lower edge of the case cover. The end of the chart hanging out of the case must be weighted to insure proper feeding of the paper. A six ounce clamp-on device is sufficiently heavy for this purpose. Do not pull or jerk on the end of the chart as this may throw it out of time.

CAUTION: To prevent writing elements from sticking to chart paper, always turn off stylus heat 30 seconds before stopping chart drive.

DISASSEMBLY

To remove the stylus mounting assembly from the instrument, loosen the lock screw located in the center of the pressure adjustment nut, and remove this nut (see Fig. 1). Unscrew the knurled mounting studs at each end of the assembly; tip the assembly slightly forward and lift it out of the instrument. When replacing this unit, see that all styluses are straight so that they will properly engage the electromagnet lever arms.

To remove the chart drive from the instrument, it is recommended that the stylus mounting assembly be removed first, as described above. Next, loosen the screw in each corner of the chart-drive mounting plate and pull the entire assembly straight out of the case. The mounting screws are self-retaining and can not be removed completely. All electrical connections to the drive are automatically broken upon removal. For additional information on removing chart drives from twin cases, see page 4 of Instruction Section IS 20.

SUPPLIES AND PARTS

Always keep enough Esterline Angus charts on hand to operate each recorder for a least one

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month. By purchasing in larger quantities, worthwhile savings can be realized.

A record chart must be ordered by assigned number. This number will be found on the right edge of the used chart. Charts * for this particular inkless recorder are currently available in lengths of 81 feet. Total running time will of course depend upon the chart speed selected. If the chart is operated at a speed of 3 inches per hour, it will have a minimum continuous running time of 12-1/3 days. This calculation takes into consideration the loss of an entire 24-hour period so that chart time numbers may always be made to coincide with the correct time of day.

When ordering replacement or spare parts, always give the instrument serial number as well as the individual part numbers. Refer to the assembly drawings in this manual for correct part numbers.

* For additional information on "Tempen" charts, see your E-A representative.

GUARANTEE

Esterline Angus instruments are guaranteed to be free from defects due to faulty materials or workmanship. Any instrument proving defective within one year from date of shipment, and that has not been tampered with or misused, will be re-

paired or replaced free of charge when returned to our factory prepaid. We do not assume responsibility for repairs made outside our factory.

PACKING FOR SHIPMENT

If the instrument is to be returned to the factory, send for shipping instructions and state reason for return. In correspondence about the instrument, always identify its type and serial number. The serial number is stamped on the nameplate inside the meter case and on the chart drive nameplate.

Before shipment, remove exterior mounting hardware; see that the front cover or door is in place, and protect the glass with a small board. If only the chart drive or stylus assembly requires service, remove the unit from the instrument and carefully pack it for shipment.

Wrap and seal the instrument in heavy paper to prevent packing material from sifting into the mechanism. Use a strong packing box—large enough to permit several inches of dry excelsior on all sides of the instrument. Mark "HANDLE WITH CARE" and ship by prepaid express to:

ESTERLINE ANGUS INSTRUMENT CO., INC.
MAIN STREET
SPEEDWAY, INDIANA

INSTRUCTIONS FOR OPERATION AND MAINTENANCE OF ESTERLINE ANGUS Model A620X EVENT RECORDERS

Do not attempt to put the event recorder into service until you have read this instruction book and have studied the connection diagram. Failure to make connections properly may result in unsatisfactory operation or permanent damage to vital parts of the instrument.

The Esterline Angus event recorder is not difficult to service, but the writing system does require regularly-scheduled attention. If this system is periodically cleaned and supplied with fresh ink as described below, the instrument can be expected to give continuous trouble-free service.

UNPACKING

Esterline Angus instruments are carefully packed; carriers are responsible for damage in transit. If the packing case shows damage, make a notation to that effect on your express receipt or freight bill. If it is found that the shipment has been damaged, notify the carrier at once.

Included with each shipment is a packing list showing every item in the shipment. Check off each item as the goods are unpacked, and if any item appears to be missing, go through the packing material carefully before throwing it away. The missing articles may have been overlooked when the packing material was removed.

Each instrument is carefully inspected at the Esterline Angus factory before shipment. New instruments are shipped complete with one record chart and a box of accessories containing one 2 oz. bottle of red ink, an inkwell filler, a pen filler and a pen point cleaner. Two charts and two accessory boxes are furnished with twin instruments.

DESCRIPTION

Event recorders are fully described in Catalog No. 6506. The Data Sheet in the front of this book and the nameplate in the recorder show whether this instrument is Switch or Voltage

Type. Read the portions of the Event Catalog relating to your type of recorder.

OPERATING VOLTAGE

The nameplate in the instrument and the instrument data sheet give the correct operating voltage for the pen units. Although the pen electromagnets are designed to operate on voltages 15% over or under rated voltage, best results will be obtained by keeping the operating voltage as near to the rated value as possible. The speed of response of the pens is such that they will follow as many as ten complete "on-off" cycles per second provided the "on" and "off" times are about equal.

INSTALLING

Front switchboard, wall, and flush instruments should be mounted level in a clean, light place. It has been found that these instruments can be easily read and serviced if installed with the bottom of the case about four feet above the floor. The recorder should be mounted where it will not be subjected to vibration or extremes of temperature. If excessive steam, smoke, moisture, dust or corrosive fumes are present, a protective cabinet should be built around the instrument. Dimensional diagrams should be followed when holes are drilled in preparation for mounting the recorder on a panel.

Series resistances for front switchboard and wall type recorders, when required, are housed in separate boxes and marked with the recorder serial number. All separate resistance boxes must be mounted vertically. Never put a resistance box in a small closed compartment or obstruct the flow of air through it.

Cases of portable, front switchboard, and wall type recorders have latches that can be sealed with standard meter seals or locked with a small padlock. All flush cases have a flush

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latch and built-in lock. Two keys are furnished with each flush recorder. They are in an envelope taped to the top of the case.

SETTING UP FOR USE

This procedure is described in the chart drive instructions, IS 20. Refer to the illustrations on charting the drive and inking the instrument in this section.

CONNECTING

Do not connect the recorder without first referring to the wiring diagrams in this book. Incorrect connections may cause permanent damage to the recorder. All terminals are marked with an identifying number corresponding to the pen number. The marking appears on instrument terminals and on the connection diagram. The Esterline Angus Company does not furnish the switches or contacts for operation of the pens, but operating voltage and electrical data for the recorder will be found on the nameplate inside of the case at the bottom, and on the Data Sheet.

In permanent installations where the pen electromagnets are to operate on DC, the electromagnet coils should be connected to the negative polarity of the power supply; the switches or relay contacts which actuate the electromagnets should be connected to the positive polarity between the power supply and the electromagnets.

FILLING WITH INK

Remove pens #12 and #13 from the inkwell assembly. Use the inkwell filler to add ink through the filler hole in the center of the inkwell cover. Replace pens #12 and #13 making sure that the pen tails engage the flat, finger-like lever arms extending from the electromagnets.

Fill each pen, using the pen filler furnished with the recorder. First lower the scale-plate slightly so all pen points rest on the chart. Compress the bulb of the pen filler, lay the flat side of the rubber tip on the chart under the pen to be filled, raise the pen element and insert the pen point into the hole in the rubber tip. A pair of tweezers will facilitate lifting each pen point off of the

chart and inserting it in the hole in the pen filler. Let the filler draw ink through the pen until you can see ink in the glass tube of the pen filler. Remove the pen from the filler and let the pen rest on the chart. It should write a clean line when pushed back and forth.

DO NOT SPILL INK ON THE RECORDER. Remove any spilled ink immediately with a rag or blotter. If ink is spilled on clothing, wash it out as soon as possible, preferably with warm water and Lava soap. By persistent washing, the spots can usually be removed.

INSPECTING THE RECORD

Any length of chart can be pulled from the reroll for inspection of the record. Pull the chart straight out from the reroll. The reroll has a lock system whereby a sudden release of tension on the unrolled portion of the chart will lock the reroll, removing tension from the chart and allowing it to be examined at leisure. To rewind the chart, first pull it forward slightly from the reroll and then let it wind slowly back onto the reroll roller.

REMOVING THE RECORD CHART

To remove the rerolled chart, grasp the chart with the left hand and push down the reroll latch on the right end. Pull the chart roll forward, out of the instrument.

To remove the chart roll from the reroll, pull the plug out of the right end of the reroll tube by grasping the edge of the right hand disk. The chart can then be pulled off the tube by holding the disk on the gear end. If the chart sticks on the tube, twist the tube in a counter-clockwise direction (as seen from the gear end) as it is being withdrawn from the chart. The chart is then ready for inspection or filing. An Esterline Angus Chart Inspector is a useful device for routine examination of record charts and its purchase is suggested if a number of charts are to be studied.

FEEDING USED CHART OUT OF BOTTOM OF CASE

On all instrument cases, provision may be made for feeding the chart out of the case through a slot in the bottom. To feed the chart in this manner instead of rerolling, remove the rubber strip (or section of gasket) at the lower edge of the case cover. The end of the chart which hangs out of the case should be weighed. A one ounce clamp-on object is sufficiently

heavy for this purpose. Do not pull or jerk on the end of the chart, as this may throw it out of time.

CARE OF THE INKING SYSTEM

Use only Esterline Angus recorder ink. It is made especially to satisfy the exacting requirements of recording instruments. Keep the bottle tightly capped to minimize evaporation and to prevent dirt from getting into the ink. Ink begins to thicken at low temperatures and heat must be provided in the recorder if the temperature stays below 20° F.

The inkwell and pen elements of the event recorder are made so that any pen element requiring attention can be removed and replaced individually, or all the pen elements can be taken out with the inkwell, and both inkwell and pens can be replaced in the recorder in one operation. When removing the inkwell, or setting it in place, hold it by the lifter handles. The inkwell should be pushed to the right as far as it will go when removing or replacing it. When the inkwell is in place, springs will hold it in the correct position. Be sure that the inkwell is held firmly in place and that the tails on the pen elements are all engaged with the flat, finger-like lever arms which project from the electromagnets.

Once per week or every two weeks, the inkwell and the pen elements should be thoroughly cleaned. There are two methods of cleaning; the choice of method is left up to the user. The first method starts with the removal of the inkwell and pen elements from the recorder. Remove the pen elements and pry the cover off the inkwell. Do not damage the pen elements while removing them. Wash out the inkwell, removing all dried ink. Use the rubber pen filler to force water through the pen elements. When both inkwell and pens are clean, replace the cover on the inkwell by pressing it firmly into the inkwell. Position the pen elements in the inkwell cover and reinstall the assembly in the recorder. Fill the inkwell with fresh ink and prime the pens.

The second method enables the user to wash both inkwell and pen elements in the same operation. After removing the inkwell assembly from the recorder, remove one of the end pens from the inkwell cover and, holding other pens in position, pour out remaining ink through the end hole. Replace the end pen and remove the two pens covering the inkwell filler hole. Direct a stream of water into the filler hole of the inkwell. As the inkwell fills, water will be forced through the pen elements.

Continue the operation until the water coming from the pens is clear. Flush out the other two pens removed and replace them in the inkwell. Remove the end pen again and pour out all water through the end hole in the cover.

To remove water from the pen elements, lay the inkwell so that the pen tips rest on an absorbent paper towel or blotter. It will take approximately ten minutes for the water to be drawn out of the pen elements. Any water remaining on the inkwell should be blotted off.

With the pen elements in place, carefully remove the inkwell cover for inspection of the inkwell. The inkwell should be thoroughly clean, but if there is any dried ink still in the inkwell or pen elements, it should be removed. When the inking system is cleaned, it may be filled with ink and reinstalled in the recorder.

It is convenient, and sometimes advisable, to have an extra pen element to use in the instrument if one is dropped or bent in handling.

CAUTION: Always remove pens and inkwell before taking the chart drive out of the recorder, or before subjecting the recorder to any handling which may spill the ink.

PEN ADJUSTMENT -- If the chart drive has been repaired or moved from one instrument to another, adjustment may be required to make the pens write on their respective lines. This adjustment is made by moving the comb stop to right or left. This stop is held in place by the two screw studs that support the inkwell. Remove the inkwell and pens. Loosen the two studs and pry the comb stop to the right or left as required. Tighten the studs and replace the inkwell and pens. If some pens do not write on their respective lines, the pen elements can be bent slightly to align them. A print illustrating this operation will be furnished upon request.

SUPPLIES AND SPARE PARTS

Although the Esterline Angus factory is prepared to ship charts and ink within two or three days after the order is received, the user should forecast his need for these essential items so that his recorder need never be idle for lack of supplies. Keep on hand at all times enough charts and ink to operate each recorder for at least one month. By purchasing in larger quantities, worthwhile savings can be made on these items.

INK -- Esterline Angus ink is supplied in three colors, red, green, and black. All

IS 50 EVENT RECORDERS

colors are furnished in two-ounce and one-pint bottles. Red ink is standard and will be supplied unless otherwise specified.

CHARTS -- Use only E-A charts. We cannot guarantee satisfactory recording unless our charts are used. Record charts should be ordered by number. This number will be found on the right-hand edge of the used chart.

SPARE PARTS -- When ordering parts, always give the instrument serial number as well as individual parts numbers. See the Movement Assembly print in this book for electromagnet parts numbers and assembly drawings. Refer to the chart-drive print for parts data on the chart drive.

GUARANTEE

Esterline Angus instruments are guaranteed to be free from defects due to faulty materials or workmanship. Any instrument proving defective within one year from date of shipment will be repaired or replaced free of charge when returned to our factory, shipping costs prepaid, provided the instrument has not been tampered with or misused. We do not assume responsibility for repairs made outside our factory.

PACKING FOR SHIPMENT

If the recorder is to be returned to the factory for repairs, send a purchase order and ask for shipping instructions and at the same time state clearly the reason for its return. If time does not permit this normal handling, the following procedure may be used: Wash out the inkwell and pen elements. After replacing the emptied inkwell and pen elements, raise the pens by means of the pen lifter wire, and tie the wire to the scaleplate. Next, tie the scaleplate down to the chart drive. This prevents the pens from moving during shipment. Remove all studs from switchboard instruments. Protect the glass front with a small board and wrap the recorder in heavy paper to prevent excelsior from sifting into the mechanism.

Use a strong substantial packing box, large enough to permit several inches of dry excelsior on all sides of the recorder. Ship by prepaid express

and mark:

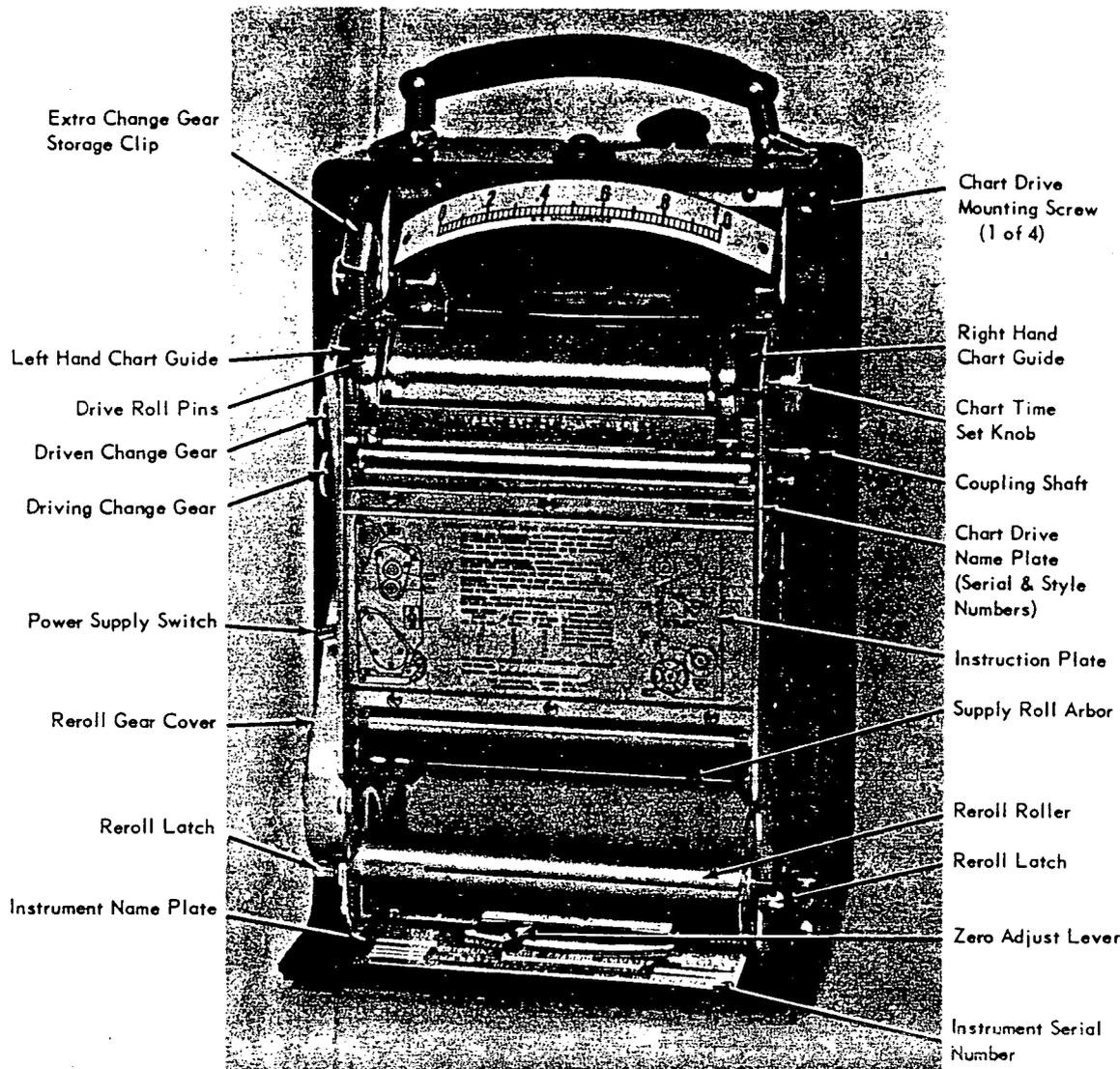
"ELECTRICAL INSTRUMENT, HANDLE CAREFULLY"

INSTRUCTIONS

FOR THE OPERATION AND CARE OF

PHANTOM CHART DRIVES

WITH ELECTRIC REROLL, STYLES 91-P (TYPE 6EX), 92-P (TYPE 6EC) AND 92-PC (TYPE 6ECC)
93-P (TYPE 6EX), 94-P (TYPE 6EC) AND 94-PC (TYPE 6ECC)



The phantom chart drive is propelled by a source of power external to the drive. This external source is commonly a self-powered chart drive installed in one side of a twin recorder; the phantom drive is installed in the other side and is directly coupled to the powered drive.

All phantom chart drives have their own power for rerolling the used record chart. In the series 90

styles, this power is provided by an induction motor which winds a storage spring. The spring transmits the power to the reroll. The rated frequency and voltage for the motor are shown on the chart drive nameplate and in the terminal markings on the back of the recorder. Operating limits are $\pm 10\%$ of rated voltage; frequency need not be too closely regulated. Complete electrical data is provided in the table on the following page.

IS 20D - PHANTOM CHART DRIVES WITH ELECTRIC REROLL

Reroll Motor Data

Rating	VA	Watts	Amperes
120 Volts, 60 Cycles	15	6	0.13
240 Volts, 60 Cycles	15	6	0.07
120 Volts, 50 Cycles	15	6	0.13
240 Volts, 50 Cycles	15	6	0.07
120 Volts, 25 Cycles	9	4	0.08
240 Volts, 25 Cycles	9	4	0.04

Unwinding the Reroll Spring - The reroll gear train can be replaced as a unit or the reroll storage spring assembly only can be replaced. In either case, be sure to let down the reroll spring before attempting disassembly. With power off, hold the chart reroll roller in the hand and let it revolve slowly, until it does not turn. Damage may result if disassembly is attempted with energy stored in the spring.

Chart Travel vs Coupling Shaft Rotation

No.	Type	Chart Travel	Recommendations
91-P 93-P	Electric reroll, without clutches	Phantom drives contain no power unit. One revolution of coupling shaft propels ¾, 1½, 3, 6 or 12 inches of paper under pen point with corresponding gears in place. Furnished complete with coupling.	Use in twin meter equipped with synchronous or motor-wound spring chart drive. Also where chart motion is proportional to some quantity other than time, AC is available and driving source exerts restraining torque when chart is not in motion.
92-P 94-P	Electric reroll, with drag clutch		Use where chart motion is proportional to some quantity other than time, AC is available and driving source does not exert restraining force when chart is not in motion.
92-PC 94-PC	Electric reroll, with drag and back-up clutches		Use where chart motion is proportional to some quantity other than time, AC is available, driving source exerts no restraining force and can reverse rotation. Coupling must be made on right side.

Lubrication - Use E-A 40 Oil to lubricate all bearings. This oil is available from the Esterline Angus Company in 1 oz. bottles and is for use on chart drives normally operating at temperatures of 20° to 100° F. Temperatures outside of this

Coupling to an External Shaft or Motor - When the application of an E-A instrument or a phantom chart drive requires that it be driven from some external shaft or motor instead of a powered chart drive, the driving member should be attached to the coupling shaft by means of a flexible coupling. The ends of the coupling shaft are fitted with a ball and cross pin which engages the slotted coupling head. The Esterline Angus Company can furnish a variety of couplings or simply a coupling head so the user can make up his own coupling shaft. The uses which these drives will accommodate are listed under "recommendations" in the accompanying table on this page.

Reroll Capacity With Power Off - When the power to the reroll motor of these drives fails, the reroll storage spring has the capacity to wind up 18" of used chart.

range require special lubrication. Consult the factory. Do not oil ratchets and pawls; they operate better if dry. In oiling, it is well to remember that too much lubrication is almost as bad as too little. **Do Not Over Oil**

ESTERLINE ANGUS INSTRUMENT COMPANY, INC.

INDIANAPOLIS 6, INDIANA

Electromagnet s

VOLTAGE TYPE—Common or Separate Return

Rated Voltage*	Coil Style	Milli-amperes***	Watts per Circuit	Ohms per Coil (DC) ± 10%	Ohms in Series with Coil
Direct Current**					
2 Volts	N	570	1.1	3.5	None
4 Volts	K	286	1.1	14	None
6 Volts	J	231	1.4	26	None
8 Volts	G	131	1.0	61	None
10 Volts	F	99	1.0	101	None
12 Volts	F	119	1.4	101	None
14 Volts	E	90	1.3	156	None
16 Volts	D	67	1.1	238	None
18 Volts	D	76	1.4	238	None
24 Volts	C	65	1.6	372	None
28 Volts	B	42	1.2	666	None
32 Volts	A	29	0.9	1,092	None
48 Volts	T	29	1.4	1,650	None
125 Volts	T	31	3.5	1,650	3,000
250 Volts	T	26	6.5	1,650	8,000
50-60 Cycles AC					
6 Volts	N	447	1.6	3.5	None
12 Volts	K	233	1.7	14	None
24 Volts	G	103	1.5	61	None
120 Volts	T	20	1.5	1,650	None
240 Volts	T	21	4.5	1,650	7,000
SWITCH TYPE—Common Return Only					
50-60 Cycles AC		Electrical characteristics of individual coils are the same as listed for voltage type, 24 volt, 50-60 cycle, style G coil, in above table.			
120 Volts	G				
240 Volts	G				

*All electromagnets are guaranteed to operate at voltages 15% above or below rating.

**In permanent installations, it is preferable for the recorder coils to be connected to the negative polarity of the power supply, the switches or relay contacts to be in the positive lead between the power supply and the recorder.

***Recorders with high input impedance can be ordered for DC circuits. The input rating can be as low as 12 V DC or as high as 55 V DC. Signal current at rated voltage will be approximately 1 MA. These high impedance recorders are especially applicable to the study of telephone circuits which cannot carry high instrument burdens.

Response Speed—For pens to make full deflection, circuit must be closed or open for at least 15 milliseconds. On repetitive signals, a maximum of 10 "on-off" cycles per second with equal "on" and "off" periods can be accommodated.

Stylus Heating Circuit—On inkless recorders an independent circuit is provided for stylus heating. This circuit can be rated for operation from 120 or 240 volts, 50-60 cycles, 40 VA. A 400 cycle rating may be obtained on special order. A rheostat is provided to adjust stylus heat thereby widening or narrowing the recorded line. Stylus heat must be on 5 seconds before record is made.

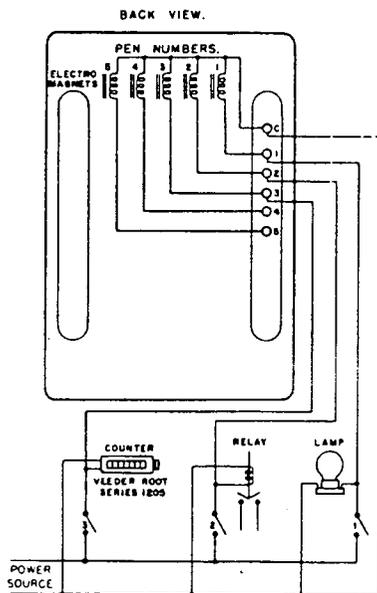
Leads—None furnished. Leads used with switch-type recorder may have resistance up to 35 ohms per circuit (approximately 5,000 feet of No. 18 wire, 2,500 feet one way).

Binding Posts—Not furnished. Screw connections are made to terminal strips.

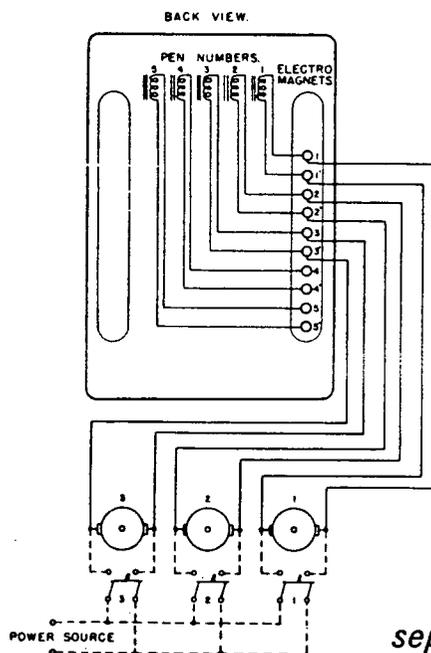
Dielectric Test—1,500 volts, 60 cycles, for one minute.

Intermediate and Special Ratings—Voltage-type recorders can be furnished for any voltage from 2 to 250 volts DC, and from 6 to 240 volts AC, 50-60 cycles. For series operation, such as in the secondary of a current transformer, special low impedance coils should be used. Consult factory, giving details of application.

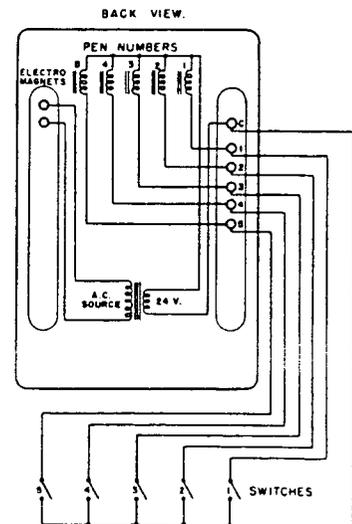
Recorder Types



common
return

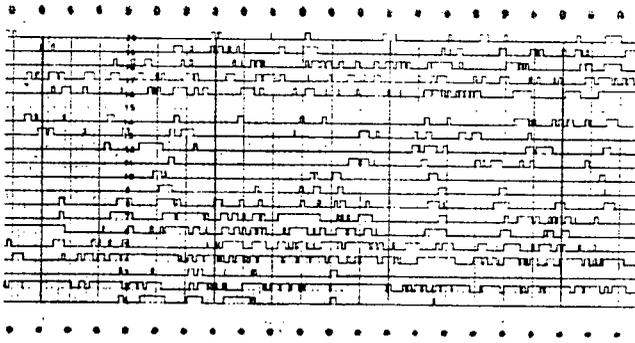
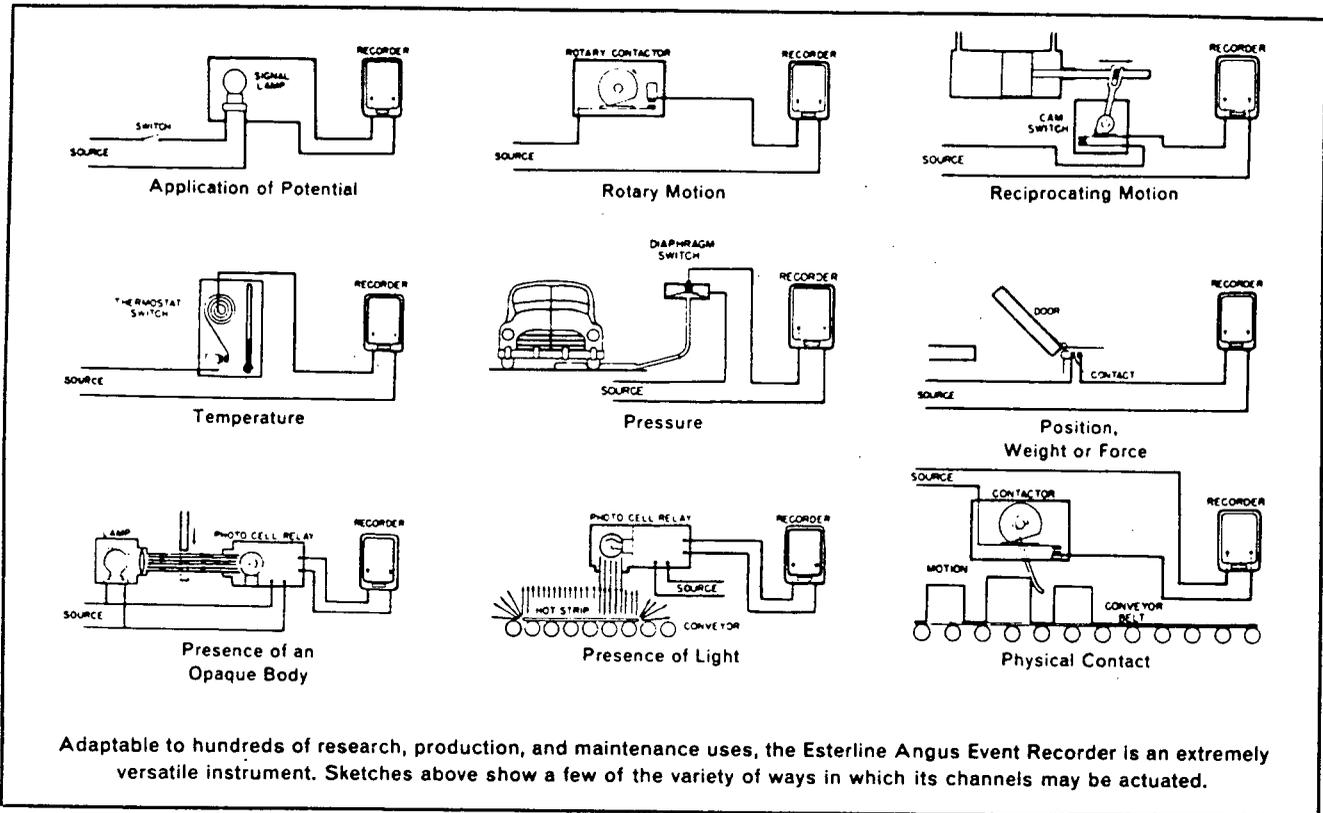


separate
circuits



switch
type

Recorders Actuation

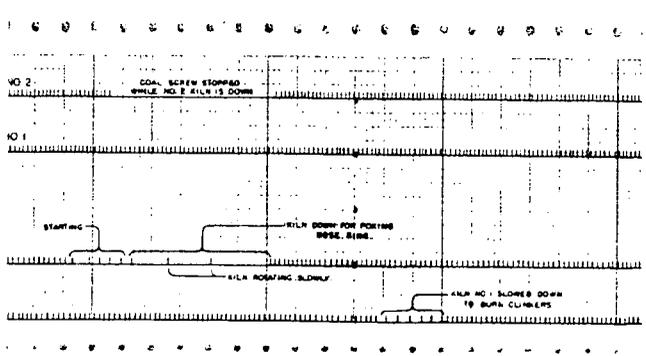
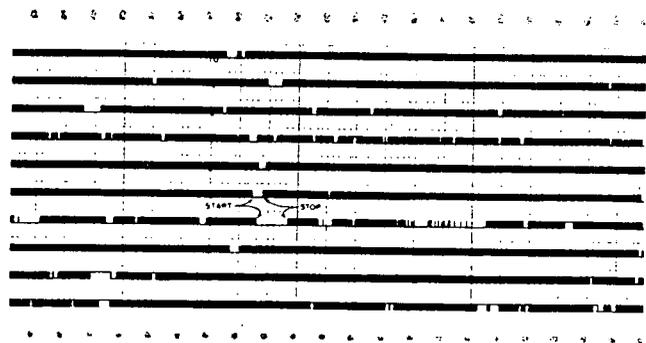


Rectangular Record—A majority of Event Recorder charts look like the one above. The open rectangles reveal the times during which electromagnets were energized; that is, the times during which events occurred. When the events were no longer taking place, the electromagnets were de-energized and the writing elements returned to their base lines. Telephone studies, circuit breaker operation, elevator movements and chemical process supervising often produce records such as these.

Band Record—This type of record (above right) is produced by rapidly opening and closing contactors, usually those connected to reciprocating or rotating machines. Chart speed and method of actuation are chosen so the writing elements produce overlapping marks. The bold band contrasts sharply with the single straight line drawn when the machines were not running.

Impulse Record—When the writing element is energized only momentarily, its return stroke falls on almost the same place as the active stroke. This produces a single cross-wise mark (right). This type of record is valuable for counting objects on a conveyor, vehicles on a highway or billets coming from a furnace.

Combination Record (not illustrated)—Any combination of the three types of records can be obtained in a single recorder simply by making proper selection of actuating devices.



DEFENSE



ESTERLINE ANGUS

INSTRUMENT DATA SHEET-CUSTOMIZED SPECIFICATIONS

1-B.3.
1-REP.
NONE.

DATA SHEET for Model A 620 T EVENT RECORDER WITH THERPEN

Sold to SOUTHERN CALIFORNIA EDISON CO., OXNARD, CAL.

Pur. Order No. OB-3269-6 I/O No. _____ SO No. 116923A Date 4/29/70

For use by STATE-ORMOND BEACH GEN. ST., VENTURA COUNTY, CAL.

CASE VIT-TN FLUSH GRID For _____ panel. Lamp 120V-50HZ-197071

Other Case Features _____

Number of Channels TWENTY NP No. 8920-0

Electromagnet Assemblies 120-TPT-3

Scale 21 THRU 40 CHANNELS Sc. No. 8812-R4 CHANT No. 37040-A

Electrical Rating: Volts 125 Cycles DC

Type: VOLTAGE TYPE-COMMON RETURN

Int. Transformer: Pri. Volts _____ Sec. Volts _____ Cycles _____

Mult. Box ATTACHED No. 17090 Volts 125 DC Mult. NP No. 17090

Mult. Box SEPARATE No. S-20016 Volts DIODE HTG. BOX Mult. NP No. 2717

Chan. Numbers 21 THRU 40 Rating 125V-DC Av. Coil Resistance _____ Series Res. 3000-3.2

Chan. Numbers _____ Rating _____ Av. Coil Resistance _____ Series Res. _____

Chan. Numbers _____ Rating _____ Av. Coil Resistance _____ Series Res. _____

Chan. Numbers _____ Rating _____ Av. Coil Resistance _____ Series Res. _____

DIODES CONNECTED INTERNALLY SUCH THAT CURRENT FLOW THRU EACH IS TO A COMMON.

ID No. D-1690, 17469 Connection Diagrams S-10501

SPECIAL FEATURES: THERMAL SUPPLY 120V-60HZ.

CHART DRIVE: Type No. 4R-MINUTE FEED SYNCHRONOUS WITH SPEC. RESET EX. MOTOR DR.

Feeds: In. per Hr. 3-1/2-3-6-12 in. per Min. 3-1/2-3-6-12 In. per Sec. 3-1/2-3

FS No. 190-MT MOD. G Internal Motor: Volts 120 Cycles 60

Int. Trip Coil: No. _____ Volts _____ Cycles _____ Ohms _____ Series Ohms _____

External Motor: FS No. 22 Volts 120 Cycles 60 No. 20007B Rho. _____

Other Chart Drive Features N.O. 20040 COPPER PLATE MODIFIED PER D.W.G. S-20017

FOR ADDITION OF G-C ELECTRO-CRAFT #33-296-R BINDING POST

BINDING POST CONNECTED INTERNALLY TO "C" ON MICROSWITCH.

DIELECTRIC TESTS (AC Volts): Coil Circuits 1500 Internal Motor 1500 Ext. Motor 900

Lamp Circuit 1500 Trip Coils _____ Aux. Transf. _____

THERMAL ELEMENT INPUT TERMINALS TO CASE 1500 VOLTS-60HZ.

AUXILIARY APPARATUS FURNISHED BY ESTERLINE ANGUS

Control Trans. _____ Mfr. _____ Model _____ Volts: Pri. _____ Sec. _____ Cycles _____

Elec. Counter _____ Mfr. _____ Model _____ Mtg. _____ Volts _____ Cycles _____

DS by 4/ _____ Assem. by _____

Inspections: Ist. _____ Final _____ Date _____

Life and Sequence Test _____ Date _____

Meter card entry M-202, #9247

SERIAL No. 181012-R
Mention this number in correspondence.

BEFORE



ESTERLINE ANGUS

INSTRUMENT DATA SHEET-CUSTOMIZED SPECIFICATIONS

1-B.C.
1-REP.
1015.

DATA SHEET for Model A 620 T EVENT RECORDER WITH TEMPER
 Sold to SOUTHERN CALIFORNIA Edison Co; OXNARD, CAL.
 Pur. Order No. OB-3269-6 M.O No. _____ SO No. 116923A Date 4/29/70
 For use by SAME-ORMOND BEACH GEN. STATION, VENTURA COUNTY, CAL.
 CASE NO. WT-TW FLUSH GRAY For _____ panel, Lamp 120V-60/12-17707-1
 Other Case Features _____
 Number of Channels TWENTY NP No. 8920-A
 Electromagnet Assemblies 120-TPT-3
 Scale 1 THRU 20 CHANNELS Sc. No. 8812-R3 CHART No. 37020-A
 Electrical Rating: Volts 125 Cycles DC
 Type: VOLTAGE TYPE - COMMON RETURN

Int. Transformer: Pri. Volts _____ Sec. Volts _____ Cycles _____
 Mult. Box ATTACHED No. 17090 Volts 125 DC Mult. NP No. 17095
 Mult. Box SEPARATE No. 5-20216 Volts DIODE MFG. BOX Mult. NP No. 2717
 Chan. Numbers 1 THRU 20 Rating 125V-DC Av. Coil Resistance _____ Series Res. 3000-Ω B.D.
 Chan. Numbers _____ Rating _____ Av. Coil Resistance _____ Series Res. _____
 Chan. Numbers _____ Rating _____ Av. Coil Resistance _____ Series Res. _____
 Chan. Numbers _____ Rating _____ Av. Coil Resistance _____ Series Res. _____

6923A

DIODES CONNECTED INTERNALLY SUCH THAT CURRENT FLOW THRU EACH IS TO A COMMON.

ID No. D-1620, 17437 Connection Diagrams S-10501
 SPECIAL FEATURES: THERMAL SUPPLY 120V-60 HZ.

CHART DRIVE: Type No. 6EX-ELECTRIC PHANTOM
 Feeds: In. per Hr. 3/4-1/2-3-6-12 In. per Min. 3/4-1/2-3-6-12 In. per Sec. 3/4-1/2-3
 FS No. 191-PDT Internal Motor: Volts 120 Cycles 60
 Int. Trip Coil: No. _____ Volts _____ Cycles _____ Ohms _____ Series Ohms _____
 External Motor: FS No. _____ Volts _____ Cycles _____ No. _____ Rheo. _____
 Other Chart Drive Features 12674-B COUPLING

DIELECTRIC TESTS (AC Volts): Coil Circuits 1500 Internal Motor 1500 Ext. Motor _____
 Lamp Circuit 1500 Trip Coils _____ Aux. Transf. _____
THERMAL ELEMENT INPUT TERMINALS TO CASE 1500 VOLTS-60HZ

AUXILIARY APPARATUS FURNISHED BY ESTERLINE ANGUS

Control Trans. _____ Mfr. _____ Model _____ Volts: Pri. _____ Sec. _____ Cycles _____
 Elec. Counter _____ Mfr. _____ Model _____ Mtg. _____ Volts _____ Cycles _____

DS by 4/1 Assembled by DeCa Assem. by _____
 Inspections: Ist _____ Final _____ Date _____
 Life and Sequence Test _____ Date _____
 Meter card entry M-202, #7247

172

SERIAL No. 181011-1
 Mention this number in correspondence.

