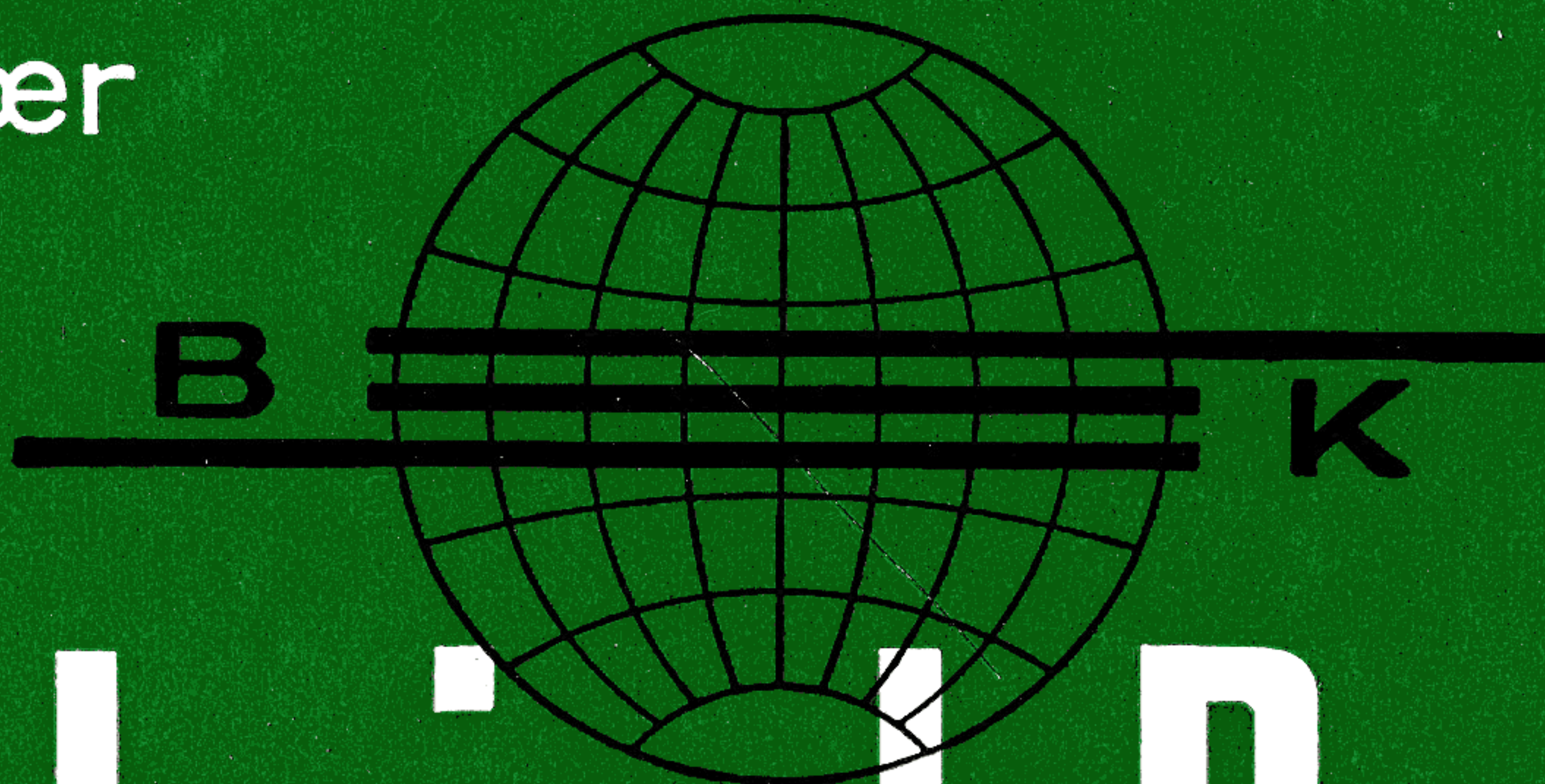


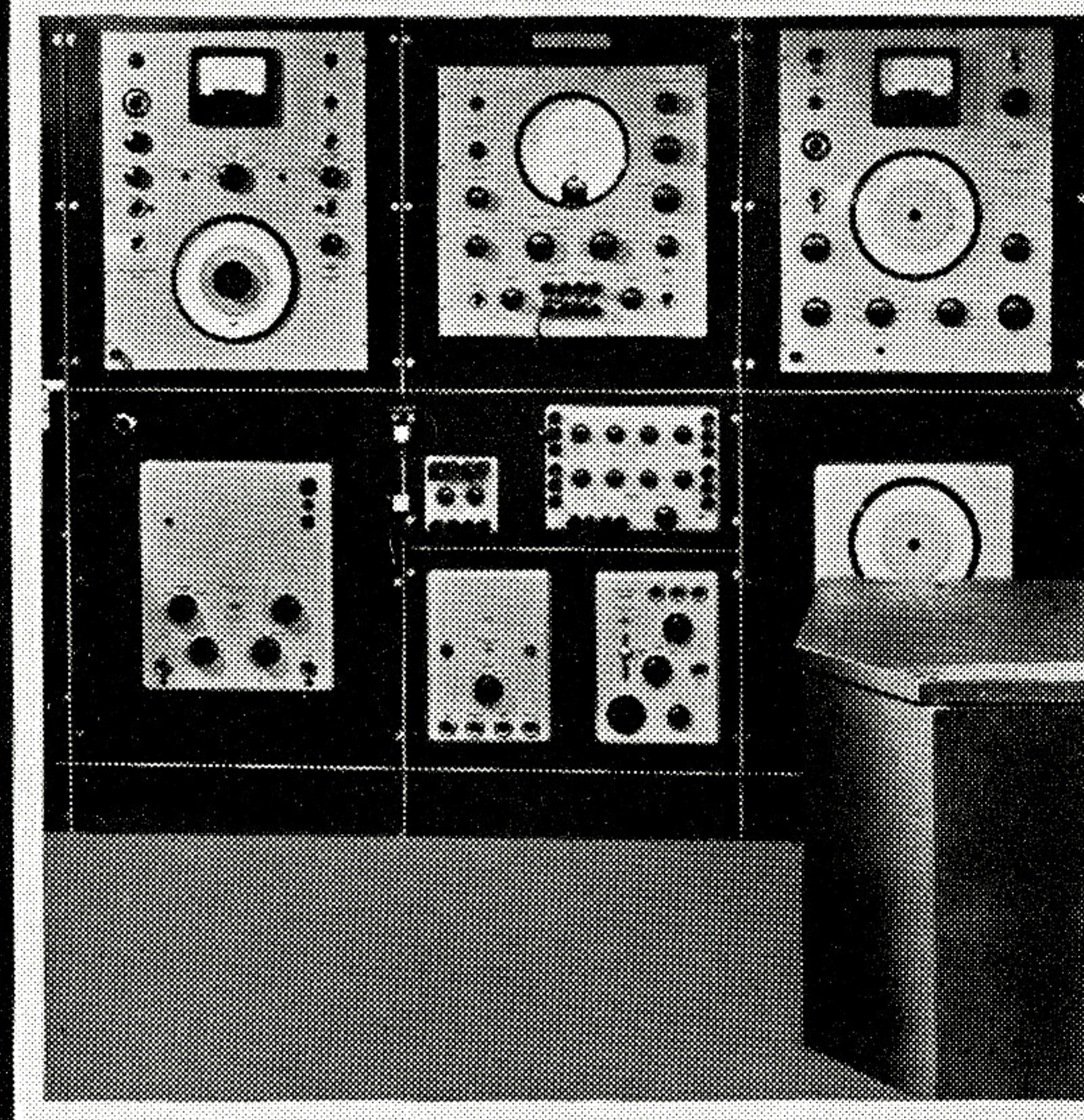
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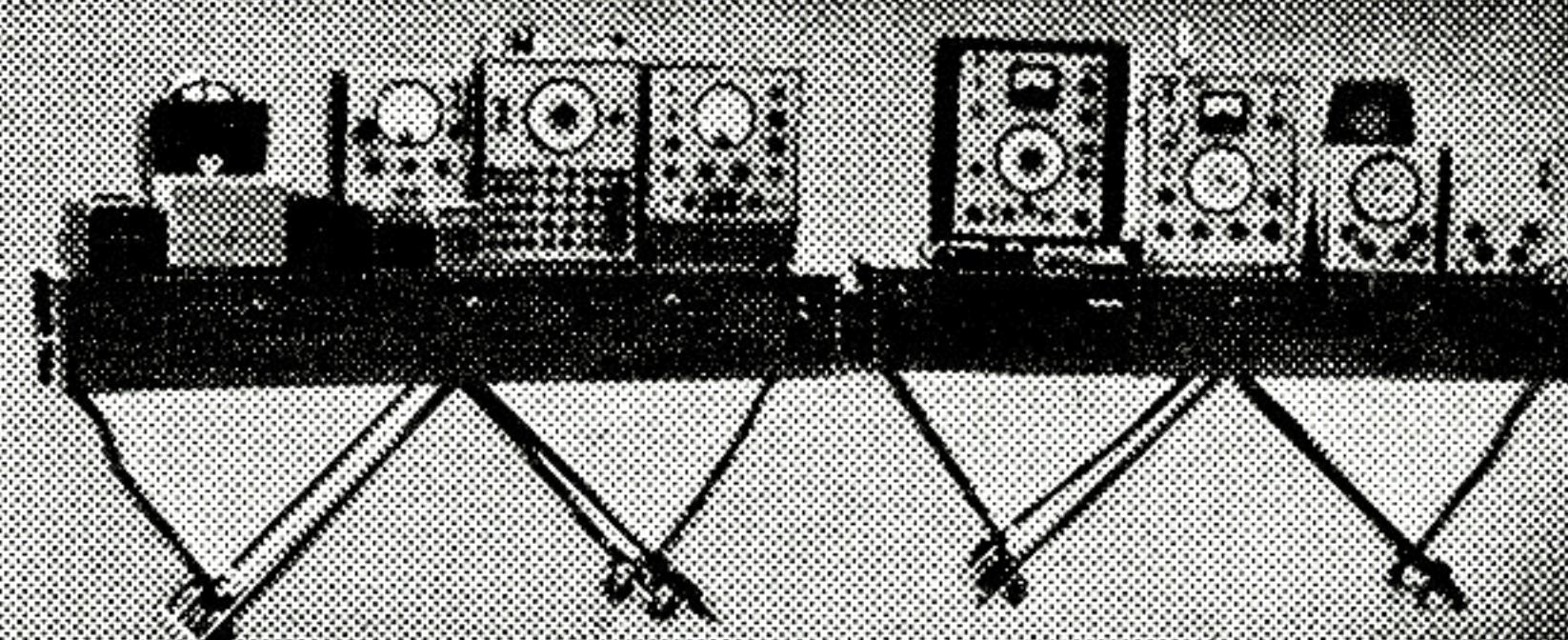
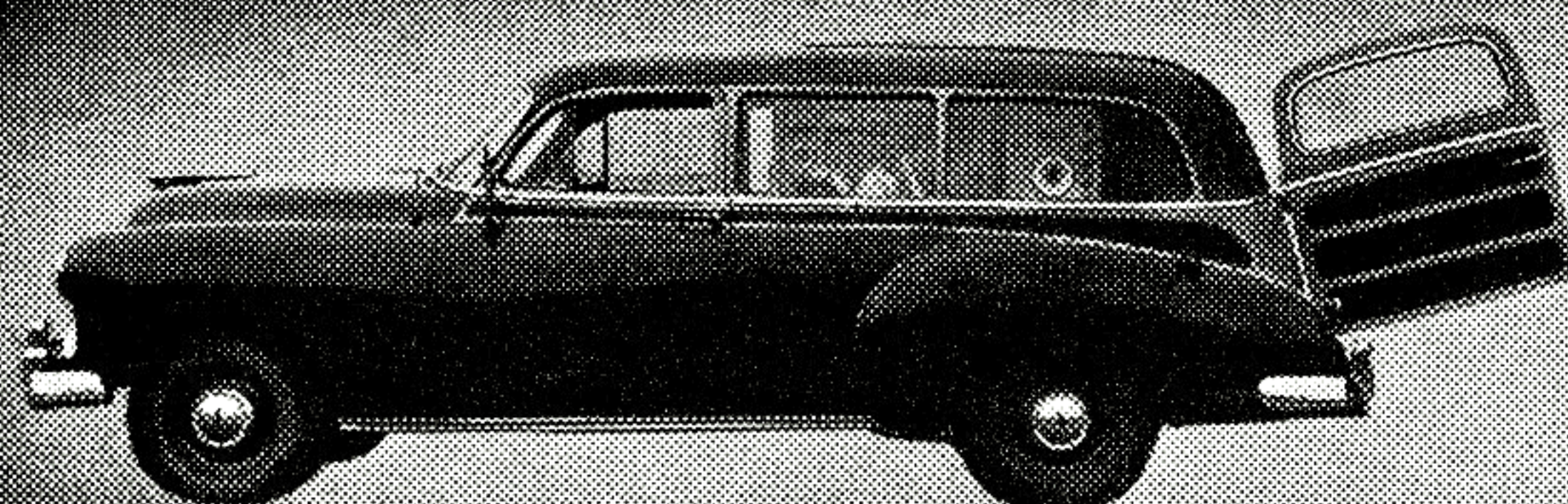
Technical Review

Teletechnical Acoustical, and Vibrational Research

MOBILE



LABORATORIES



MOBILE LABORATORIES

by

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When measurements and investigations in building acoustics are carried out, the measuring equipment has to be moved out to the actual building site and the measurements made there, often under very primitive conditions. One often finds that it takes a much longer time to arrange a complicated measuring set-up than to take the actual measurements. Experience shows that it takes a long time to pack expensive instruments for transport, unpack them at the measuring site, set them up on stands or tables and interconnect them.

A natural conclusion is to place the instruments, ready for use, in a car and drive this to the measuring site. A mobile laboratory is thus obtained. In what follows, various viewpoints and experiences with mobile laboratories will be discussed.

Most laboratories concerning themselves with building-acoustic measurements also carry out investigation of vibration problems in vehicles and in diverse fields of machine industry, as a large part of the electronic measuring equipment is the same as is used in acoustic measurements, the only difference being that vibration pick-ups are used instead of microphones. Out of considerations of economy in apparatus, it is also desirable that the mobile laboratory should be able to carry out measurements in electro-acoustics, such as the recording of frequency characteristics of loudspeakers and similar items.

The Building Research Station, Watford, England, and TNO, Rotterdam, Holland, have both set up a mobile laboratory for building acoustic and technical vibration investigations. The vehicles used have been relatively large buses with adequate internal working space, and a roof height so great that one could stand erect while working. The instruments have been both of rack-mounting type permanently fitted in the vehicles, and ordinary laboratory instruments set up on the working tables in the bus.

Mobile laboratories of this kind are very convenient for working in, and give good accommodation for personnel, but the disadvantages of using specially built buses as mobile laboratories are also considerable.

First and foremost there is the very great cost of such a bus compared with the price of an ordinary smaller van. When the capital investment is considered, one must not only consider the purchase price but also what price one could get for the vehicle if one wished to sell it again. A specially constructed bus has thus a resale value which is only a fraction of the purchase price, whereas a smaller van only decreases in value according to age and wear, and often the sales price even many years after purchase is still about the half of the purchase price.

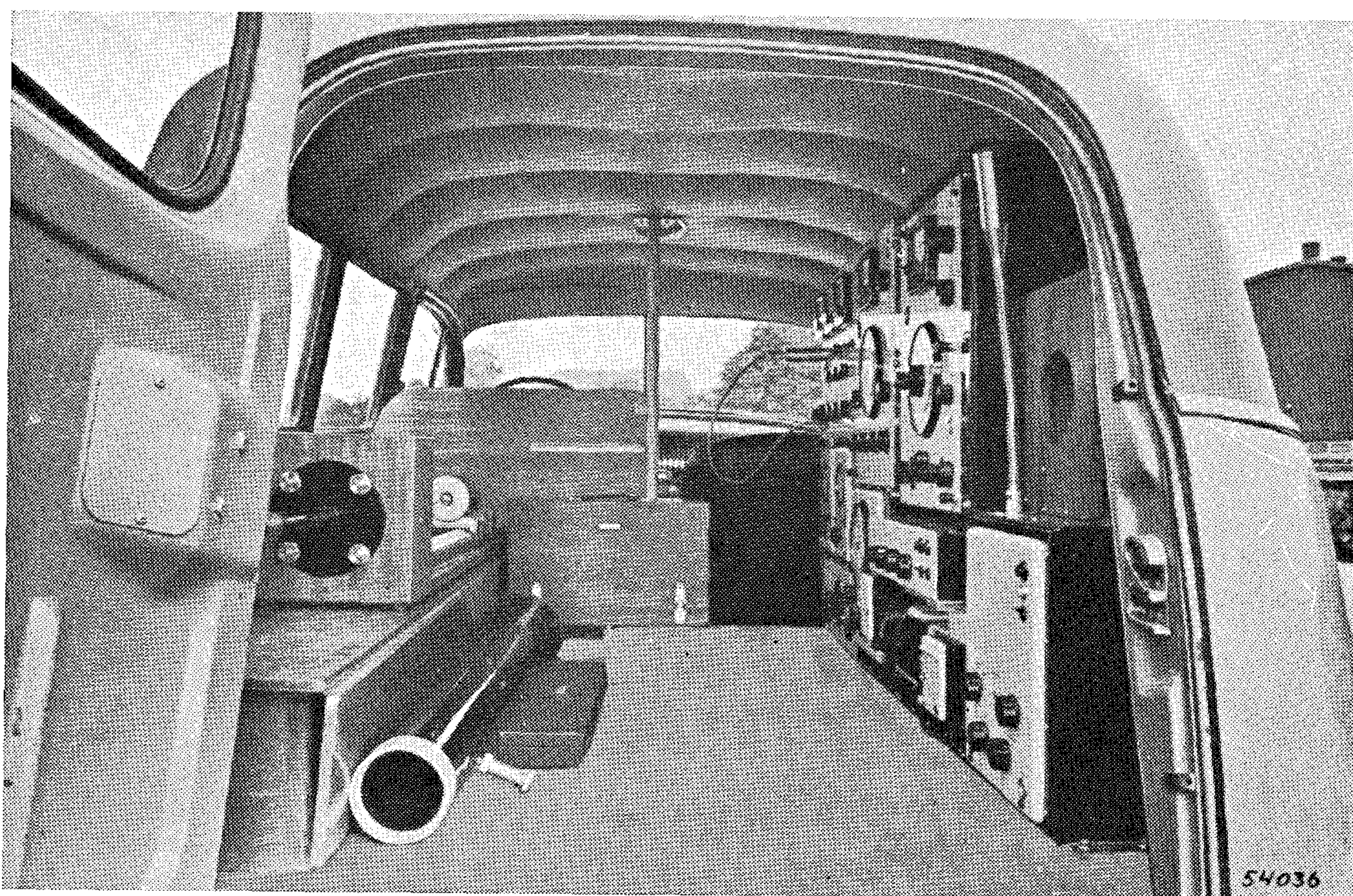
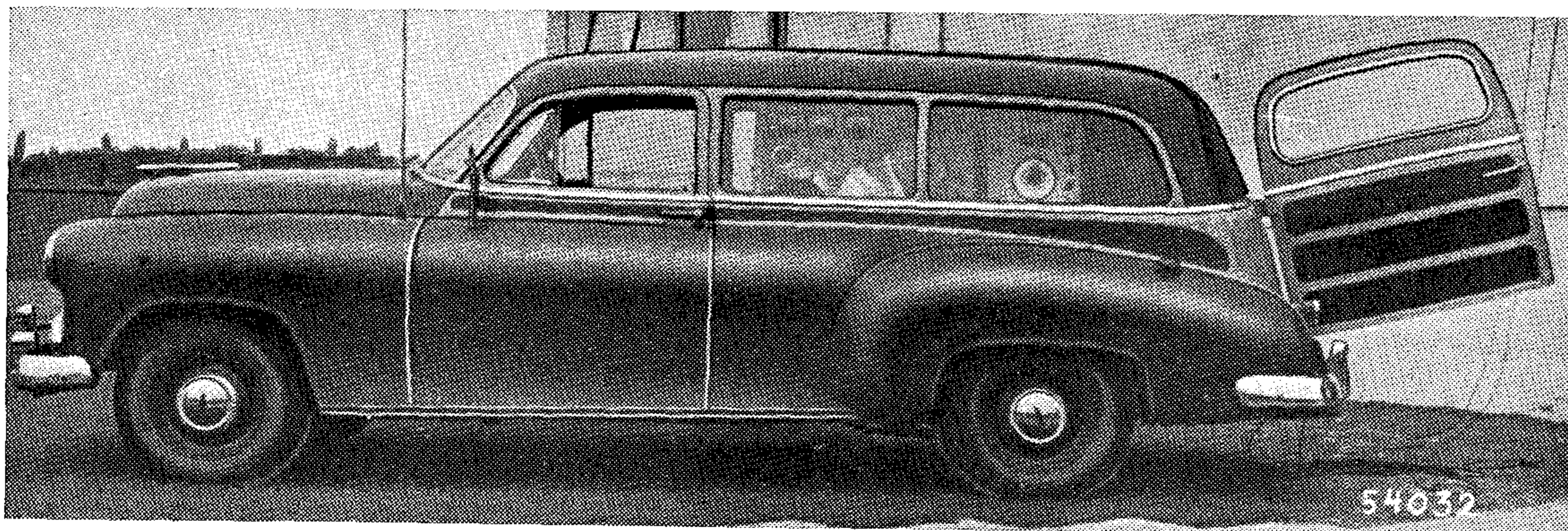


Fig. 1. Chevrolet Station Wagon with instruments for building acoustic measurements. The wagon has the following instruments installed in a rack on the right hand side: 1032 - 2334 - 2601 - 2105 - 1602 - 2002 - 2407 - 1604, and on the left hand side, under the seating places: 4111 - 4114 - 4002 - 4303 - 4304 - 2345 - 2348 - 4113 - 4405 - 4407.

Among the considerations to be taken into account is also the fact that an ordinary van can be used for other purposes than measuring work. A small van of the delivery type can be used for goods and personnel transport, necessary in every laboratory. A large bus can only seldom be used for such purposes. If the mobile laboratory is to run long distances, the running expenses them-

selves (gasoline, oil, tyres and wear) are considerable, and the thrice greater expense per km run of the large bus by comparison with the ordinary van is a considerable factor in the decision. Further, one often has difficulties on account of the weight and size of the bus. For example, a bus can only get into an ordinary factory hall with difficulty, and must be driven up as close to the building as possible, with cable connections between the point of measurement and the bus made through doors, windows etc,

On many building sites it is difficult to find roads and places strong enough to carry a heavy bus, and even with a smaller van there is often the risk of getting stuck fast, but the work of hauling out an ordinary van is considerably easier than that of freeing a bus which cannot go further under its own power.

Taking these disadvantages into account, we have experimented with mobile laboratories, using in all cases quite ordinary commercially available vans, whereby the capital investment has been kept down to a minimum, and where the van has not as a rule been larger than that it could be driven into most buildings.

Fig. 1 shows one of the first vans we fitted out specially as a mobile acoustics laboratory. It contains instruments capable of solving all the normal acoustical and technical noise problems which can arise, such as measurements of reverberation times, sound insulation, footstep noise, sound intensity measurements and recordings, vibration analysis, measurements of acoustic impedance, estimates of absorption coefficients, recording of frequency characteristics of electro-acoustic material, etc.

All the large instruments are mounted firmly in a rack on the right hand side of a Chevrolet station-car. The power supply is available from either the car's own standard accumulator via a rotary converter, whereby the instruments can be kept running for about 2 hours, or from the power supply by a cable connection, if the supply is available on the site. An auto-transformer is built-in, so that all possible voltages can be used.

All accessories, cables and smaller instruments are placed in drawers and cupboards on the left hand side of the car, and in spaces under the floor boards. The roof height is not so great that it is possible to go upright, but one can sit and operate the instruments in comfort. In front, in the driver's seat, is a built-in dictaphone, so that all reports can be dictated on the spot. This latter is a very great advantage in practical work, as one is then sure that no important details have been forgotten.

When working with the car, it is a rule that all measurements should be treated before leaving the measuring site, and the report then dictated. This is done to ensure that all the necessary measurements have been carried out, and that it should not be necessary to return a couple of days later to repeat a measurement or carry out supplementary investigations.

We have made some experiments with the mechanical mounting of the electronic instruments in a mobile laboratory. Many have tried supporting the instruments in shock-absorbers, either with steel springs, rubber absorbers, or such like. With a very carefully carried out mounting in shock-absorbers, it is possible to reduce the acceleration of the instruments somewhat, but if the suspension is not done very carefully, while at the same time allowing for large amplitude swings of the instruments, they will sooner or later be exposed to powerful blows. Shock absorbers without high internal damping are quite unsuited: suspending the instruments in steel springs, for example, will be immediately damaging, as sooner or later the car will be exposed to such frequencies that resonance will be produced, and the amplitude of the vibrations will be so great that the instruments will strike the supporting frames and receive powerful blows. To satisfactorily suspend electronic instruments in shock absorbers in automobiles thus requires very much space, and we have finally come to the result that it is more advantageous to mount the instruments firmly in the car on solid frames, racks, etc., but without springing of any kind.

It is worth noting that this experience is contrary to general practice in aircraft, where most electronic instruments are mounted on vibration dampers. However, the problem in aircraft is somewhat different from in automobiles, as in aircraft one only wishes to insulate against vibrations of high frequency, while allowing the instruments to follow all low frequency movements. Thus, in aircraft one can sharply distinguish between a high frequency region, which can be easily insulated against, and a low frequency region, in which one wishes the instruments to follow freely. In automobiles, the problem is more complicated, as here the frequency range is greater, and it is impossible to distinguish a typical high frequency range and a typical low frequency range. As it is the high frequency vibrations which to a large extent reduce the life of the bearings in pointer instruments, it is natural to wish to insulate against these in aircraft. As the high frequency vibrations are not so powerful in automobiles as in aircraft, it is unnecessary to insulate against them in automobiles.

An insulation which is effective at high frequencies must of necessity have a resonance range somewhere in the medium frequencies, and as vibrations in the medium frequencies are powerfully represented in automobiles, as opposed to the conditions in aircraft, insulation against these high frequency vibrations would be directly dangerous in automobiles. We thus definitely recommend a fixed mounting of instruments in automobiles, and this is also advantageous from the point of view of economy and space saving. It is important that the instrument be mounted particularly firmly. If they are not really solidly mounted, they will quickly begin to rattle, and damage will very easily arise. All screw fastenings should naturally have spring washers.

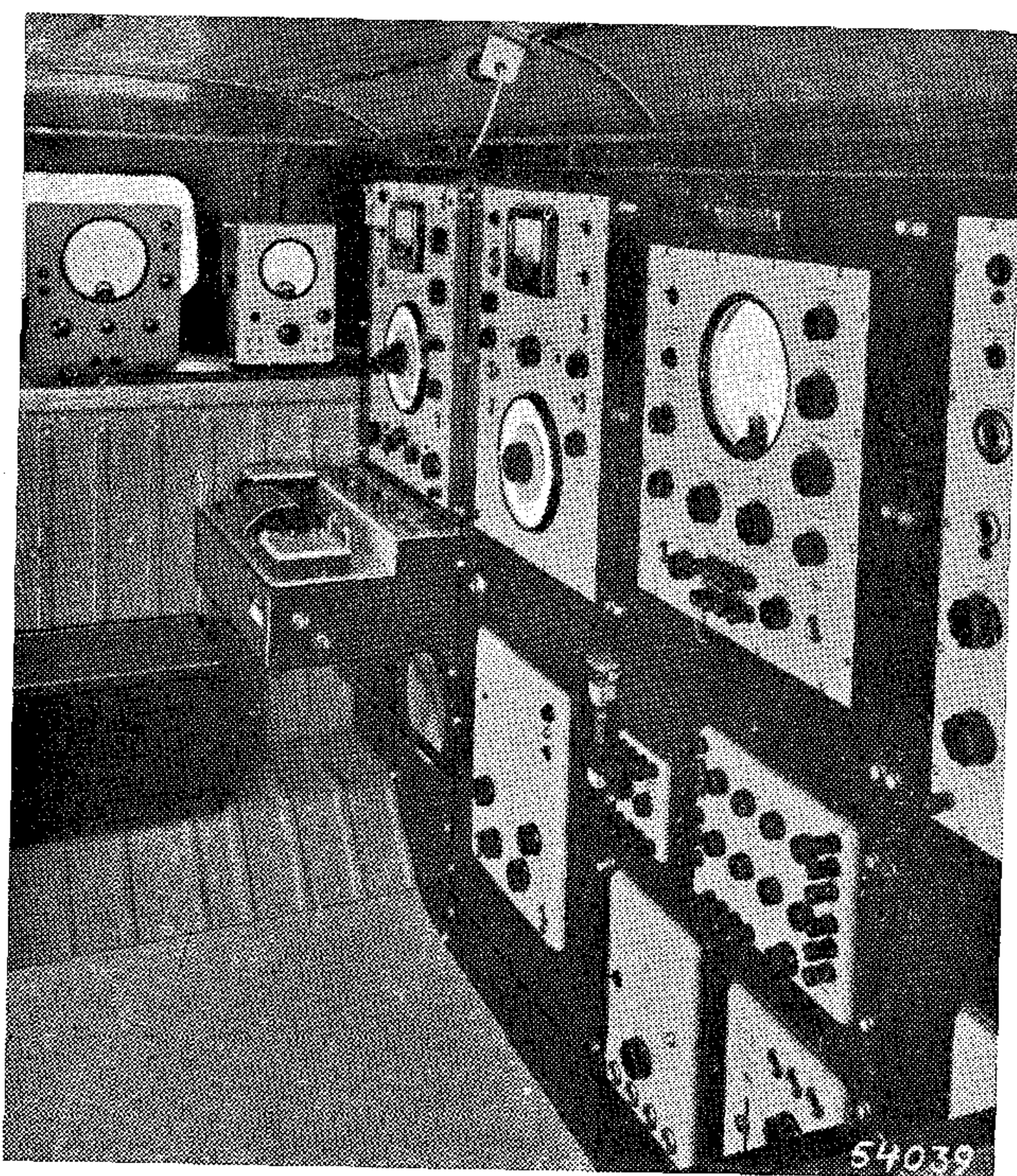
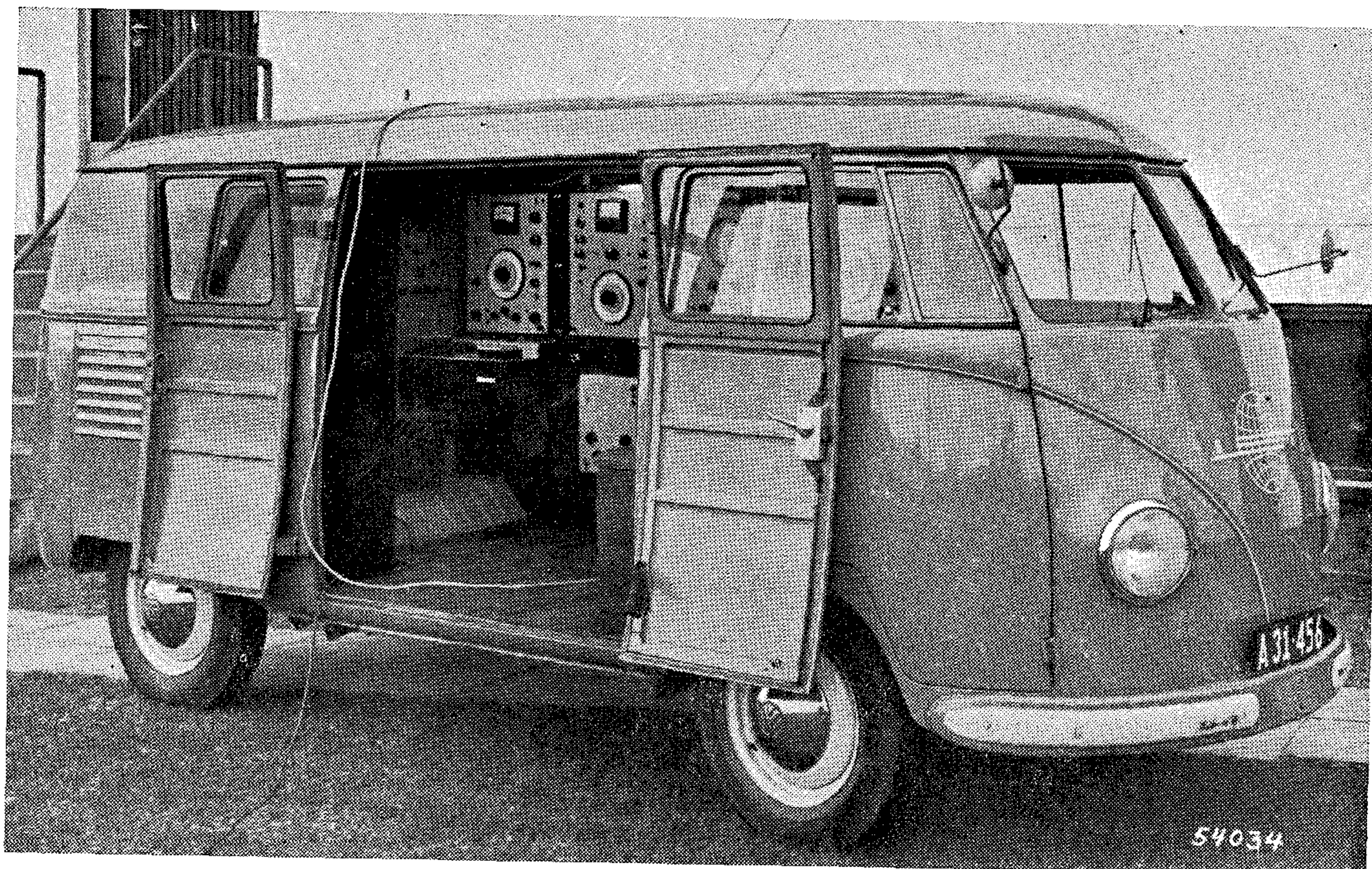
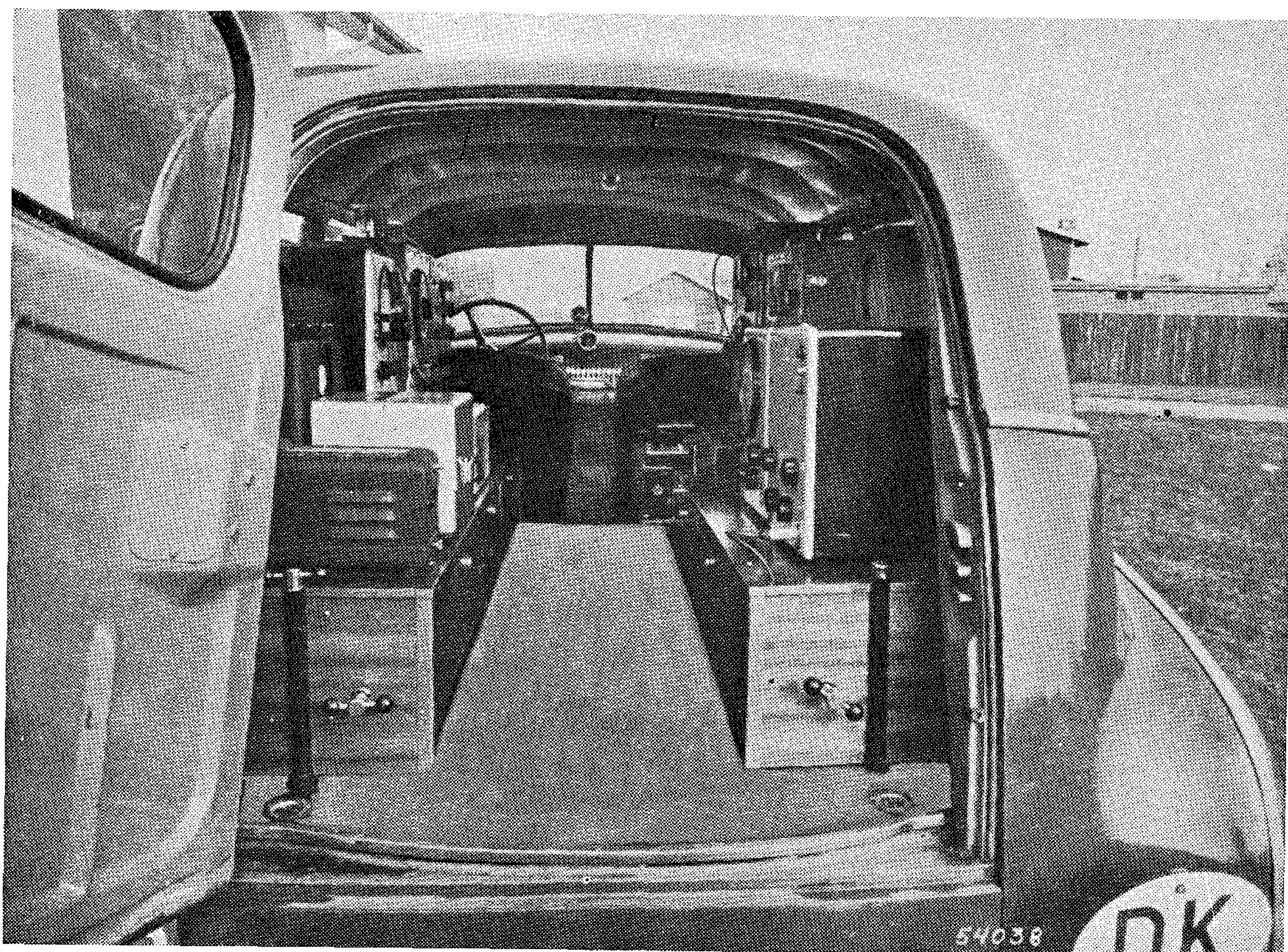


Fig. 2. Volkswagen van with instruments for building technique acoustics, engineering and electrical measurements set up in racks at the sides, as well as some instruments screwed down at the back of the van above the motor. In the left hand rack: 2314 - 2109 - 2105 - 2601 - 1516 - 1530 - 1531 - 1602 - 1604 and a loudspeaker. In the right hand rack: 2002 - 2407 - 5402 - 2423 - 2415.

Furthest back: 4707 - 1502 - 4120 - 4210. In the spaces under the two racks and under the seats: 2370 - 2345 - 2348 - 4109 - 4111 - 4114 - 4115 - 4430 - 4405 - 4303 - 4304 and cables and accessories.

Fig. 2 shows another form of arrangement, where a whole row of different instruments for acoustical, teletechnical, electrical, engineering and building technique investigations has been mounted in a Volkswagen van. Here, the instruments are set up in racks fastened to the van's floor and ceiling. Power supplies to the instruments, as before, are either from the power line or from the van battery by means of a small rotary converter. In the Volkswagen van the battery has been supplemented by another accumulator, and the two batteries are connected in parallel (6 volts) when charging, but in series (12 volts) when running the rotary converter.

Many laboratories uncertain whether they can spare a complete measuring equipment for a mobile laboratory, are reluctant to use the solution here described whereby the instruments are permanently mounted in a van, as it is then difficult to remove the instruments for laboratory use. Some laboratories have therefore equipped their mobile laboratory in such a way that there is a row of shelves in the van into which the instruments can fit. When the van is not being used for measurements the instruments can then be relatively easily removed from the shelves. However, in this method a whole series of instrument connecting cables is obtained, which have to be connected and disconnected each time the instruments have to be used in the van or laboratory in turn.



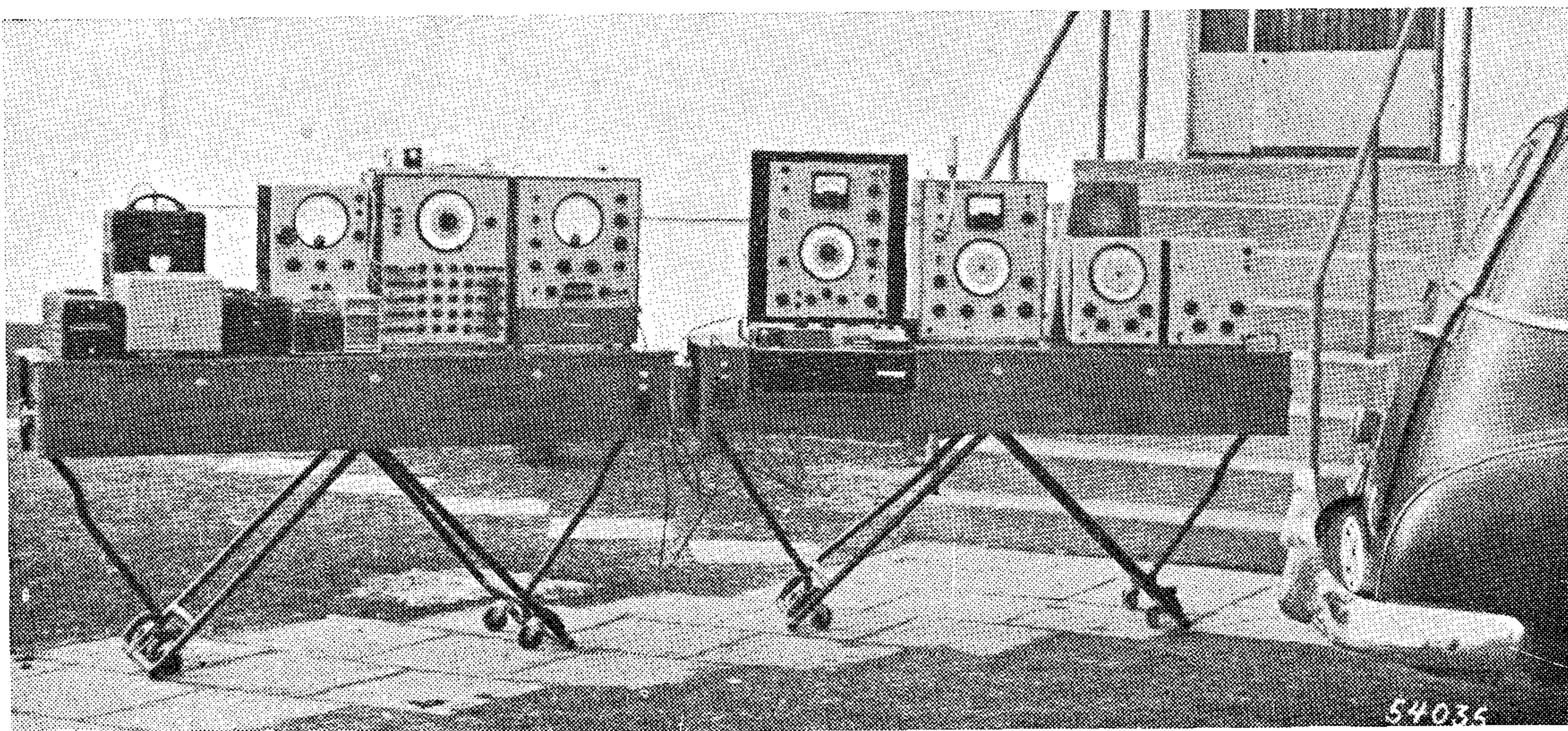
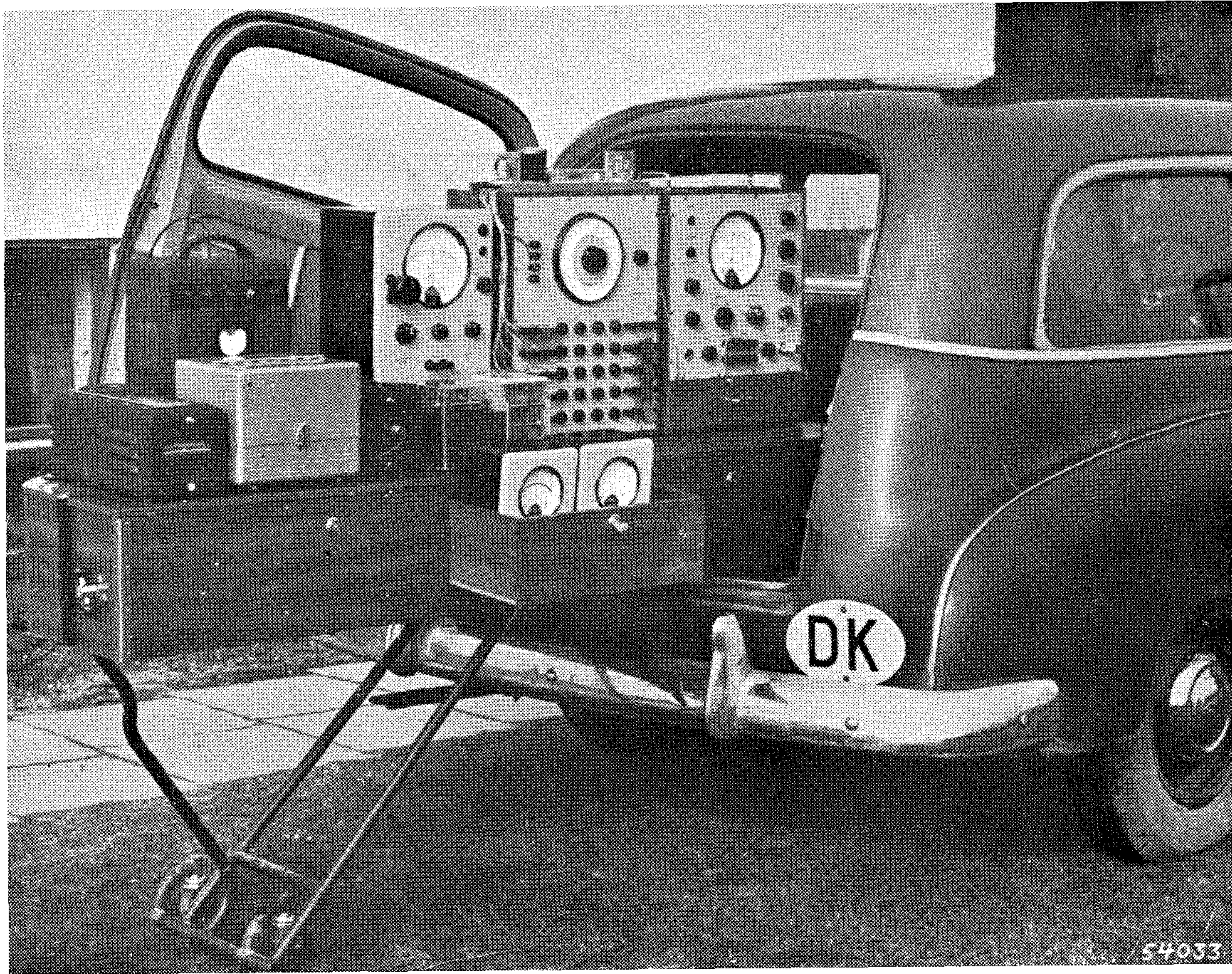


Fig. 3. Mobile laboratory equipped with instruments for building acoustics and vibration measurements, stress analysis in the building and machine industry, noise and electroacoustic measurements. The instruments are mounted on two tables which are easily removed from the wagon. On the right hand side table are: 2314 - 2105 - 1602 - 2601, all firmly fastened down. On the left hand table: 1516 - 1536 - 1502 - Brush instruments BL905 - BL932 - BL110 - BL202.

We have therefore sought for yet a third solution to the problem of the mobile laboratory, as shown in fig. 3. Here, the instruments are mounted firmly on long tables, which are made fast in a Chevrolet station wagon by means of 3 hand-screws. The tables are thus easily dismounted. They can be simply rolled out, as they have a built-in collapsible frame on wheels, as shown in fig. 3, below, so that when they come out of the wagon they can continue along the ground on their own wheels. The small wheels under the frame are on casters, and so arranged that when the frame is folded up under the instrument table in the wagon, the wheels can still be used to roll the table in the wagon. Only first when it is in place, and the screws which hold the table are inserted, can the wheels be screwed up with special screws, so that the instrument table sinks down into its proper position.

Fig. 4 shows a drawing of the frame for the instrument table. The right hand side shows the frame opened out in the position used when the instruments are out of the wagon, and on the left is shown the position used when the tables are rolled into position in the wagon. Note that the turning axes of the

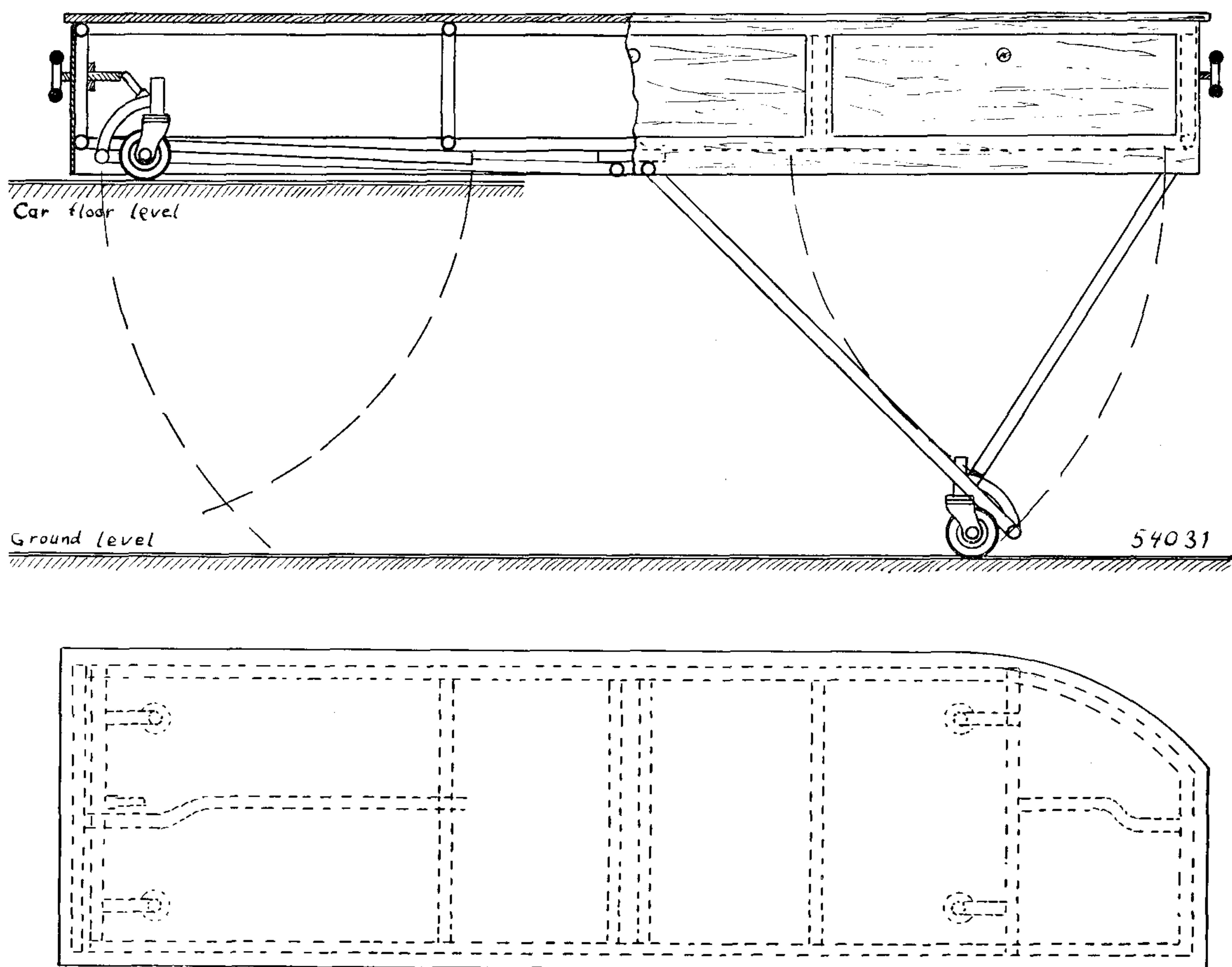


Fig. 4. Drawing showing principle of the wheeled frame used for the tables in the mobile laboratory shown in fig. 3.

small wheels are vertical in both positions. There are drawers in the instrument table for accessories, cables, papers etc. With this mobile laboratory measurements can be carried out with the instruments in place in the wagon, or, when at the measuring site, the instrument tables can easily be taken out of the wagon. All the necessary cable connections are attached firmly to the instrument tables, and it is only necessary to connect up a power cable to one point. The two tables are interconnected by only 3 cables, whereupon the instruments are mutually connected for all measurements. The tables are not so long that they cannot be transported in a factory goods lift, and in case of need they can also be carried up a flight of stairs.

Back in the laboratory, the instrument tables can be taken out of the wagon and easily transported around, so that the instruments, fastened firmly to the tables, can be used for measurements at any point. This form of mobile laboratory has shown itself very practical for all forms of acoustic and vibration measurements.

Finally, fig. 5 shows a few instruments for measurements of building acoustics built into an ordinary private car. The instruments are fastened firmly in the trunk in such a way that they can be easily operated without the necessity of removing them from the car. They can, however, be easily removed if required for measurements elsewhere.

A list of the instruments with which the different mobile laboratories are equipped is given under each illustration. The instruments are identified by their type numbers, and below we give a list which will identify the individual types.

1012	Beat-Frequency Oscillator	4109	Artificial Ear
1502	Deviation Test Bridge	4111	Condenser Microphone
1602	Distortion Measuring Bridge	4115	Extension Rod
2002	Heterodyne-Voltmeter	4114	Extension Cable
2407	Audio Frequency Voltmeter	4120	Microphone Calibration Apparatus
2423	Megohmmeter	4210	Artificial Voice
4708	Frequency Response Tracer	4405	Two Channel Selector
2105	Frequency Analyzer	4407	Universal Selector
2109	Audio Frequency Spectrometer	4610	Inverter
2304	Level Recorder	1516	Strain Gauge Apparatus
2311	Audio Frequency Spectrum Recorder	1530	Balancing Unit
2314	Automatic Frequency Response Recorder	1604	Integration Network and Adjusting Unit
2370	Polar Diagram Recorder	4303	Piezo-Electric Vibration Pick-up
2601	Microphone Amplifier	4304	Piezo-Electric Vibration Pick-up
4002	Standing Wave Apparatus		

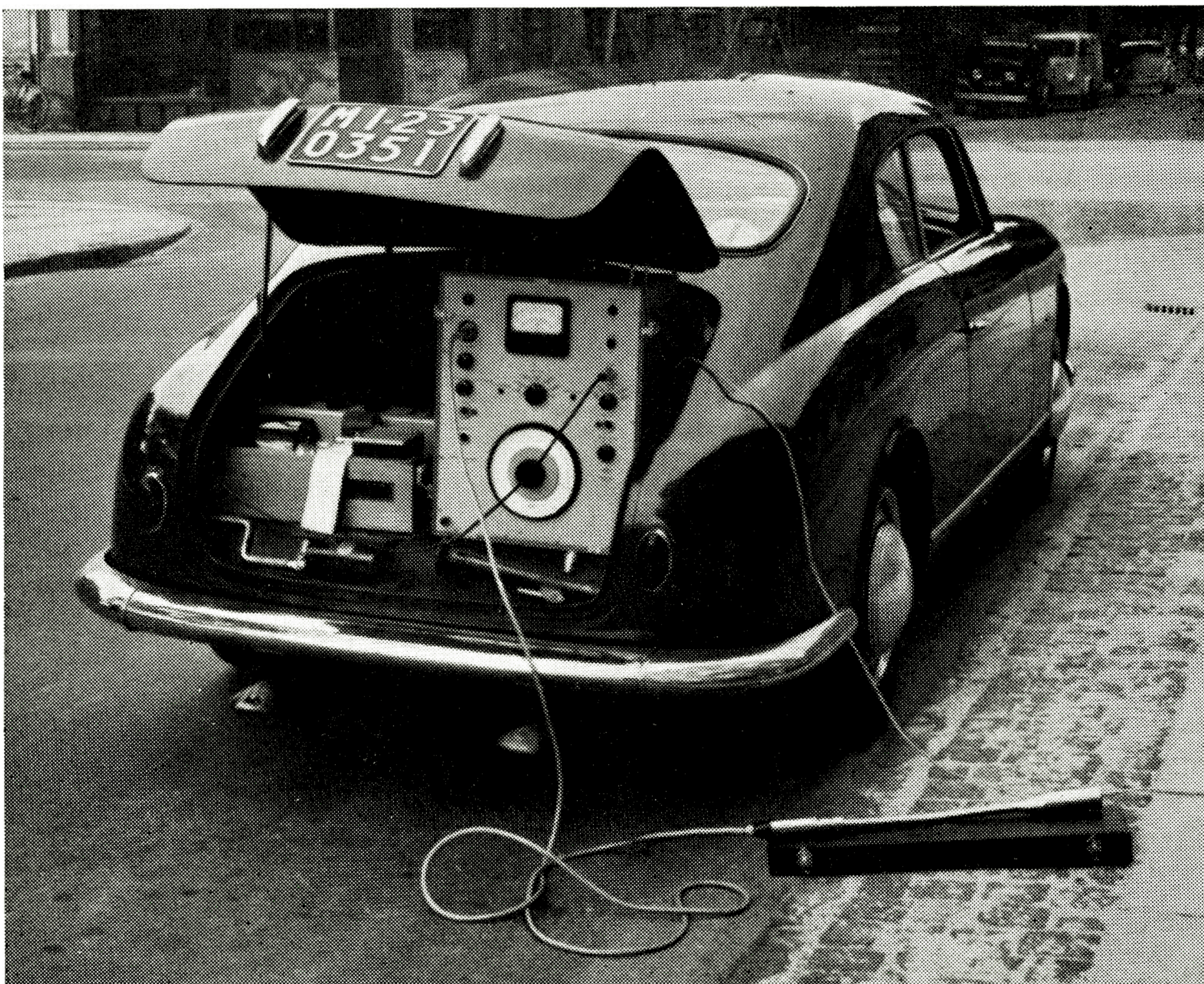


Fig. 5. A few instruments for simple noise analysis measurements, mounted in an ordinary private car.

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