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This device, which senses the presence of metals and other conductors, has many uses in automation.

Servicing R.F. Proximity Controls

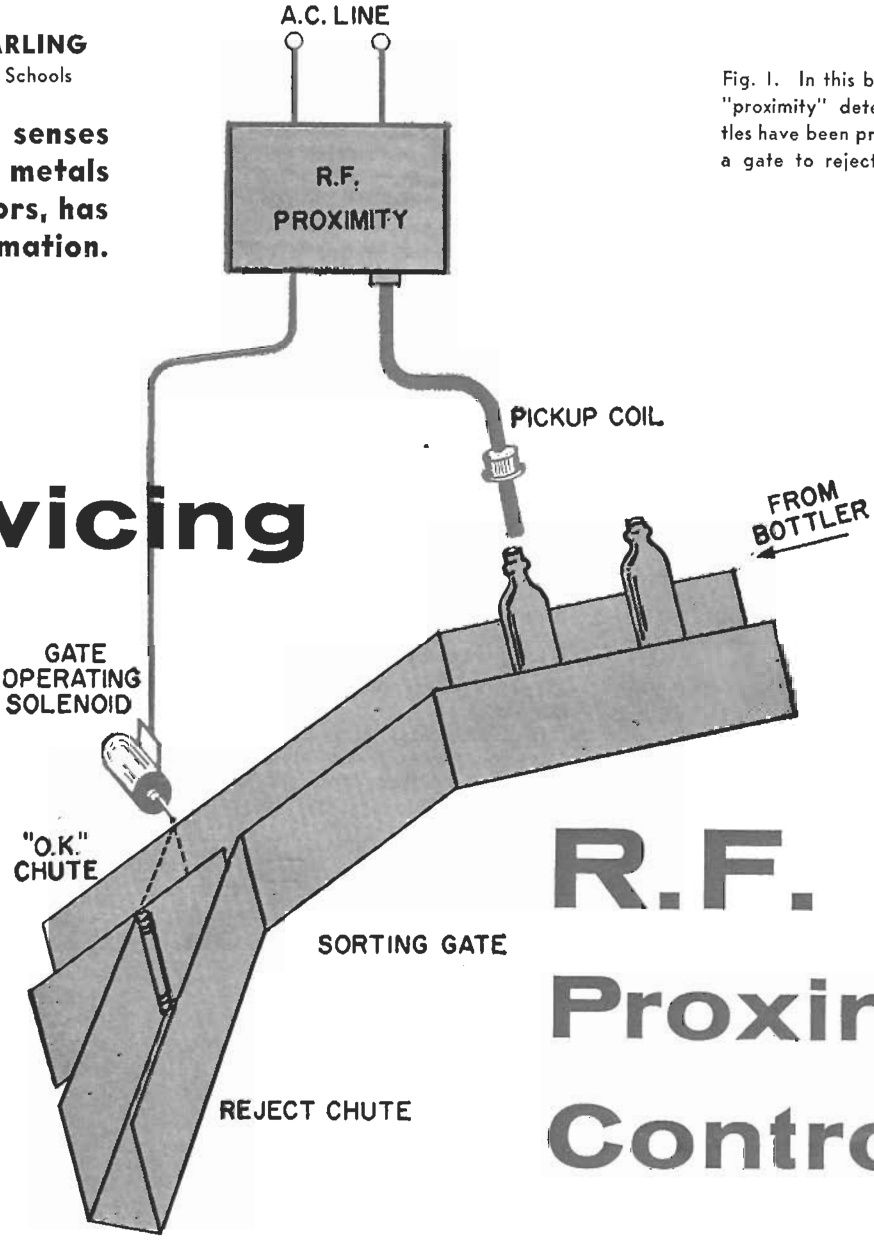


Fig. 1. In this bottling operation, the "proximity" determines whether bottles have been properly capped, opens a gate to reject those without caps.

AUTOMATION is the operation of machines without direct human control. A human operator has the wonderful ability to see, hear, or feel various parts of his machine or product; to tell when things are positioned right for the next operation; to know whether a new piece of work has been inserted. An automatic machine must have these senses built into it, in the form of limit switches, photocells—or proximity controls.

One very popular type of sensing device is the "r.f. proximity," which is capable of sensing the presence of almost any type of conducting material (such as metals and conductive liquids). Anyone going out to do industrial electronic servicing is bound to come across these units. A good understanding of their operation and possible troubles will be a big help.

Although there are several brands on the market, the basic principles of all are similar, so let's take as an example the Model 4905, made by *Electro Products Laboratories*. This unit (Fig. 3) is housed in a JIC (Joint Industrial Committee) approved steel case, about 6¼" x 8" x 3½" which can be sealed up tight against gas and liquid for protection.

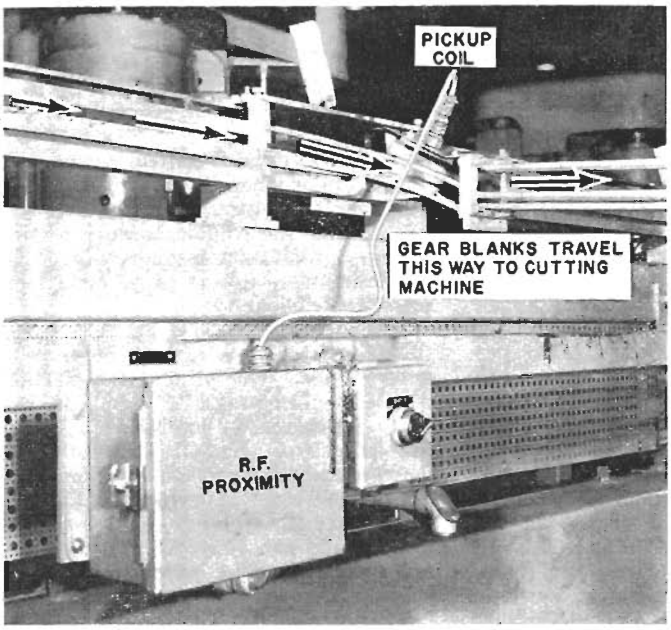
The case is opened by loosening one clamp bolt, and the entire chassis (Fig. 4) can be removed by taking out four corner screws. Although the chassis is fairly simple, you are impressed with the care that has gone into making it. All parts are first quality, and the wiring is neatly, carefully, and completely color-coded. (Industrial purchasers are more interested in quality and reliability than they are in price.)

Fig. 2. Various types of external sensing coils may be fitted to the control.

The only part of the control not housed in the box is the pickup coil, which is on a cable to allow it to be mounted in the best position for sensing. Various types that may be used, to suit the particular job, are shown in Fig. 2.

How It Works

Take a look at the schematic diagram (Fig. 5) or "print," as an industrial technician would call it. The pickup coil is the tank of a conventional, fairly simple r.f. oscillator, using one-half of a 6SN7 tube, V_{1A}. Sig-



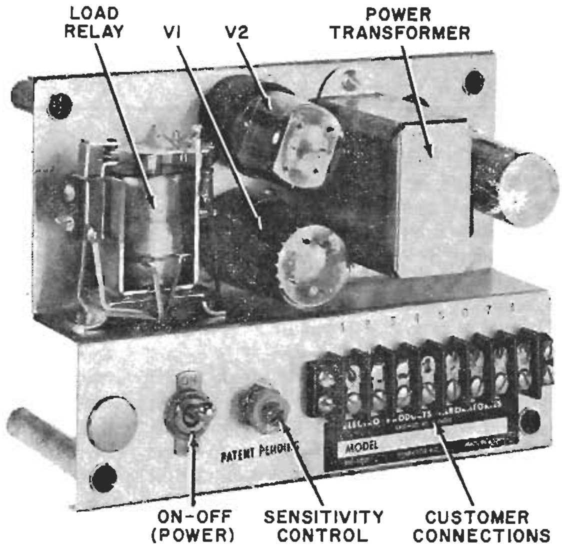


Fig. 4. The Electro Products Model 4905 with cover removed.

◀ Fig. 3. In a Ford Motor Co. plant, the Model 4905 checks gear blanks as they are being fed to a gear-cutting machine.

nal from this oscillator is fed from the cathode into the grid of V_{1B}, which operates as a resistance-coupled r.f. amplifier.

From V_{1B}, the r.f. signal is passed to V_{2A}, where it is amplified again and fed to a rectifier circuit (1N34A), which charges a .002-µf. capacitor to provide negative bias for the grid of V_{2B}. V_{2B} has a relay in its plate circuit, with contacts to switch the load on or off.

Normally, r.f. signal from the oscillator, amplified and rectified, keeps a negative bias on V_{2B} large enough to cut it off and leave the relay de-energized. When conducting material comes near the pickup coil, however, the latter absorbs enough energy from the coil to lower its "Q" to the degree that oscillation stops. When this happens, no r.f. will reach the 1N34A diode, and the cut-off bias will be removed from V_{2B}. This permits V_{2B} to conduct and operate the relay. This tube keeps on drawing current until the conducting material moves away from the pickup coil and permits the oscillator to come back into operation.

Sensitivity is controlled by varying the plate voltage on the oscillator tube with a 10,000-ohm pot, screwdriver-adjusted from the front of the chassis. (This adjustment has a lock-nut on it, which must be loosened and then retightened when an adjustment is made.)

Applications

There is almost no limit to the number of jobs that can be done by a unit of this type. With an external, electromechanical counter connected to the relay contacts, the proximity will count passing objects at rates up to 600 per minute. (With an all-electronic counter, using no relays, rates up to 1000 per *second* are possible!)

One or more r.f. proximities can be used to sense the position of a piece of work in an automatic machine, to control the sequence of machining operations. Tolerances in a setup like this are often small, and the pickup coils may have to be positioned to within thousandths of an inch for satisfactory operation.

An r.f. proximity control can be used to inspect packages or to check bottles, among other things. In the case of bottles, it could make sure that there is a cap on each or that there is *not* a metal object inside the bottle. After all, a nail in a bottle of beer doesn't exactly improve customer relations. A possible arrangement for a bottle-capping system is shown in Fig. 1. The control itself is mounted away from the moving line of bottles and the sensing coil, on an extension cable, is placed just above the moving line of bottles.

The load relay, instead of going to an external counter, is connected to a solenoid that operates the sorting gate, whose position determines into which of two chutes the moving bottles will be passed. When an uncapped bottle passes the pickup coil, the solenoid swings the gate to close off the "OK" chute, and the bottle is rejected.

A complete list of applications would fill volumes. Nevertheless, some are mentioned here because the job the proximity is doing often has a direct bearing on the troubles it can be expected to develop.

Troubleshooting

Although these controls are basically simple and very reliable, trouble, quite

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Fig. 5. Simplicity characterizes the circuit for the proximity device of Fig. 4.