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RADIO CRAFT

HUGO GERNSBACK, Editor



**BRUNETTI
WRIST-WATCH
TRANSMITTER**
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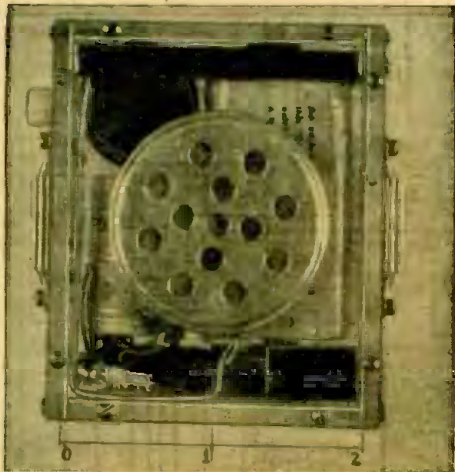
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30¢

RADIO-ELECTRONICS IN ALL ITS PHASES

CANADA 19¢

COVER FEATURE



Close up view of transmitter.

Brunetti Wrist-Watch Transmitter

By HUGO GERNSBACK

Even smaller radios than this 2-x 3-inch transmitter may be made when smaller and better batteries are built.

PERHAPS the most revolutionary advance in radio set building methods was developed during World War II. This is known as the printed circuit technique.* The man chiefly responsible for most of the new ideas in this branch of radio is Dr. Cleo Brunetti and his co-workers of the National Bureau of Standards.

When it became necessary, during World War II, to design extraordinarily small radio sets which, however, had to be extremely efficient at the same time, it was Dr. Brunetti who solved the host of problems which made these tiny radios possible.

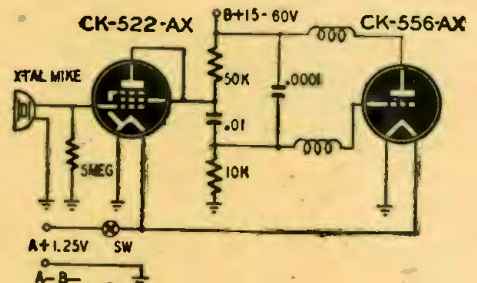
In the proximity fuse, for instance, a tiny radio transmitter with combined radar was required. This entire transmitter (complete with batteries, tubes, etc.) is so small that it fits in the head of the small projectile. In use the shell

is set to explode at a predetermined height from the ground, or from any object it may pass in flight. When the shell reaches this point, a radar impulse bouncing back from the ground (or object) to the shell, activates the proximity fuse, which now bursts.

Actually millions of these were manufactured during World War II and did much in helping to win the war. Many similar radio weapons were designed by Dr. Brunetti and his associates.

Dr. Brunetti, who is the Chief of the Engineering Electronic Section of the National Bureau of Standards, is a physicist of the first order. He and his associates had to overcome tremendous difficulties in compressing a standard radio transmitter into a space that measures less than the fist of a small child. Extraordinary problems had to be solved in carrying out this work, which included much pioneering in many different directions.

So important has this new technique become, that the Bureau of Standards felt it necessary to bring out a 44-page book entitled: "Printed Circuit Techniques" by Cleo Brunetti and Roger W. Curtis. This is a National Bureau of Standards circular No. 468, for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., for 25c. In this book will be found all the various complex techniques that have enabled Dr. Brunetti and his



The wrist-watch radio transmitter schematic. The wrist-watch radio transmitters actually staff to build radio transmitters actually down to the size of a lipstick case (minus batteries and microphone).

One of the most recent Brunetti developments is his wrist-watch radio transmitter featured on this month's cover. It is so small that it can be worn like a wrist watch. The entire transmitter (including crystal microphone, A and B batteries) is all housed in the plastic case. The size of the case is $2\frac{1}{4} \times 2\frac{11}{16}$ inches. From the diagram it will be noted that there are two tubes, a CK522AX and a CK556AX.

These are well-known miniature battery types. The A-battery is a small Mallory dry cell which measures about 1 inch in diameter and $\frac{5}{8}$ inch in height. The B-battery is a small hearing-aid type manufactured by several battery manufacturers.

The wrist-watch radio is a transmitter only and has no receiver. There is no aerial, yet the transmission is reliable over a range of about 100 ft. Any receiver tuned to the correct wavelength (in the 6-mc region) can receive the signals.

In a demonstration, which the writer witnessed, Dr. Brunetti was walking



Dr. Brunetti's smallest and latest transmitter compared with a box of ordinary book matches.

*See RADIO-CRAFT, June and September, 1947 issues.

about the floor whispering into the wristwatch radio, yet his voice came out clear and strong from the table radio receiver at a considerable distance away from the transmitter. As a matter of fact it is necessary to be some little distance away, otherwise there will be an audio feedback howl.

Dr. Brunetti built a similar miniature pocket-radio for President Truman, which was presented to him on Christmas Day. In the White House there are a number of receivers attuned to the President's transmitter. The President can now walk about the entire White House, including grounds, and talk to the personnel wherever he is located. It is not possible to "talk back" to the President as there are no radio transmitters for the White House staff.

There are many practical uses for wristwatch transmitters of this type, only a few which are listed here:

During building construction when the architect or the foreman wishes to talk to a temporary office, contact can easily be established.

Such a walking transmitter is a great boon in commercial departments between stock clerks and main office.

For mines, quarries, etc., foremen—if equipped with a wristwatch radio—can keep in touch with the distant office at all times. It would be particularly effective during mine disasters. These are only a few uses. There are of course thousands of others.

Dr. Brunetti has not stopped at the small wristwatch radio, but has since developed even smaller units. A number of these are reproduced here for the first time in any publication.

There is, for instance, an astonishing new two-stage audio amplifier, illustrated in these pages, which is incredibly small. This amplifier (complete with tubes) is a cylindrical plug-in unit and weighs 17 grams (a little over half an

ounce). It is $1\frac{1}{4}$ inches long and $11/16$ inch in diameter. The prongs are $7/16$ inches long. The entire amplifier is cast in solid transparent plastic. Therefore, it cannot be taken apart or opened. The only way this could be done would be by dissolving the plastic in a solvent. It could not be taken apart mechanically because in the process all the parts would be ruined. The circuit diagram of this transmitter is also reproduced here. It is probably at the moment the smallest two-stage audio amplifier ever made.

Since Dr. Brunetti constructed his wristwatch radio—shown on the cover of RADIO-CRAFT this month—he has developed an even smaller one. It is the smallest ever built up to now. The small flat two-tube transmitter is shown in our illustrations. The entire circuit is printed on a $1/16$ inch lucite plate; the transmitter (tubes, resistors, circuits, base plate, etc.) weighs exactly 8 grams ($2/7$ oz.). The tiny set, smaller than a book match, measures 1 inch by $1\frac{15}{16}$ inch and is $5/16$ inch in maximum height.

As we go to press Dr. Brunetti has come up with some even more astonishing versions of his miniature radios. During the first part of last February he demonstrated his "Half-Dollar Radio Station" before the local section of the Institute of Radio Engineers in Washington.

He exhibited a whole "network" of radio broadcast transmitters which he carried in his pockets. Among others he demonstrated a tiny transmitter which fits in an empty lipstick container. He also had a "Calling Card Radio," the size of a calling card.

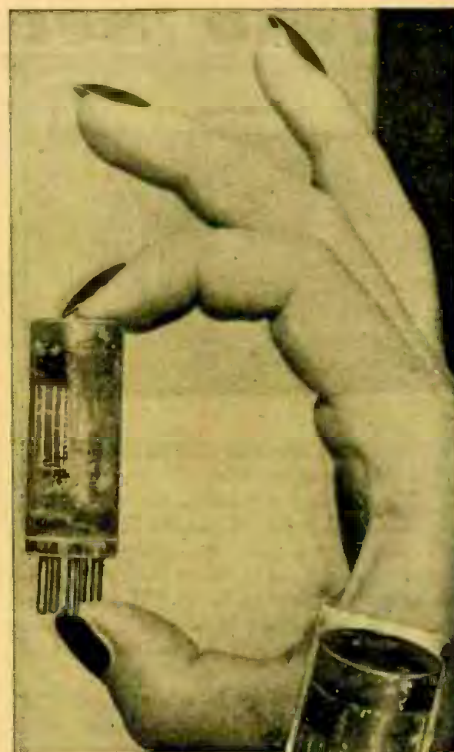
His "Half-Dollar Broadcasting Unit" is built on a square which barely covers a 50c piece. The thin plastic square measures $1\frac{1}{4}$ inches each way. Flat painted lines, which are the radio circuits, are used instead of wires. The tiny tubes are soldered to the flat surface. Small hearing-aid batteries supply the power for this sub-miniature radio station.

Dr. Brunetti also presented a duplicate vestpocket transmitter and receiver of the type presented to President Truman, as above mentioned.

These small radio transmitters and receivers are no longer in the theoretical stage nor are they "stunt" exhibition pieces. The National Bureau of Standards, in a recent survey revealed that more than 65 radio manufacturers have begun to use printed circuit techniques in various of their products.

There is already in use at present a hearing aid manufactured with the printed circuit. Plans are under way for two-way personal radios at present.

Dr. Brunetti illustrated to the assembled engineers at Washington how large stores can use the midget transmitters in routine inventory taking. The idea for this use of miniature radios came from an executive of a large chain store. One clerk would count the stock, broadcasting by radio the resulting stock figures to the main office where they would be recorded and tabulated. This would be quicker than having the clerk write down the results himself, because



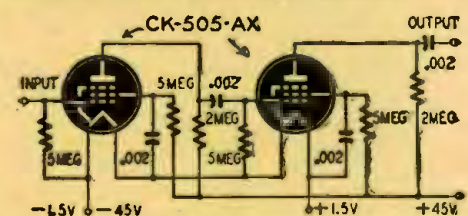
This plug-in amplifier is hermetically cast in a Bureau of Standards-developed potting (plastics) resin.

he could not count stock while writing, whereas the voice transmission to a competent stenographer works twice as fast.

At the present time Dr. Brunetti and his staff feel that while the electronic parts of their radios have shrunk to a size never contemplated before, the battery interests have not kept pace with electronic developments.

Both A and B batteries still bulk many times the space of electronic parts of the miniature radios. It is along this line of attack that greatest progress is expected in the immediate future.

During the war years dry-battery manufacturers have made some advance



Schematic of the potted two-stage amplifier.

in reducing dry cells to smaller size, but they are still far too bulky and much too large.

If it were not for the bulky batteries, Dr. Brunetti's various transmitters and receivers could be made far smaller than they are today. It is felt, however, that this problem too will be solved in the near future, once the battery interests understand how tremendously important sub-miniature radios will become in the future.



Another view of the new smallest transmitter, shown also on preceding page.