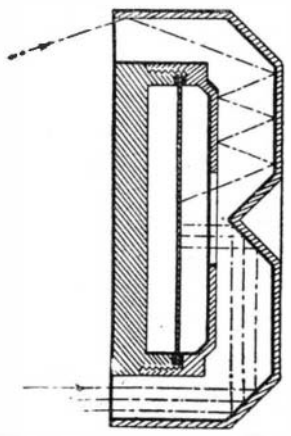
of factories, a workman using this apparatus poured a heat in a minute less time than the workman who was not supplied with the appliance. The apparatus does not offer the slightest obstacle to the man's operations, since he can clearly see what he is doing throughout the process. Our photograph showing the apparatus in operation affords a striking testimony of the purer atmospheric conditions under which the workmen labor with this appliance, since only five per cent maximum of the fumes escape into the air within the factory.

But the invention possesses another valuable feature. The zinc-oxide fumes emitted from the molten brass, as is well known, are a commercial commodity. This chemical is deposited upon the inside of the flexible tubing and galvanized pipe, whence it can be easily recovered. About ninety per cent of this scale is zinc oxide, so that the process of recovering the chemical from the deposits is neither expensive nor protracted, owing to its abundance. The main galvanized-iron trunk, in which the flexible exhaust pipes connected to the hoods fitted to the pots terminate, are provided with dampers, so that they may be shut off as desired. The zinc oxide deposit within the exhausts is removed by means of a brush; and so quickly and thickly does it collect, that cleaning has to be done at least once a week to insure a clear passage for the fumes through the pipes.

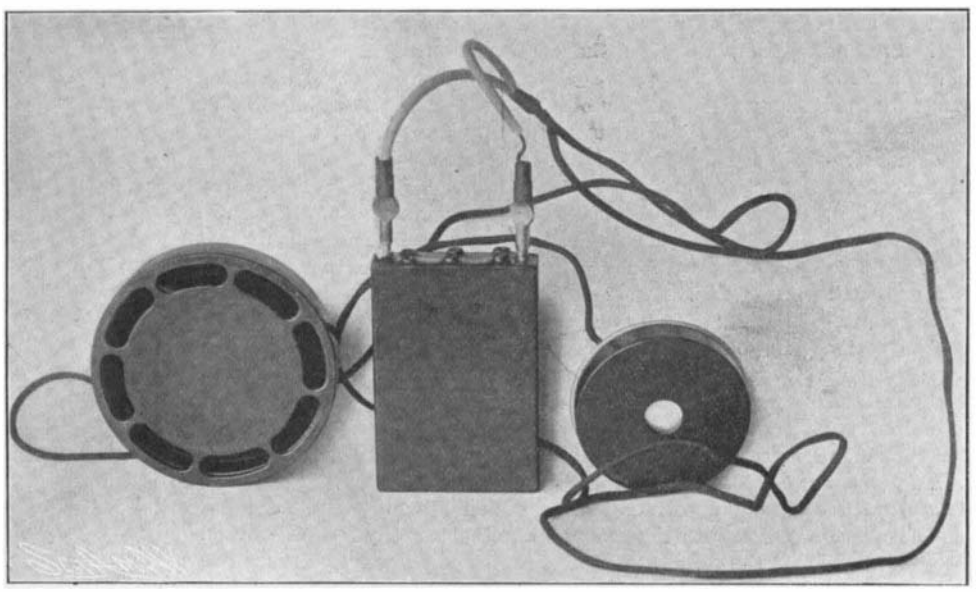
So successful has the apparatus proved itself, that its more extensive utilization is being strongly recommended by the inspector of factories as an efficient solution of the problem of rendering the brass-casting industry less dangerous to the health of the workmen employed therein.

NEW INSTRUMENTS FOR ENABLING THE DEAF TO HEAR.

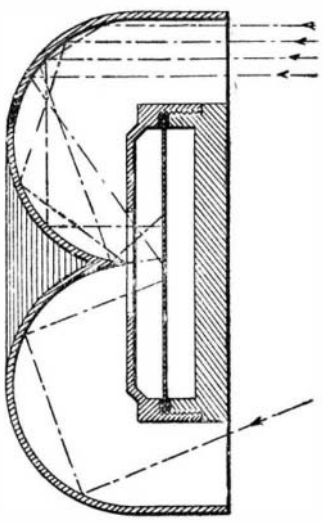
About a hundred men and women recently gathered in the laboratory of Mr. Miller R. Hutchison, in New York city, for the purpose of witnessing tests of certain instruments which he has devised to enable deaf mutes to hear. The results attained were



Section Showing the Principle of Deflection of the Acousticon.



The Acousticon. A Portable Apparatus for the Deaf.



Another Form of Acousticon.

How the Acousticon is Carried, Showing the Compactness of the Apparatus.

The Massacon. A Photo-Electric Ear-Massaging Device.

Listening to Music, Transmitted by the Opera Box.

Teaching a Deaf Mute How to Hear and Speak with the Instruction Outfit.

The Desk Outfit.

NEW INSTRUMENTS FOR ENABLING THE DEAF TO HEAR.

almost incredible. A young woman of twenty-two who had lost sight and hearing at the age of six listened rapturously to the sounds of musical instruments and the human voice, conveyed to her for the first time since her affliction, by the new instruments. A boy student of the New York Deaf and Dumb Institution, who although deaf, had been taught to speak by watching the lips of others, repeated the words "papa," "mama," and "hello," after he had heard them with the aid of the apparatus, much to his own astonishment. A girl, born blind, deaf, and dumb, clapped her hands in ecstasy, when she heard herself utter "mama," and wistfully reached out toward the piano when the musician stopped playing and she no longer heard the harmonies that had thrilled her. Similar examples could be multiplied almost without end, for the instruments have been used on thousands of deaf and partially deaf persons.

After having witnessed so impressive a demonstration, one comes away with the idea that after all no one, except the man whose auditory nerve is paralyzed, is totally deaf. Many of those whom we are accustomed to regard as deaf are only partially deaf. The essential parts of the auditory apparatus are still present. It is only the subsidiary parts that are missing or defective. Your deaf mute, so called, is really not in need of an instrument which will amplify sound enormously. What he really needs is something to take the place of the missing or defective parts of his ear. And this is the result which has been attained in some of the instruments devised by Mr. Hutchison. In order to comprehend clearly what his apparatus really does it is necessary briefly to outline the structure and functions of the human ear.

The ear may be considered as composed of three parts—the external, the middle, and the internal ear. The visible ear is the external ear. It extends inwardly to the ear drum. Here begins the middle ear, which may well be regarded as a cavity filled with air. This air-filled cavity contains the ossicles—a chain of three small bones, connected together and extended across to the entrance of the internal ear. Of these small bones, the first is attached to the ear-drum; and the last to a membrane in the entrance of the inner ear, called the "oval window." Beyond this window lies a column of liquid in which float some three thousand nerve terminals, which, on their route to the brain, are wound together into a cable, which is known as the auditory nerve. If this nerve be affected to such an extent that deafness results, hearing can not be restored, any more than a man whose optical nerve is affected can be made to see. Sound agitates the column of liquid with more or less violence, depending upon the volume and pitch of the sound, and other circumstances. Each of the three thousand nerve terminals selects its proper sound and conveys it to the brain by means of the auditory nerve. Acoustic vibrations will not pass from a gas to a liquid without the assistance of some intervening medium of translation. The atmosphere through which we talk is a gas; the internal ear is filled with a liquid. It is the function of the ear-drum and the small bones to take up the sound waves from the air, to translate them into mechanical movement in order that the liquid of the internal ear may be properly excited. Sound, conveyed by the atmosphere to the ear, causes the ear-drum to vibrate. The vibrations of the drum are communicated to the chain of small bones, which, as they move, cause the oval window to pulsate, and hence the ear liquid to wash back and forth. Then the nerve terminals and auditory nerve are excited.

It is the purpose of one of Mr. Hutchison's instruments (the "acousticon") to take the place of the middle ear. The "acousticon" is the outcome of a prior instrument, called the "akouphone," which has been abandoned for the reason that the new instrument better answers the purpose of transmitting articulate sound to the inner ear. Since important patents are pending on the "acousticon" we are able only meagerly to describe the principle of its construction.

The "acousticon" may broadly be considered a combined telephone and microphone. The principle underlying the construction of the mouth and ear piece is well shown in one of the accompanying diagrams.

The essential feature of the invention is a cup-shaped body, into the open end of which the sound-waves enter, the bottom or inner end of the body being shaped to reflect and concentrate the sound-waves and finally direct them backward until they strike the center of a vibrating diaphragm mounted in the cup at right angles to its axis.

Besides the merit of compactness, the device is distinguished by the fact that there can never occur that interference of reflected sound waves which is so grave a drawback to the use of tubes, trumpets, and horns. In addition to the mouth and ear pieces, an exceedingly small but powerful storage battery, so small indeed, that it can be slipped into the coat pocket, is employed.

It is one of the peculiarities of the "acousticon" that the articulation of the spoken words is magnified, and not so much their sound-volume. In other words, the instrument talks inversely. A deaf mute who has never heard sound must learn not only to know what sound is, but, what is of more importance, must learn the meaning of different articulations. For that reason the "acousticon" has been designed not to amplify sound-volumes, but to emphasize articulation by magnification. So admirably has this result been accomplished that even a faint whisper is clearly heard by the deaf mute.

The "acousticon" is not intended for indiscriminate use by the deaf. The art of hearing must first be taught. And for this purpose an instruction outfit has been devised, which, since it is not intended to be carried about by the deaf mute, is of more pretentious appearance and size than the "acousticon." The mouthpiece and the earpiece of this instruction outfit are each provided with a nosepiece by which the nasal sounds, which by other instruments are either lost or only partially transmitted to the ear, are wholly conveyed to the earpiece. The nosepiece serves the subsidiary purpose of preventing the pupil from watching the movements of the lips; for many deaf mutes are wonderfully skillful lip-readers. Instruction in the art of hearing is of far more importance than may be imagined. The normal man has the faculty of eliminating sound and of concentrating his sense of hearing on one particular sound. To such an extent is this faculty sometimes developed that an experienced telegraph operator can translate the message sent or received by a single telegraph instrument, despite the incessant ticking of a hundred others in the same room. On the other hand, the deaf man who has either never heard at all or has forgotten how to hear, does not possess this power of elimination and concentration. If the "acousticon" were allowed to convey the sounds of the outer world to him he would hear so much that it may be said he hears nothing, paradoxical as that may seem. In other words, he hears not only the sound of the human voice upon which his mind ought to be bent, but also the rattling of wagons in the street, the walking of persons in the room, and the many sounds which we have all become so accustomed to that we no longer heed them. Practice is necessary before the deaf man can eliminate sounds he does not wish to notice. And this practice he acquires by means of the instruction apparatus in the hands of a competent teacher of deaf mutes. By means of this apparatus he not only learns what articulate sound is, but also acquires a feeling for vocal inflection. Many deaf mutes, although they can not hear, have been taught to speak. Unable to hear, however, their utterances are almost inflectionless, hard, and unmelodious. The instruction outfit enables them to learn something of the nature of pitch and inflection. After the pupil learns to speak properly, a special "acousticon" is provided for him, just as special lenses are prescribed for the eye.

Here two ingenious modifications of the "acousticon" should be briefly referred to—the one a portable outfit for the collection of sounds in concert halls and theaters, the other a desk outfit. The first of these, which may be termed the opera outfit, consists of a double sound-receiving instrument contained within a small box, and has been used with marked success by deaf mutes in listening to orchestral music. Indeed, so sensitive is the device that spoken words can be heard by the deaf at a distance of twenty-five feet and more. With this instrument, the previously mentioned girl who had lost both sight and hearing at the age of seven, was able to enjoy the music at the opera in New York city, as if she had never been stricken. The desk outfit mentioned comprises a collector of sounds, of parabolic cup-shaped form, by which the sounds are amplified for hearing with a regular "acousticon" earpiece. This earpiece is hung upon a hooked switch-arm, which, when the earpiece is removed, automatically turns on the battery current. The speaker talks in the ordinary way, in his usual conversational tone, without placing the mouth to any instrument. The hearer uses only the earpiece, which is so small that it seems as if he were holding his hand to his ear in order to catch the spoken words more easily, just as every one who is hard of hearing naturally does.

Another instrument invented by Mr. Hutchison is the "massacon," to be used for phono-electrically massaging the ear in cases of deafness resulting from catarrh. Probably 65 per cent of those who are deaf or hard of hearing may safely attribute their affliction to catarrh, associated with after-acquired secondary troubles. The "massacon" is not a device to enable the deaf to hear, but a contrivance for producing sharp impinging sounds to exercise the enervated and disused middle ear and adjacent parts. It is not an instrument to be carried on the person, like the "acousticon," but to be used by physicians only, at whose discretion it may be prescribed for individual use by the patient. It has been stated that the middle ear is an air-cavity in which the three small bones or ossicles are contained. The air enters the middle ear through the Eustachian tube, extending to the ear from the nasal cavity. The Eustachian tube is lined with mucous membrane; so is the middle ear cavity. The small bones of the middle ear are covered with mucous membrane. Catarrh starts from the nose and creeps gradually through the Eustachian tube to the middle ear cavity. It spreads over the walls of this cavity and finally attacks the small bones, inclosing them in a firm anchylosis and binding them at the joints so firmly together that they can no longer move individually to transmit sound from the ear drum to the internal ear. Deafness results, varying in degree, with the anchylosis. Inaction, due to catarrh, enervates the auditory apparatus. As any muscle of the body refuses to respond to the will after long disuse, so the ear, rendered inactive by catarrh, refuses to respond to sound. The "massacon," by massaging the small bones, restores to them their old vigor and sufficiently eradicates the effects of the catarrh so as to restore lost hearing, at least partially, and often fully.

The principle of the "massacon" is simple enough. A diaphragm, contained in the earpiece, is caused to vibrate by means of an electromagnet with any desired rapidity. When the earpiece is held to the external ear, the vibrations are transmitted directly to the ossicles. Such is the nicety with which the instrument can be adjusted, that a movement in the small bones is produced, exactly equal to that incurred when they normally transmit sound waves. The parts thus stimulated soon regain most of their old activity.

A COMPARISON OF THE GERMAN BATTLESHIP "WETTIN" WITH THE "MAINE."

BY FRED T. JANE.

The "Wettin" is one of five sisters of the "Wittelsbach" class—"Wittelsbach," "Wettin," "Zaehringen," "Mecklenburg," and "Schwaben." Most are now in commission, or if not thus far advanced, at least available should Germany need them.

In the matter of date and conception the "Wittelsbach" class corresponds to the U. S. S. "Maine" class. Though they do not equal the American vessels in displacement they nevertheless represent much the same idea, the increased size of the "Maines" being largely due to the fact that they are given a superior radius of action—a strategical advantage. Neglecting this strategical quality for the present, we may compare the "Maine" and "Wettin" as two different methods of disposing of certain tactical qualities. The extra tons of coal carried by the "Maine," together with other weights, may be held to balance her superior weight in such a matter as displacement.

With this preamble we may now tabulate the two designs against each other. There are, unfortunately, no other foreign ships of the same date and size, British ships running to 14,000 or more, the French "Suffren" to 12,728, and the Russian "Kniaz P. Tavritchesky" is, so far as can be ascertained, simply a copy of the "Maine" with minor alterations.

Now, looking at the above comparisons, the first point of note is the difference in proportions, the "Wittelsbach" being a much narrower ship than the "Maine." This means that she should be relatively less handy. Since, however, her deadwood aft is very much cut away while that of the "Maine" is only so treated to a less degree, the tactical diameters do not greatly differ. This relative narrowness enables the "Wittelsbach" to do with 14,000 I. H. P. what the "Maine" requires 16,000 to accomplish; but on the other hand this extreme deadwood cutting in German ships causes structural weaknesses, displayed when the ships are docked unless the greatest care is taken in arranging the blocks. The 5½ feet extra beam of the "Maine" does not look much, but coupled with her lesser length is relatively of considerable importance, and she should be by far the steadier ship of the two in a gale. She is, in fine, far better fitted to cross over to Europe than the "Wittelsbach" is to go over to America—though neither vessel, perhaps, is eminently suited to such a task. Ability to go a long voyage and fight at the end of it is the characteristic of British battleships rather than of those of any other power, and it is secured at the cost of putting an armament decidedly inferior to the "Maine's" into a ship nearly three thousand tons larger. It is a heavy price—one that may hardly be worth paying for any other nation. It is evidently not so considered by Germany, whose ships are alternately believed to be destined to try conclusions with those of the United States and England. Compelled to adopt moderate dimensions by the shallow nature of their waters, the Germans have put their money on tactical features and let the strategical ones go. This, seeing that any great degree of excellence in both qualities on moderate dimensions is impossible, seems the wiser course, though curiously enough the one and only watchword of the German navy is: "Attack. Be the odds ever so great the German fleet must always assume the offensive." Regarded as a doctrine *pur et simple* it is an excellent doctrine, but so far as Germany is concerned, many of her ships coast defenders, all of small coal supply, it seems a little suggestive of knocking heads against a brick wall. The "Wettin" and her sisters can indeed cross the herring-pond at economical speed, but they would arrive with depleted bunkers—the worst pos-