

factory that took a thousand men to operate by techniques used nowhere else, weighed a thousand tons, and cost \$50 million.

[344] Such a vast enlargement of the permitted nature of the instrument would naturally lead to the invention of one or more very strange, novel instruments, and to the composing of new music for them, with great improvements like those brought in by the inventions long ago of the organ, harmony, and violin. We could replace our tempered intonation by reviving the natural, "just intonation", which today we hear only in the beautiful, ringing chords of a *cappella* choirs. The "just intonation" in a piano would require twelve times as many strings, but in a world music instrument would be easy. Such an instrument was invented and set to broadcasting by wire, partially developed, \$200,000 worth, with much artistic success in the Telharmonium of Cahill in 1907;³⁵⁵ but it was bankrupted by the war, the competition of radio, and other difficulties.³⁵⁶ We could also use quarter intervals like some folk music, 24 to the octave, instead of our 12. We could invent new timbres (tone qualities, instrument equivalents), and give to each one a range of ten octaves, and varied envelopes, e.g., to add *sostenuto* continuance to a guitar's *pizzicato*. Best of all, we could make sounds synthetically, scientifically, taking all the time desired to shape each note, starting by drawing ideal sound waves on paper, then combining these paper curves and finally sounding them, just as a composer or poet selects each note or word with care and time. But today for final performance we must depend on split-second technique and cooperation by two to a hundred musicians, and on whatever limited sounds their ancient instruments can produce. A synthetic singer or orator might be given a range of seven octaves, enunciation of the utmost clarity, and musical tones more beautiful, or speech more winning, than any we have heard or imagined. This would be combined with a visual projection of an actor or an animated, three-dimensional color drawing. The possibilities, for art, for advertising, for persuasive propaganda, education or reindoctrination, appear limitless.

[345] Such synthetic music, starting with the drawing of the waves, was proposed in 1892,³⁵⁷ and imperfectly realized in 1932. Mechanical production of voice-like sounds has been tried for centuries, and advanced to comprehensible quality by the telephone company in its Vocoder, seeking the limited purposes of telephony. Neither invention is likely to realize its enormous potential for many a year in the future, unless scientists are set to work on it, with different means of financial support from any it has today, presumably by cooperation between the Government and the whole big industries to be benefited. Ordinary patents would be no use at all. The business must be highly concentrated from the start.

2. INVENTIONS FOR INDEXING THINGS AND PEOPLE

[346] *Documentation*, supplying to researchers any information extant and available in the world, is another big field where invention is much needed and little supplied. Development here is crippled because those who directly need better documentation, the scholars,

³⁵⁶ Modern electric organs and experimental "electronic music" embody some of the telharmonium's ideas.