LETTERS TO THE EDITOR

Note to Members: This is your column. It is designed for the discussion of papers published in the Journal *and other pertinent topics about which you feel strongly.*

INSTRUMENTS FOR RECORD CLEANING*

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"The Gramophone" Magazine, Middlesex, England

THIS paper describes several minor techniques and two instruments developed on the principles published in the *J.A.E.S.*, April, 1965. One instrument is automatic in operation and (wet) cleans soiled records (1 minute per side). The other tracks in front of the stylus and maintains cleanliness.

Record Contamination

The previous paper gave the conclusions reached from a prolonged research into record contamination. Three forms of contamination were identified: relatively hard discrete particles such as dust, grit and fluff; deposits from household sprays (including spittle from blowing), soot and preparations such as anti-static dopes and detergents deliberately applied; and condensates from air-borne fumes of an oily nature such as cooking vapors, tobacco smoke and smog loaded with diesel fumes.

So long as it is not attached to the groove the first type can readily be removed by a cleaning device which precedes the stylus. The second and third, if not of long standing, can also be removed in this way: they are soft at the beginning but gradually become sticky and then harden and trap the discrete particles; the whole mass then becomes more or less firmly attached to the groove. At this stage only a wet cleaning process can remove the contamination completely. Even then, if the record has been repeatedly played while the particles were firmly stuck, they may have been pressed into the record material and their removal may leave slight pits. It is in fact easy to distinguish between the "pops" caused by particles and the fainter noises of the pits left behind.

Dry and Wet Cleaners

Two instruments have been developed for dealing with this situation: the Record Player Cleaner (R.P.C.) and the Record Doctor (R.D.). Both depend on the use of a degree of suction from a separate suction generator (S.G.).

The R.P.C. is normally used without application of liquid, though a small amount of humidity (which can readily be provided) is an advantage. It is a self-tracking device carried along by the groove and it is of importance that the tracking force should be kept low if damage to the groove is to be avoided. It is also important that the disturbed contaminate should be instantly removed and not run the risk of being re-deposited: hence the value of suction operation. A suction of about 4 to 6 liters per minute through a tube of ¼-in. decreasing to ⅛-in. bore has been found to be adequate. It should be noted, however, that the air impedance is high, and therefore the ordinary run of suction generators, such as domestic vacuum cleaners, is ruled out. Special types such as "solder gobblers" are suitable but they are apt to be noisy.

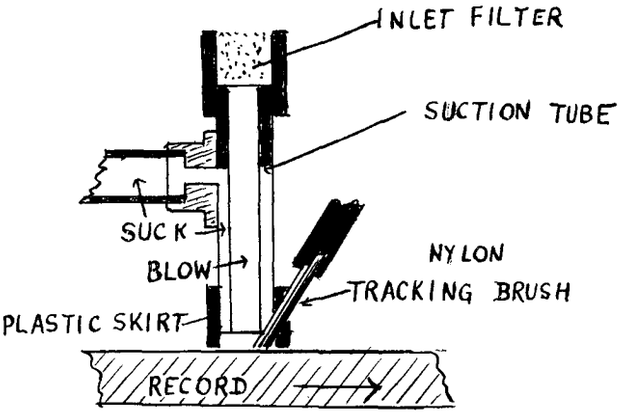

FIG. 1. Blow-suck-scrub nozzle of the record-player cleaner.

The R.D. operates through the application of a suitable liquid, followed by a groove scrubber to loosen the contaminate, then a suction mop to remove the liquid sludge and finally a spinning brush which, by contact and by its blowing action, completely dries the surface of the groove and leaves it in a highly polished condition. For this instrument a higher degree of suction is advisable: from 8 to 10 liters per minute is aimed at.

The Record Player Cleaner

The R.P.C. operates through a forward-facing brush with 2 dozen or so nylon bristles inclined at an angle of about 45°. This loosens the contaminate, which is then removed through suction. To assist in the loosening process the brush is arranged to work at the mouth of a nozzle where both blow and suck actions are operating together so as to create turbulence. This nozzle is shown in Fig. 1. The suction is through the annulus of the larger tube and automatically draws the air down through the inner tube. There is a possibility of a leak effect by air drawn in parallel to the record surface, but this is minimized by having a plastic skirt round the tube which is arranged to be close to the record surface. By having it actually

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* To be presented October 14, 1965 at the Seventeenth Annual Fall Convention of the Audio Engineering Society, New York.

in contact in the first instance and then dropping the nozzle (on its arm) gently onto the surface, the change of noise from a sharp tap to a soft thud indicates that the brush has taken charge of the contact in place of the skirt. By this simple technique a clearance of as little as 0.002 in. is easily realizable.

The nozzle is carried by an arm in the form of a plastic tube which houses a cotton-batting filter through which the suction is drawn. It is continued through a perspex section mounted on a single pivot situated in the center of the suction channel. The counterbalance arrangement at the end of the arm operates for both longitudinal and lateral balance. A picture of the device is shown in Fig. 2 and its mounting in relation to a sophisticated playing-deck arrangement in Fig. 3. It will be noticed that an additional filter has been provided at the base of the arm. This was found desirable to prevent any contaminate which had escaped past the edge of the floating filter from being drawn into the suction generator. This, as well as the state of the floating filter, which becomes quite dirty after only a few record sides have been played, is ample indication that the nozzle captures microscopic particles as well as larger ones from the record surface.

A number of important considerations dictated the adoption of this design rather than several alternatives, including the one exhibited at the 1964 Fall Convention of the A.E.S.

1. A forward-facing brush has been found essential for dislodging particles stuck to the groove by fume contaminate even in their softer state. If damage by such a brush

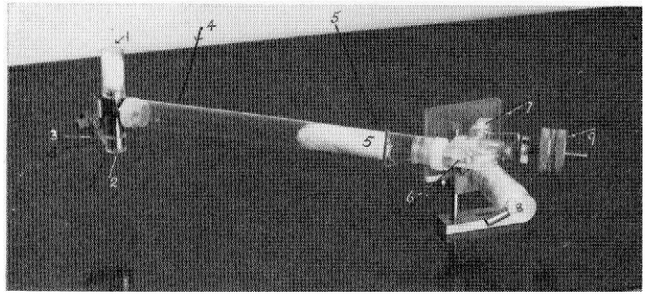

FIG. 2. Photograph of the record-player cleaner. (*1*) Input air filter (also acts as tracking weight). (*2*) Blow/suck nozzle. (*3*) Tracking (forward-facing) brush. (*4*) Transparent tube as carrying arm. (*5*) Suction filter. (*6*) Perspex suction channels. (*7*) Universal pivot member operating in suction channel. (*8*) Suction-out through final filter. (*9*) Counterbalance: longitudinal and lateral.

to the finer groove modulations is to be avoided the lightest possible tracking force is to be aimed at. In the present design this is represented by the mass of the inlet filter at the top of the nozzle, the arm being balanced on the pivot, in the first instance, with the filter removed. Actually, a total tracking force of 0.25 gram has been found feasible, and since this is applied through some 2 dozen bristles the force between each bristle and the groove is of the order of 0.01 g. This is an ample safeguard against wall damage even if the groove is dry. It is also possible to arrange for a modicum of lubrication by putting a drop of distilled water onto the loosely compacted cotton batting composing

FIG. 3. Photograph of record-player cleaner in operation. (*1*) *through* (*9*), as in Fig. 2. (*10*) Stylus microscope (swivelling to preset position). (*11*) Arm stop positioned for microscope. (*12*) Lamp to illuminate stylus.

the input filter; the air drawn down the nozzle will then be slightly moist.

2. To have so low a tracking force the arm must be of low mass and be perfectly balanced. Bearing friction and tracking error must also be at a minimum. These considerations dictated that the suction tube should itself form the carrying arm. The tube is made of transparent acetate, or thin-walled perspex, so that the degree of collection of contamination can be regularly observed. In some dirty areas it is seen to be desirable to change the filter after only 10 record sides have been played.

The use of transparent tubing has another advantage because of its lightness: the arm inertia becomes so low that quite substantial record warps, even when combined with "swingers" (eccentric discs), have no effect on the operation.

Figure 3 also shows another desirable feature: the pivoting, balancing and counterweight system have been so designed that the mounting can be made quite comfortably in the triangular space left between a 12-in. turntable and a 13½-in.-square motor board. This is done by giving the arm a linear offset at the pivot end, so reducing the amount of offset required at the nozzle end to give proper tracking. With this arrangement the arm, when not tracking, sits back along the parallel to the player cabinet. Incidentally, the same sort of system might be used with advantage in pickup arm design.

To facilitate the cleaning which is periodically required, the R.P.C. can be quickly taken to pieces into separate parts, though it should never be necessary to dismantle the nozzle.

The prototype has now been in regular use since December, 1964, the filters having been renewed many times. One can in fact become rather scared at the amount of dirt picked up, even in the comparatively clean air of the residential part of Oxford, where the author lives. Another prototype has been in use by an associate in a residential area on the outskirts of London where smog, diesel fumes

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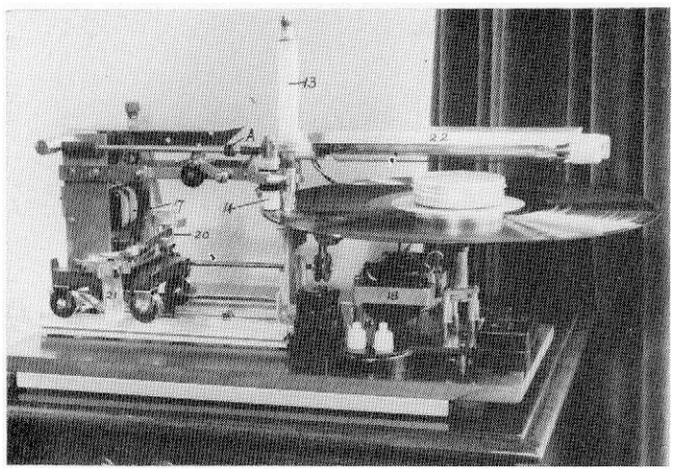

FIG. 4. The Record Doctor. (*13*) Liquid applicator. (*14*) Suction mop: suction through tubes (*A*) and (*B*). (*15*) Forward-facing groove scrubber. (*16*) Spinning brush operated by (*17*) Motor mounted in traverse carriage. (*18*) Rim-drive turntable (miniature) motor. (*19*) Belt drive of screw traverse mechanism, operated from turntable spindle. (*20*) Twin trigger mechanism for lifting half-nut clear of traverse screw at end of run. (*21*) Container for applicator at end of run, linked to trigger mechanism to permit suction mop and spinning brush to proceed up to record label. (*22*) Strip lamp, to provide sufficient heat to control humidity and rate of drying, adjustable as to height on (*23*) Post to carry strip light.

from a nearby motorway, and even factory fumes from an industrial area within a few miles give rise to substantial air pollution. In his case, the arm filter becomes black within a few hours' playing time.

In both cases, the use of the R.P.C. has resulted in a remarkable improvement in high-note and transient reproduction.

Figure 3 also shows another feature of interest besides the special adaptation of the pickup arm (which is another story). This is the permanent fixing of a long-focus stylus microscope in such a way that when the arm is set back against a pre-set stop, the microscope can be swivelled into position for viewing the stylus without any fumbling adjustments. This arrangement has made it simple and quick to determine the condition of the record (and the efficiency of the cleaning techniques) by the amount of muck picked up by the stylus after playing any chosen

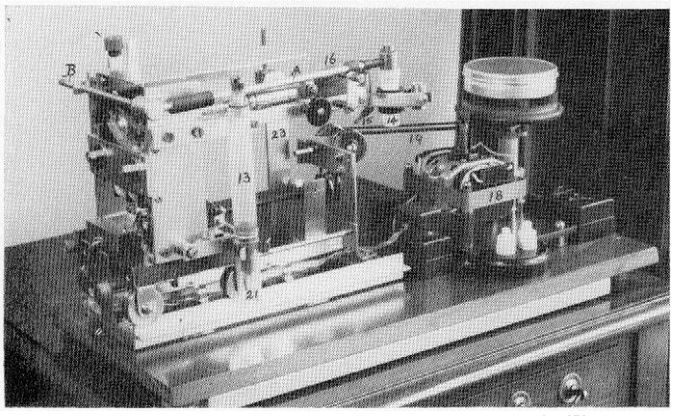

FIG. 5. The Record Doctor. (*13*) *through* (*23*), as in Fig. 4.

annulus of the record. It is even possible to determine by the contamination left on each side of the stylus whether greater pressure has been exerted on one wall of the groove than on the other. (Hence the delicate anti-skating devices at the back of the arm, and the cleaning brushes kept on the playing deck in convenient positions.) All this, of course, is highly sophisticated and non-commercial. But it has provided a wealth of valuable information in this research.

The "Record Doctor"

If the household spray, finger mark, fume condensate films have been left undisturbed for some time and been allowed to harden, dry cleaning with the R.P.C. becomes no longer effective. The more drastic measures of wet cleaning are needed to remove the contamination. Because of the lubrication afforded by the applied liquid, consid-

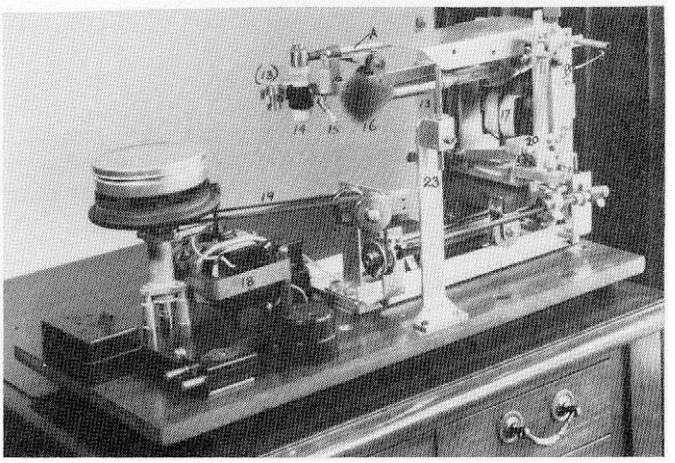

FIG. 6. The Record Doctor. (*13*) *through* (*23*), as in Fig. 4

erably greater pressures between tracking devices and record become permissible without risk of damage. Scrubbing action can therefore be greatly improved and this, combined with the loosening effect of the liquid itself, makes possible the removal of even hard stuck material.

The main problem has been to maintain the cleaning efficiency while expediting the process and leaving the record grooves quite dry.

As explained in the previous paper, a miniature turntable is used, rotating at a high speed—now 150 rpm—so as to minimize the vortex action of the air on the record and the onset of new contamination during the process of removing the old.

The cleaning operation is done by 4 devices mounted on a carriage which is drawn radially towards the record by a half-nut on a screwed rod. The pitch and rotation speed of the rod has now been arranged so that the 4-in. traverse takes place in one minute.

Figures 4, 5 and 6 show the details. Of the four devices involved, the last to come into operation is the spinning brush (*16*) which does the final drying and polishing. This

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must move radially across the record; its motor drive (*17*) is mounted in, and moves with, the traversing carriage. Preceding that comes the suction mop (*14*) with suction provided through tubes *A* and *B*. This comes into operation just after the forward-facing groove scrubber (*15*) whose bristles are inclined at an angle of 30° to 45° to the record surface. First in operation is the liquid applicator (*13*) which consists of a nozzle containing a brush with nylon bristles, backed by a plastic foam sponge through which liquid percolates from a tubular container, the rate of flow being controllable by a simple valve at the top.

Elements (*13*),(*14*) and (*15*) are each mounted in tubular items attached to a carrying arm which is fixed to the face of the traverse carriage, about 1½ in. from the radial line followed by the spinning brush. In this way they are given a freedom of vertical motion, thus maintaining independent contact with the record whether the latter runs true or not.

The more important thing to notice about them, however, is that each has a path across the record along a different chord. Their traverse lengths and their contact with successive grooves are therefore quite different. Quite a tricky geometrical problem has therefore been presented to ensure that *1*. At the beginning of the transit the applicator (*13*) starts at the run-in groove, and at the end it is clear of the record label. *2*. Elements (*15*) and (*14*) are lowered on to the record in such a way that (*14*) is just on the rim when (*15*) is in the first groove a little after (*13*) has passed it. *3*. Item (*15*) never overtakes (*13*) but keeps ahead of (*14*) throughout the transit. *4*. Neither (*14*) nor (*15*) touch the label but do reach the run-out groove. *5*. The carriage stops before the spinning brush touches the label, but goes far enough to allow the brush to clear any remanent liquid from the blank space outside the label.

In the model illustrated, adjustable, independent mountings were provided for (*13*), (*14*) and (*15*), so that these adjustments could be made. The appropriate positions having been determined, a later model has all the positional holes cut in a perspex block attached to the carrying arm. In both cases (*14*) and (*15*) can be raised and lowered onto the record together.

The operation was much facilitated by the provision of the trigger mechanism shown at (*20*). This was a double stop. The first triggers the catch, permitting the spiral spring to lift the half-nut clear of the screwed rod and therefore stopping the traverse. Applicator (*13*) is then removed from its transit position and placed through a ring into the little bottle (*21*) mounted on the carriage. Its weight on the ring releases the first catch and permits the carriage to proceed further until the mop and spinning brush have finished their transit. Then the second trigger catch comes into action and stops the traverse again. In this way it is ensured that no liquid deposited by the applicator (*13*) is left on the record beyond the recorded surface.

The rim drive of the miniature turntable should be noticed. The motor, which runs at 1450 rpm, is mounted on two pillars and rests by its own weight, with its rubber-encased spindle resting against a rubber ring on the turntable rim. The dimensions are such as to produce the turntable speed of 150 rpm so that the belt drive to give the required rotational speed to the screwed rod is a simple affair.

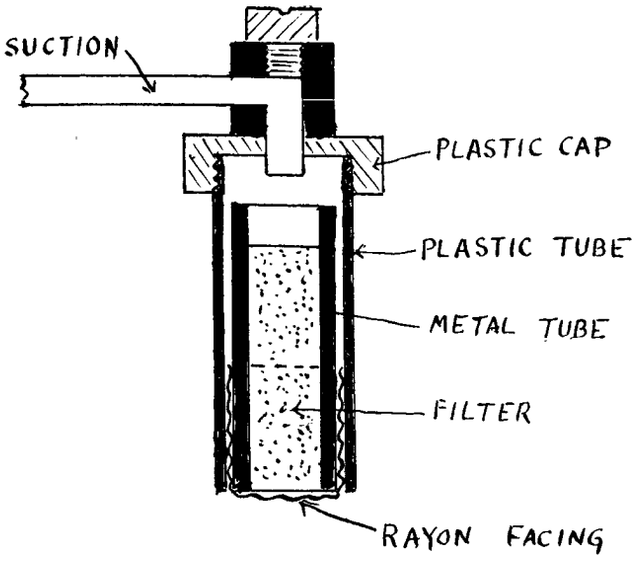

FIG. 7. Detail sketch of the suction mop.

Particular attention has been paid to the design of the suction mop. In the early experimental models this was just a hand-rolled cylinder of cotton batting faced with a piece of linen, and pushed into the suction tube so that the linen face would rest on the record. This worked surprisingly well, but the finished design is much more efficient in that it maintains a flat instead of a bulging surface on the record, and there is thus less suction leakage.

The details are as shown in Fig. 7. There are two tubes, the outer being plastic and the inner of aluminum with a machined end-face. Inside the inner tube is a standard cigarette filter. Over the end of the tube a piece of rayon is placed, and with that it is pushed into the outer tube—a tight fit—until the rayon face is just clear of the end. The outer tube is then screwed into the holder which is attached to the suction tube (*A*). Rayon is better for the purpose than linen, being of a more open weave and with no fluffy threads: the suction is therefore more effective in pulling the liquid sludge through into the filter which often goes black with the cleaning of one side of a record, the rayon facing remaining fairly clean. The suction generator is connected through a vacuum flask by flexible tube to the inlet at (*B*).

An adjustable strip lamp (*22*) has been provided so as to improve the drying effect during days of high humidity. This was an afterthought, but it was found to be worth retention not only for that primary purpose but also because it was found, by adjusting the height so as to give a greater heating effect, that during a few minutes of record rotation it would warm a warped or dished record sufficiently to permit it to be nicely flattened by insertion between two pieces of plate glass.

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The liquid usually used is water, preferably distilled water or filtered rain water. It is more effective at a temperature of 120°F to 150°F than at a lower temperature; at a higher, there is a risk of causing some deformation. Three cc in the applicator (*13*) is enough. If the record is badly soiled, and especially if it is greasy, even if only with finger marks, a preliminary treatment with a mixture of 25% ethyl alcohol and 75% water can be carried out with advantage. (If ethyl alcohol is not available methylated spirit can be used.) It can be applied by means of a soft (baby's) hairbrush. But remember the caution in the previous paper: *do not wet a record surface unless an efficient method of instant drying is available.*

A special suction nozzle has also been devised to be used in place of the mop for obliterating light scratches. This consists of a glass tube with a fused flat end, surrounding a suction tube into which nylon bristles are inserted at the record end, the glass tube being capable of up-and-down motion independently of the suction tube. The combination of brush and suction with the burnishing action of the glass tube will rub out many a light surface scratch —"paper scratches" one used to call them. Deep scratches nothing can remove, at least so far as is known at present.

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Most of the development work described in this paper was carried out by one of the author's associates who desires to remain anonymous. But the author thinks it only proper that his indebtedness should be acknowledged.

Since the photographs were taken this associate has elaborated the R.D. even further so as to eliminate all the manual control except the preliminary charging and setting. As many as 20 sides can now be cleaned in succession without changing the mop filter or recharging the liquid applicator.

Further experiments are proceeding to ascertain whether the machine could be made more effective, or simpler in operation, by reversing the motion, i.e., by starting the cleaning at the inner grooves and letting the cleaning devices drop off in succession at the rim of the record.

A POWER SUPPLY FOR TRANSISTOR-TYPE AMPLIFIERS*

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Any power supply meant for solid-state amplifiers must be moderately well regulated against power-mains voltage changes and against load demands that change at a slow rate. The regulation must be excellent for load changes that occur in or near the audio frequency region. There must be low ripple and other noise in the output of the supply. Provision must be made to protect the rectifiers against mains surges of high amplitude and short duration, and the entire supply should be protected against abnormally high load current demand. In addition, there may exist the requirements for remote regulation sensing (so that the voltage may be held constant at the load instead of at the supply proper) and for slow build-up of output voltage (instead of a sharp transient) when mains power is applied to the unit.

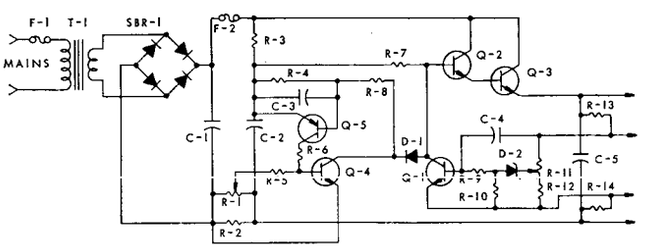

FIG. 1. Schematic diagram of the power supply. All transistors are silicon n-p-n except for Q-5, which is silicon p-n-p. See Table I for the function of the principal parts of the circuit.

TABLE I. Function of the principal components of the power supply circuit illustrated in Fig. 1.

PART	FUNCTION
Q-3	Series regulator transistor
Q-2	Driver for *Q-3* (*Q-2* and *Q-3* form Darlington compound pair)
Q-1	Output voltage regulating driver for *Q-2*
Q-4	Output current limiting transistor (overrides *Q-1*)
Q-5	Bootstrapping driver for *Q-4*
D-1	Coupling, during limiting or shut-off, between *Q-2* and *Q-4*
D-2	Reverse breakdown (Zener) reference diode
C-3 *R-4*	R-C delay between limiting and shut-off
R-1	"Set Current" potentiometer for controlling limiting
R-2	Low-value resistor for current sensing
R-11	"Set Voltage" potentiometer for determining output volts
C-4	Dynamic filtering coupling (Made large to provide slow rising of output voltage after supply is turned on.)
R-5 *R-14*	Provide partial coupling to plus and minus output terminals (preventing regulator runaway) in case user of supply fails to strap "remote sensing" feature into use.

When all of the above points are satisfied in a given power supply design, the end result may well be a formidable amount of circuitry. The complexity may be such that dependability is degraded and that maintenance is difficult. Worse, the personnel assigned to service the unit may not readily understand the theory of its operation.

The general practice in the professional audio field has been to design power supplies that either omit some desirable features or that present a compromise. The alternative taken by some designers was to include everything and accept the complexity.

The circuitry outlined below attempts to retain all de-

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* Presented April 27, 1965 at the Twelfth Annual Spring Convention of the Audio Engineering Society, Los Angeles.