THE OSCILLOGRAPHER

VOL. 16, No. 1

DOUBLE CHECKING THE HEART

see page 2

"Who and Why"

Du Mont Selling Agents

After this article went to press, Mr. Robert A. Waters retired from his selling agency activities to devote more time to his manufacturing business. Because he did a good job for us, we felt we would like to have his story appear anyway — as a thank you. The New England territory is now covered by our own Du Mont Branch Sales Office in Newton, Mass.

When we wrote to Bob asking for a sketch of his life so that this column could be written, he sent a letter that depicts Bob far better than any words we could write. So, we print it as he wrote it.

"In reply to yours of October 28th, I am not bashful and I am very happy to give you some information about your 'peddler' in New England. I am also happy to furnish you with a picture showing the advanced state of my balding head.

"For some unknown reason, I was born in New York City on December 1, 1917, and very quickly moved from New York to Bethlehem, Pennsylvania, where I lived for about six months, ending up in Montclair, New Jersey. There I spent a very eventful childhood tormenting both the teachers in the Montclair Public School and all of my neighbors with the noise of many jalopies and a self-excited oscillator in my ham rig on 80

(*Continued on Page* 10)

ROBERT A. WATERS

On the Cover

Our front cover shows a Du Mont Type 304-H Oscillograph serving surgeons during a heart operation at the National Heart Institute. The instrument is monitoring two separate body events of the patient shown in the foreground. The screen is displaying the output of an electrocardiograph (top pattern) and the arterial pulse (bottom pattern).

THE OSCILLOGRAPHER

A publication devoted exclusively to the cathode-ray oscillograph providing the latest information on developments in equipment, applications, and techniques. Permission for reprinting any material contained herein may be obtained by writing to the Editor at address below.

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A Special Announcement From the Editor

With this issue we put to rest "The Oscillographer". Since March 1937, "The Oscillographer" has enjoyed an enviable reputation as one of the better technical external house organs written and sponsored by a manufacturer. Many of the technical articles appearing in its past issues, contributions of authors from all over the globe, have been adapted as standards of reference in the electronic and related industries.

Although "The Oscillographer" has earned its enviable niche among technical journals, the electronic industry has undergone a tremendous change since the journal was started — and so must everything concerned with the industry. To keep pace with the ever advancing technological developments and philosophies of the industry, Du Mont — along with its new program of diversified instrumentation — has decided to change the name and appearance of its external house organ.

Beginning in February 1957, the Du Mont Technical Products Division will publish "Du Mont Instrument Journal". This new quarterly house organ, henceforth, will have a two color cover and be slightly altered in format for attractiveness and ease in reading. The caliber of the articles will be in at least as high a plane as those appearing in "The Oscillographer", with feature articles written by experts in all facets of the electronic instrument industry.

Our mailing list for "Du Mont Instrument Journal" will be the same as that for "The Oscillographer" unless we are notified to the contrary by you, our 35,000 readers. We will appreciate your comments and suggestions on the new journal after you receive your first issue in February.

Strain Gage Control — A Boon To Oscillography

by: Harold E. Beaver, E.E.

Through use of electro-mechanical transducers, the oscillograph has found many varied applications in non-electrical fields. The Strain Gage Control provides convenient coupling and control of such transducers for use with a scope, providing a sensitive detecting and measuring system for mechanical changes.

Applications for the cathode-ray oscillograph in the mechanical and other non-electronic fields are numerous. In the field of dynamic measurements, for example, an extensive realm of new applications has been opened with the development of many new electro-mechanical transducers. These transducers accomplish the necessary conversion of mechanical energy to electrical energy in a quantity ideal for detection and measurement on an oscillograph.

Fig. 1. The Du Mont Type 335 Strain Gage Control. A self-powered instrument containing the control and calibrating circuitry for resistance-type strain gages. Gage factors from 1.5 to 4 can be handled easily and conveniently.

The introduction of highly sensitive oscillographs has made it possible to use many existing transducers without preamplification.[1] Adequate coupling of transducers to the oscillograph, formerly a problem, has been solved by the development of such auxiliary instruments as the Du Mont Type 335 Strain Gage Control (see Figure 1).

The Du Mont Strain Gage Control makes possible the convenient coupling and control of resistance type transducers, such as strain gages, in use with oscillographs for detection and measurement of minute or large mechanical changes. It provides circuitry for control of single strain gages or multiple set-ups.

Strain Gages, General Theory

Strain gages are generally made of a cupro-nickel alloy wire or an iso-elastic wire. Although there are other satisfactory materials, these two are considered by many to be superior. Cupro-nickel and iso-elastic wires change resistance when the wire is stressed. This change is caused by two factors. First, the elongation of the wire causes a reduction in cross-sectional areal. Second, a definite change in the resistivity of the material occurs. These two factors combine to give an overall change

Fig. 2. The Du Mont Type 324 Oscillograph. This instrument offers sensitivity of 4 millivolts full scale in the Y-axis. This sensitivity makes the Type 324 the ideal indicator for use in strain analysis. The Type 333, sister instrument of the 324, offers effectively two 324s in one cabinet with a dual-beam crt.

in resistance which is proportional to stress. The gage factor "K" equals $\frac{\triangle Rg}{Rg \triangle S.}$ Fig. 3 is a schematic for the use of a single gage. In this circuit, $I = \frac{Ei}{Rg+R}$ and $Eg = IRg$; thus, $Eg = \frac{EiRg}{Rg+R.}$ It can be shown that $\triangle Eg = \frac{RgR}{Rg+R} IK \triangle S$, where K is the gage factor and S is strain $\left\{\frac{\triangle L}{L}\right\}$.

This circuit is suitable for simple dynamic analysis.[2] Static analysis[3] is generally not convenient with this circuit because of the voltage division between the series resistance and the gage. This leaves a considerable d-c voltage masking the changing signal in direct-coupled indicators.

Fig. 4 shows the method of connection of two gages using additional resistors, R_1, R_2 and a balancing potentiometer. Through adjustment of the balancing pot, R_1 and R_2 are made to balance R_a and R_b, resulting in a bridge output of zero. If, however, gage A is stressed, the value of R_a changes and the output voltage of the bridge is:

$$Eo = \frac{RaRb}{Ra+Rb} IK \triangle S.$$

Of course, if gage B were stressed in the same manner as gage A, the resistance of each changes equally and the bridge would stay in balance. Consequently, E_0 would be zero. For this reason, gage B should be placed so that it either is not stressed, or stressed in such a way so that it is equal and opposite to gage A. Fig. 5 shows two methods of arranging the gages. In Fig. 5a, gage B adds to gage A so that the bridge output is twice that if only one gage were stressed.

If it is possible to replace resistors R_1 and R_2 of Fig. 4 with gages, and all gages are active—that is, gages on opposite sides of the bridge are stressed equal and opposite the re-

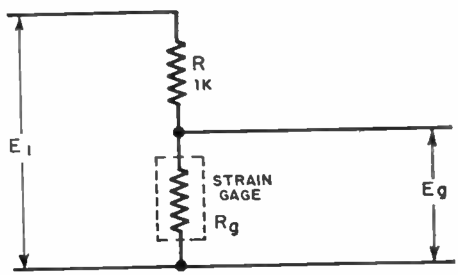


Fig. 3. The schematic of the gage circuit when only one gage is used. Although adequate for some dynamic analysis, static measurements usually cannot be made with only one gage. The impressed dc on the gage masks the output when using direct-coupled instruments.

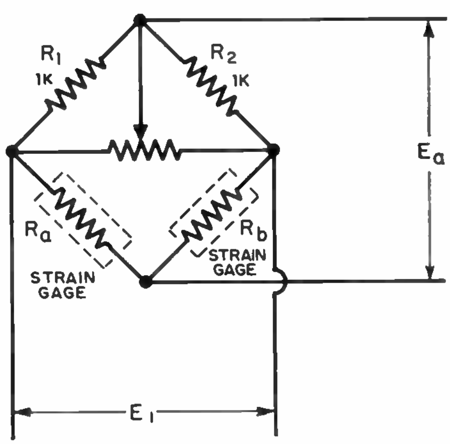


Fig. 4. The method used to connect two or four gages. The circuitry is contained in the Type 335 for powering and calibrating such a circuit.

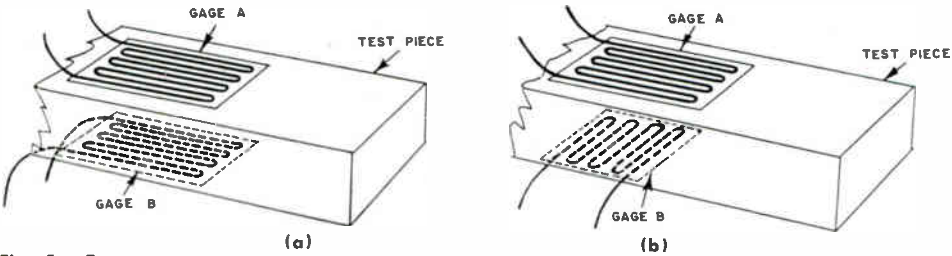


Fig. 5. Two methods of arranging the gages. In (a), above, the output of the two gages adds together for greater sensitivity. In (b), one gage is positioned so that it will not be stressed and is used for temperature compensation when measurements are taken over a period of time.

maining gages—the bridge output will be four times that of a single gage.

Frequently, during static measurements taken over a long period of time, the change in specimen or ambient temperature may introduce error into the measurements because of the expansion coefficient of the strain gage wire. Using the circuit of Fig. 4, if gage B is placed on the test specimen near gage A but in a position such that it won't be stressed, both gages will change equally with temperature, but only gage A will change with stress (see Fig. 5b). Similarly, in four-gage bridges, two of the gages can be placed in compensating positions and the remaining two can serve as active gages.

Since $K = \frac{Rg \triangle S}{\triangle Rg}$, and it follows that $\triangle Rg = K \triangle S Rg$ the change in resistance for any particular gage can be determined. If, instead of stressing the gage, a precision resistance is shunted across the gage, it then appears that the gage were carefully stressed. By calculating the effective change in resistance caused by, say, a one-megohm resistance, and using this value as $\triangle Rg$ to recalculate an equivalent $\triangle S$ for various gage factors (K), it is possible to plot a calibration curve—or series of curves—showing the strain in micro-inches per inch for various gage resistance and gage factors. Since this chart is based on a one-megohm resistor, a resistor of a multiple of one megohm merely provides a multiplier to the chart reading.

Description of Du Mont Type 335 Strain Gage Control

The Du Mont Type 335 provides supply voltages and the circuitry to operate a combination of one, two or four gages as desired. In addition, a selection of 10 precision resistors are included for calibration. These resistors range from 10K to 10 megohms, providing chart reading multipliers of 0.1 to 100. Facilities for using an external resistance for calibrating is also included. The chart supplied is shown in Figure 6.

For operator convenience, the Type 335 Strain Gage Control is a battery-powered device. Since the output of strain gages is proportionate to the current through them, considerable gains in sensitivity are achieved by using a supply voltage which will increase the current up to near the safe limit of the gage. Baldwin Type SR-4 gages handle 25 ma normally and will handle 50 ma if used on sur-

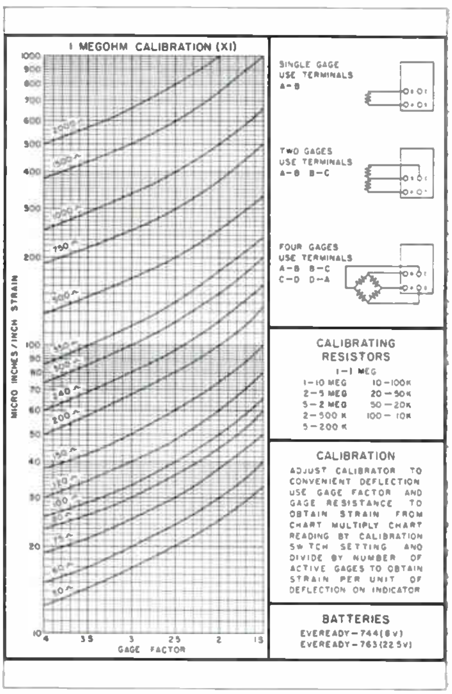


Fig. 6. The calibration chart as supplied with the Type 335. Since the chart is based on a resistance of 1 megohm, multipliers are easily applied for measurements other than those on this chart.

faces where cooling of the gage is accomplished.

The battery supply of the Type 335 is a combination of two groups. Four 6-volt and four 22.5-volt batteries are arranged through a battery voltage switch so that various voltages are obtained through series and parallel connections. For example, the battery voltage switch arranges the selected group in series, series-parallel, three in series or four in series. In this way, eight voltage steps from 6 to 90 volts are selected. A panel meter indicates battery condition while the batteries are in use.

Meter multipliers are automatically switched into the circuit so that the meter reads center scale or beyond on all ranges when the batteries are in new condition. Provision for connection of external battery supplies is included. When switched to external power supply, the meter indicates the voltage supplied by the external supply. Full scale is 100 volts.

The Type 335 permits use of any strain gage of any resistance and gage factor (change in resistance to change in length) between 1.5 and 4. When used with single gages, the circuit shown in Fig. 3 is employed and the resistance R is 1000 ohms. When two gages are connected, as shown in Fig. 4, resistors R_1 and R_2 are 1000 ohms each and are automatically switched into the circuit. The balance control is a 10-turn 50,000 ohm Helipot.

When four gages are used in the bridge circuit, they should be 120, 500, 1000 or 2000 ohm types. Appropriate resistances are switched into the circuit at the ends of the balance potentiometer to increase its resistance in proportion to the increase of gage resistance. This method serves to maintain the resolution of the potentiometer in all ranges.

The Type 335, in combination with a cathode-ray oscillograph such as the Du Mont Type 324 or 333, is a very sensitive unit. Other scopes may be used as indicators, but the use of some preamplification may be necessary. This is particularly true if the gages used are of the low resistance variety, or the voltage supply is low, or the strain being measured is very small.

Notes:

1. Du Mont Type 324 and 333 Cathode-ray Oscillographs are examples of such sensitive instruments.
2. *Dynamic Analysis*: analysis of active repetitive strains, such as a pumping action or vibration.
3. *Static Analysis*: analysis of a strain occuring in one direction, requiring some sort of adjustment before repeating itself. Example, the bending of a beam under constantly applied load.

Bibliography

"Baldwin SR-4 Strain Gage for Stress Analysis". Bulletin, 279-A, Baldwin Lima Hamilton Corporation.

Hathaway, C. M. *The Measurement of Strain.* Denver, Colorado: Hathaway Instrument Company.

Components and Accessories Catalog

Du Mont has a varied line of components and accessories applicable to a multitude of electronic instruments and devices. These are described in a catalog which can be obtained by writing to Du Mont, attention of the advertising department. Specifications and pictures of the components provide complete information for ordering right from the catalog.

Following is a partial list of the catalog contents:

- **Knobs —**
  A number of attractive and functional knobs for instrumentation. They are available in any quantity and in a variety of sizes.
- **Pulse Transformers —**
  A line of miniature and sub-miniature pulse transformers to satisfy a wide range of requirements.
- **Wide-Band Toroids —**
  Low-level wide-band transformers for the most critical requirements.
- **Test Probes —**
  A complete selection of probes for every purpose including attenuator, cathode-follower and detector types.
- **Magnetic Shields —**
  Among the great variety of shields available are multi-layer, multi-section, and single-section shields for radar indicators, and many others.

Plus —

- **Base Sockets, Clamps and Connectors**
- **Photographic Equipment**
- **Movable Tables**
- **Rack Mounting Adapters**
- **Cables**
- **Binding Post Adapters**
- **Color Filters**
- **Viewing Hoods**

— and other miscellaneous items and bits of information. All listed in categories for your ease in identification and order placement.

SELLING AGENTS OF ALLEN B. INSTRUMENT SALES DEPARTM

New Sales Agent Appointments

Emil G. Nichols. Product Manager, has announced the appointment of five domestic sales representatives. They are:

Rush S. Drake Associates, Seattle, Washington.

Engineering Associates, Inc., Kansas City and St. Louis, Missouri.

John A. Green Co., Dallas and Houston, Texas and Tulsa, Oklahoma.

Ridgway Engineering Associates, Chicago, Illinois and Indianapolis, Indiana.

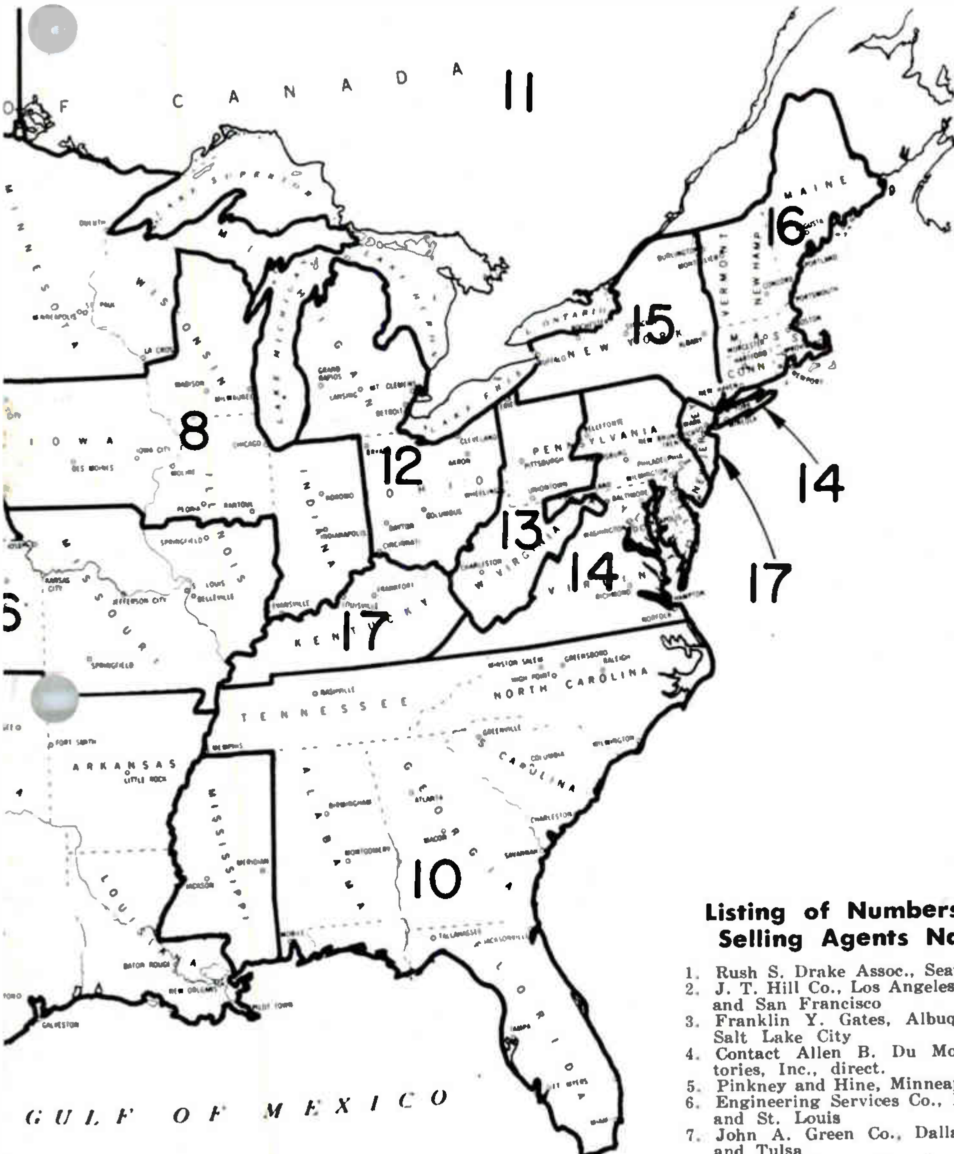
In addition, following the resignation of Robert A. Waters, Inc. as Du Mont's New England Sales Representative, (see "Who and Why"), a Du Mont Branch Sales Office was established in Newton, Massachusetts to cover that vacated territory.

J. R. Dannemiller Associates, Cleveland and Dayton, Ohio and Detroit, Michigan.

For the territories served by these new selling Agents, please consult the map.

The staff of the OSCILLOGRAPHER extend to these new Du Mont Selling Agents the best of wishes for great success.

DU MONT LABORATORIES, INC.
ENT, CLIFTON, N. J., U.S.A.



Listing of Numbers and Selling Agents Names

1. Rush S. Drake Assoc., Seattle
2. J. T. Hill Co., Los Angeles, San Diego and San Francisco
3. Franklin Y. Gates, Albuquerque and Salt Lake City
4. Contact Allen B. Du Mont Laboratories, Inc., direct.
5. Pinkney and Hine, Minneapolis
6. Engineering Services Co., Kansas City and St. Louis
7. John A. Green Co., Dallas, Houston and Tulsa
8. Ridgway Engineering Assoc., Chicago and Indianapolis
10. Murphy & Cota, Atlanta, Miami and Winston Salem
11. Bayly Engineering Ltd., Toronto
12. J. R. Dannemiller Assoc., Cleveland, Dayton and Detroit
13. H. E. Ransford Co., Pittsburgh
14. Gawler-Knoop Co., New York, Phila., and Washington, D. C.
15. Edward A. Ossmann & Assoc., Albany Buffalo, Rochester and Syracuse
16. Allen B. Du Mont Labs., Inc. (Boston Office) Newton, Mass.
17. Factory Sales Office Kentucky and Mississippi Contact Allen B. Du Mont Laboratories, Inc., direct.

"Who and Why"

(continued from page 2)

meter cw, and am actively operating under call letters W1PRI.

"Somehow or other, I got through high school in Montclair in 1935 and persuaded New York University to admit me as a student studying physics and mathematics, originally intending to become a patent attorney. After college, I started my own business manufacturing electric arc welding equipment in New York City, but between the sheriff and priorities during pre-World War II days, I finally gave up the ghost and went to work for Western Electric at Kearny, New Jersey, where I started out as an inspector of telephone parts and ended up as an electrical and mechanical engineer working on aircraft communications equipment, hearing aids, quartz crystals, semi-conductors and other various and sundry products.

"The week after V-J Day, I left Western Electric to join Du Mont as a sales engineer in the Cathode-ray Tube Sales Department. I succeeded in fooling Du Mont for just about a year and beat them to the punch by quitting in August 1946 to move to New England as Du Mont's New England Selling Agent.

"My first office in New England was right across from City Hall in Waltham and, incidentally, directly above the local pub. Within six months, the business had progressed to the point where we needed space to set up an instrument service laboratory and demonstration room at which time we moved to 4 Gordon Street, Waltham. In 1948 we incorporated the business as Robert A. Waters, Incorporated, and now have a total of 16 people operating from our office in Wayland. We are now in our new facility in Wayland, Massachusetts, a suburb of both Waltham and Boston.

"In order to get around our territory, we acquired an airplane back in 1951 and find this to be a very favorable and pleasureable adjunct to our business. The plane, a Beechcraft Bonanza, just happens to have the number 6900 which, by sheer coincidence was the telephone number of the Waltham office and which, by further coincidence, is the license number of the company station wagon. The Bonanza is a familiar sight at the many airports serving both our customers and factories along the east coast.

"I have often times described myself as a completely happy person, who if asked to describe the ideal job would merely have to sit down and write up the things that I do presently."

Cordially,
ROBERT A. WATERS, INC.
Bob
Robert A. Waters

Well, there it is.

Bob modestly left out the fact that he is a tireless sort of guy. He is never happier than when he is knee-deep in work. For example, he owns and operates WATERS MANUFACTURING, Inc. in Wayland in addition to the manufacturer's representative business. WATERS MANUFACTURING makes precision potentiometers of exceptional quality.

Boy! They're Rugged

This is the story of a dual-beam Type 322-A that had a really rough time at one of the U. S. Naval Ordinance Test Stations.

The story starts with the instrument being delivered to one of our Instrument Depots with instructions for complete restoration. When the package was opened, the service technician was quite surprised at the condition of the instrument. It seems, they found out later, that the instrument had dropped from the tailgate of a truck moving at about 25 miles per hour and had skidded along on its cabinet and panel for some distance. One of the amateur photographers in the service organization was immediately rounded up and he took the picture shown in Figure 1 (next page). Notice the abraded corner of the panel and the overall distortion.

Well, the boys thought it would be fun to "fire it up" without checking into the damage sustained. One channel of the instrument operated and the second channel operated after a broken rectifier tube had been replaced! All and all, only six receiving tubes, three fuse holders, two skirted knobs and two rivnuts had to be replaced aside from the new front panel and cabinet.

The Type 322-A that took the beating has been in operation for some four months since it was repaired with no failure of any kind. Figure 2 shows the instrument after it was put back in shape.

This all goes to prove that quality is built-in and *not* inspected-in.

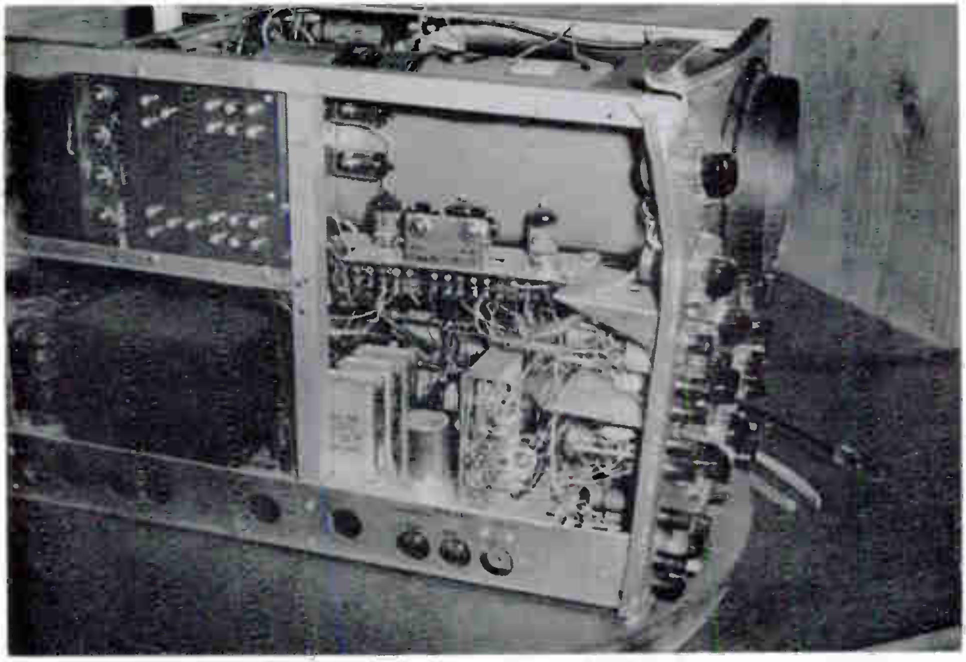


Figure 1. Conditions of 322-A after dropping.

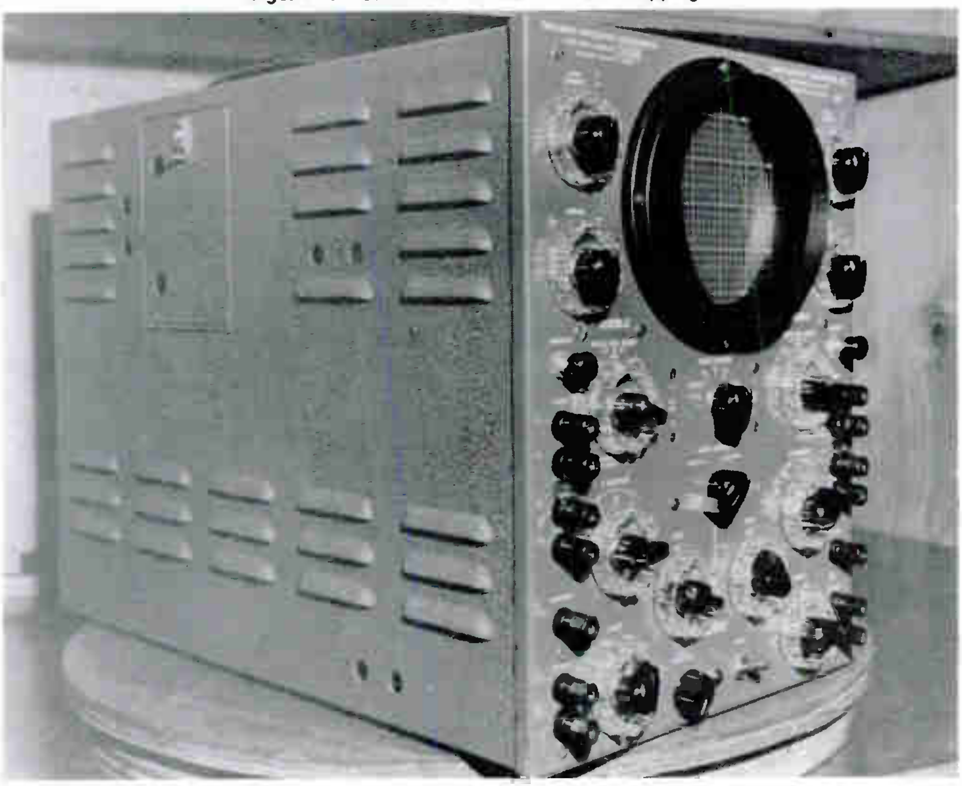


Figure 2. Same unit, refurbished.

Pulse Transformers Find Wide Applications

by: R. Arp

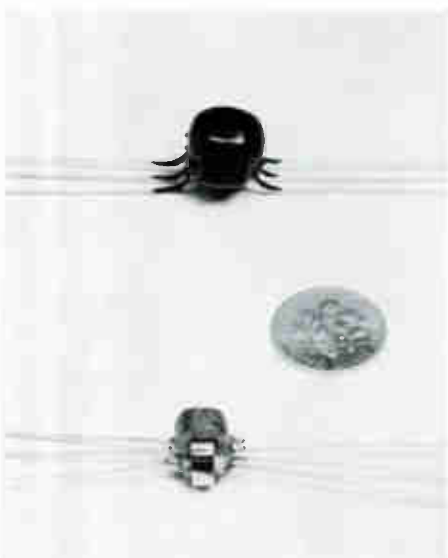
The trend toward miniaturization of electronic equipment and the necessity for increased reliability has created many new applications for miniature and sub-miniature pulse transformers. The electronic computor industry uses pulse transformers extensively in land-based and airborne computors.

Design engineers frequently have to choose between r-c coupling networks — with their component failures, or more costly transformers with their reliability. Costwise the pulse transformer compares favorably with r-c networks, because pulse transformers are more reliable, plus the fact that the winding ratio of the transformers can be selected so that a unity or stepped up transfer of pulse signal can be accomplished. A wide choice of winding ratios can be specified by the engineer — ratios as high as 15:1 are not unknown.

Generally speaking, the pulse transformers used in computor work can be classed as low power units, capable of handling up to 100 or possibly 150 watts of power. These are not to be confused with medium power units useable in the kilowatt range or the high power units capable of handling megawatts of power.

The sub-miniature pulse transformer weighs as little as 1/4 oz. and is not bigger than a cranberry when uncased. It is easy to see why sub-miniature pulse transformers are used extensively in fire control systems in aircraft, airborne gyro control circuitry and in the increasingly popular transistor amplifier where size and weight are important factors.

Another reason that the pulse transformer is so popular is that it can operate over an extremely wide range of repetition rates, extending up to 5 or 6 megacycles in some cases. New core materials and unique winding methods permit the design of pulse transformers capable of operation at these high rep rates, while exhibiting little or no back swing or ringing. The availability of ribbon type core material having the unique characteristic of high permeability at low frequencies and low permeability at the high frequencies



Newest type Du Mont Pulse Transformers. Miniaturization of components such as these have made possible smaller and more accurate systems for varied applications.

has been instrumental in permitting transformer manufacturers to design the present-day version of pulse transformers. Bifilar and trifilar winding techniques have also added to the usefulness of the modern pulse transformer.

Where the design engineer is concerned with the passage of pulse signals, he is also generally critical in his requirements for minimum degradation of the pulse due to over or under peaking. He will want the rise and fall times of the pulse to be kept as short as possible, except where the pulse is used for non-critical triggering. Fortunately, pulse transformers are available that will pass pulses without causing overshoot or undershoot, and will do this with rise and fall times kept extremely short. In fact, the rise and fall times of some of the pulses are too fast to be measured by many cathode-ray oscillographs. Of course, the rise and fall time can be measured readily where the pulse signal is sufficiently large to apply directly to the deflection plates of the CRO; however, the pulse signal is generally too small to accomplish this. Rise and fall times in the neighborhood of 0.01 usec are quite easily accomplished with pulses 0.5 usec wide.

Since size and weight are so important in many applications, the choice of case material and method of casing are also important. Where environment permits, a vacuum varnish finish will keep the transformer size to a minimum. Most often the transformer will be specified as a cast or encapsulated unit. The encapsulating material will very likely be one of the epoxy resins having good dielectric properties, and capable of quick setting after pouring. The epoxies afford good protection for the core and windings and are extensively used. If wire leads are used the epoxy resin compound firmly anchors the leads and seals out moisture. For still more critical application, hermitically sealed units may be required. Leakage in some extremely critical applications may call for seals to keep leakage below one millimicron per year!

Since pulse transformers have been developed to furnish the design engineer with units capable of complying with the foregoing formidable requirements, it is little wonder that pulse transformers are being designed into a greater array of electronic gear than ever before. Their use as blocking oscillator transformers, impedance matching and straight through coupling transformers is increasing at a rapid pace, with new applications developing continually.

Note: Literature on pulse transformer available from Component Parts Sales Department.

An Honest Success Story

This is a letter, quoted in entirety, written by Dr. Paul Greif of Hofheim/Taunus. The story needs no build-up — it speaks very well for itself.

Hofheim/Taunus
Lessingstrasse 16
Germany

Allen B. Du Mont Laboratories, Inc.
International Division
515 *Madison Avenue*
New York 22. *N. Y.*, *U.S.A.*

Dear Sirs,

"I thank you very much for sending me your extensive "operating manual" on your oscillograph Type 224-A, which gave me great pleasure. With the aid of this manual I was in a position to repair the apparatus quickly and it works now to my fullest satisfaction. I am sure it will interest you to know how this apparatus came into my possession. The equipment was originally surplus material of the American Army and was lying for years without protection on a rubbish heap. Children used it as a toy and dismantled quite some parts from its interior. When I received the apparatus as scrap without value I straight away saw that the power supply and all the valves (tubes) were still in order. Only the amplifiers were defective. Due to the exact details of your manual I could find the faults quickly and remove them and could adjust the apparatus exactly. The front plate and the tin case were rusty. I had them polished and newly lacquered, so that the apparatus now looks absolutely new. It works without any objections and is admired also by my colleagues on account of its versatile application. The special quality of the material used and the careful work of your laboratories is more than testified considering that

(*Continued on Page* 16)

'DIS 'N DATA

On frequent occasions, questions have been asked of Du Mont personnel and the staff of the OSCILLOGRAPHER concerning the applications and operations of Du Mont equipment.

If you, Mr. Reader, have *any* questions, basic or advanced, concerning oscilloscopes or related fields please send them along to 'DIS 'N DATA c/o the "Du Mont Instrument Journal" (see page 3) at the address shown on page 2 of this issue.

We are taking a random selection of questions that have been put to the Du Mont staff in recent weeks.

Q: *There is usually more than one ground terminal post located on the panel of the "scope". (a). Are they all common? (b.) Does it make any difference which ones are used on a dual-beam "scope"?*

A: (a.) All ground terminal posts on the front panel of Du Mont instruments are common. In the realm of low-and medium-frequencies, little, if any, effects will be introduced through the use of any particular one of the ground posts. High frequeneies require UHF, BNC, or similar connectors. Grounding is automatically established by the outer conductor of the coaxial cable through the shell of the connector. Actually, the term "ground" applied to a terminal post means that this post is connected directly to the instrument chassis which serves as the return circuit for virtually every function within the instrument. (b.) The same thing holds for dual-beam oscillographs; use the ground post that is most convenient.

Q: *(a.) What is meant by* recurrent *sweep? (b.)* Driven *sweep? (c.) How is the scope set up for* driven *sweep? (d.) Explain* negative *sweep sync. (e.)* Positive *sync. (f.) What benefits are there in starting the sweep with a* negative *pulse? (g.)* Positive *pulse? (h.) How much sync voltage is required to start the sweep?*

A: (a.) *Recurrent* sweep means that the spot retraces to the starting point without need for an external triggering voltage, or, repeats again and again without initiation. (b.) *Driven* sweep is the opposite of recurrent sweep in that the spot *must* be started sweeping by synchronizing or triggering voltage each time a sweep is desired. (c.) The scope is adjusted for driven sweep through the sweep *mode* control. This control adjusts the threshold of acceptability of the sweep generator circuit for a trigger voltage. Its range usually allows either a recurrent condition or a driven condition. The triggering threshold is set for optimum operation of the sweep. (d.) *Negative* sync describes the polarity of the synchronizing voltage. The circuits are set to accept a negative-going signal and in turn apply it to the sweep generator. (e.) *Positive* sync is the opposite of negative sync. (f.) There are no particular advantages in using negative sync as opposed to positive sync. The use of either is dictated by the characteristics of the synchronizing signal available. (g.) See f. (h.) The amount of sync voltage required is dependent on the characteristics of the particular oscillograph used. As a general rule, the least possible amount which insures a stable presentation on the cathode-ray screen should be used.

Q: *(a.) How much voltage can be applied directly to the X- or Y-axis input without damage to the scope? (b.) What is attenuation and how is it used in a scope? (c.) If the scope were set up with a d-c signal applied and it is inadvertently switched to a-c input will the instrument be damaged?*

A: (a.) Usually, potentials of less than 600 volts peak (a-c plus d-c component) can be applied without damage to the instrument. Voltages in excess of this value should be divided down through accessory probes. (b.) *Attenuation* is amplitude reduction of a signal without changing its waveshape to a level suitable for application to the input of a device. (c.) Switching the instrument input from d-c to a-c inputs, or vice versa, can do no harm to the instrument. In one case though, deflection of the cathode-ray beam off-screen can occur if the signal under observation contains a large d-c component and the instrument is switched to d-c without readjusting the attenuator. As for the effect on the instrument, this will do no harm for short periods of time.

Q: *Does the X- or Y-axis input put a current drain on the circuit under test?*

A: This drain is known as "loading" of the circuit under test. The input impedance of modern oscillographs is high enough for most applications so as to not load the circuit. A good rule-of-thumb is that if the input impedance of the instrument is about ten times the impedance of the circuit under test, essentially no loading will take place. For applications where this rule cannot be met, the use of a passive attenuator probe will provide an increase of input impedance at a sacrifice in sensitivity.

Q: How is the spot "found" when it is off-screen?
A: First, turn both X- and Y-axis attenuators to the highest ratio or to the "off" positions so that there will be no deflection signals applied to the cathode-ray tube. Next, set the X- and Y-pcsition controls for the approximate center of their travel. Increase the intensity control clockwise and the spot should appear on-screen. Hence, the spot is "found".

Q: What is meant by a short *persistence screen?* Long *persistence? What are their advantages?*
A: A *short* persistence screen has the characteristic of emitting light essentially only during bombardment by the electron beam. A *long* persistence screen is the opposite of the short persistence screen, that is, it emits light for a period of time *after* the electron beam has departed from it. The primary advantage of a short persistence screen is that practically no "smear" results when the observed pattern is moving across or up and down on the screen. A *long* persistence screen is useful for observation of phenomena that occurs slowly. For example, changes in pattern over a period of a few seconds. The persistence of the screen holds the pattern on screen long enough for visual interpretation.

Q: What is meant by "differential amplifier input" and how is it used?
A: "Differential amplifier input" means that the amplifier will accept signals from two different circuits, both signals referenced to the same ground of course, and give an output which is the amplified difference between the two signals. Naturally, the differential amplifier itself must be symmetrical with respect to ground, that is, its symmetry should be such that when no signal is connected to the input, there is no signal cutput, either a.c. or d.c. Thus, any signal that is common to both lines, cr circuits, "in phase", such as 60-cycle hum, is not recognized as a signal by the differential amplifier and therefore does not appear in its output. This rejection of "common mode" or in-phase signals riding on the signal lines is the most important feature of differential amplifiers. The common mode rejection ratio of a differential amplifier is a figure of merit which refers to the ratio of amplitudes between the input common mode signal and the output. The differential amplifier is ideally suited to applications where a balanced signal is available such as the signals from balanced transmission lines, bridge circuits, signals from most biological transducers and virtually every "push-pull" function.

Q: I want to examine signals coming from a circuit with my oscillograph but find that there is hum displayed along with the signal that I want to see. How can I find where the hum is entering the system?
A: There are three general possibilities for the entry of hum into the display. One, in the circuit under test; two, in the wires coupling the circuit to the instrument; and three, within the oscillograph itself. First, determine if the hum is within the instrument by disconnecting the leads to the input terminals and placing a shield over these terminals. Observe the oscillograph screen, if the hum *is* still present, consult the trouble-shooting section of the instrument instruction manual for repair techniques. If the hum is *not* present on screen, the instrument is not at fault.

With the instrument eliminated as the culprit, it should be determined if the leads coupling the tested circuit to the instrument are adequately shielded. This can be determined by connecting the leads to the oscillograph and not to the circuit under test. If the leads are adequately shielded, little, if any hum will show on screen. If the hum is present on screen, suitable coaxial cable should be substituted for the leads with the braided shield of the cable connected to the ground terminal on the instrument panel at the instrument end and to the chassis or other common point of the circuit under test.

If the leads are well shielded and the hum is still present, the circuit under test should depends on the characteristics of the circuit next be checked for hum. The procedure here and are peculiar to that circuit and consequently difficult to generalize.

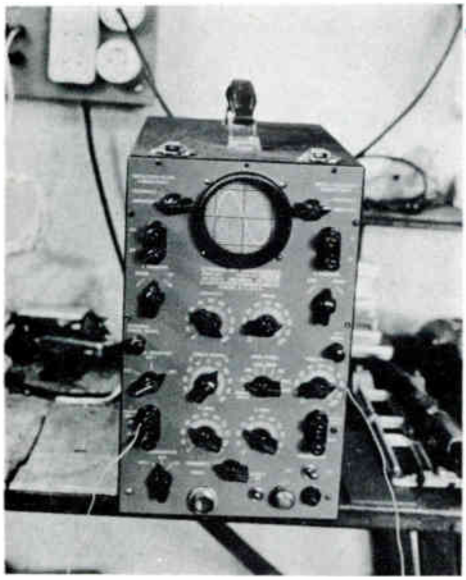
Success Story (Cont'd)

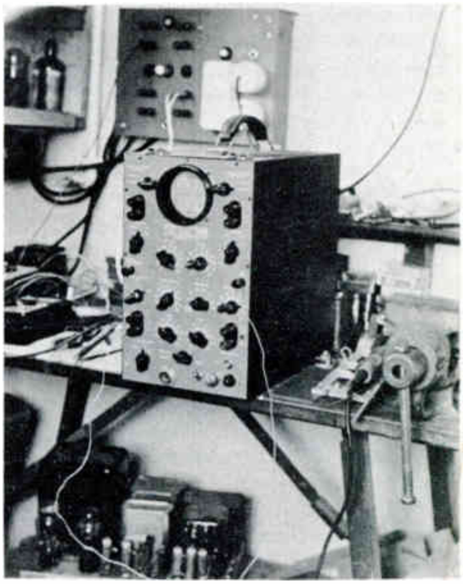
the apparatus can still be used after having been ill-treated as mentioned above. I am really proud to possess such a valuable apparatus and thank you very much for your help.

I am sending you enclosed two photos which were made immediately after the repair, the apparatus still on my working table of my laboratory, so you can get an idea of the present state of the oscillograph. I am sure you will also be satisfied with the work done, as it surely is a proof of your excellent workmanship.

I have noted that you are represented in Germany by the firm Schneider, Henley and Co., G.m.b.H., Gross-Nabas-Strasse 11, Muenchen 59, Germany and should I in future need other instruments of your manufacture I will certainly get into touch with this company."

With kindest regards
Very truly yours,
Paul Greif





Pictures of a Type 224-A after it was restored to almost original quality by Dr. Paul Greif of Germany. Instrument had been laying in an American Army surplus junk pile for years before being found and restored by Dr. Greif, now works much to his satisfaction.

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