DISCUSSION

Greenleaf W. Pickard (by letter): In reading Mr. Crossley's interesting paper I am impressed by the striking audibility curve of Figure 9, with its approach to a null point when the steel vessel carrying the pick-up coils is directly over the cable. As the author points out, this sharp change in sound is very helpful, and I am wondering how this desirable feature could be retained, in the event that our Shipping Board's non-magnetic cement ships ever became popular.

Despite the near-century of history given by Mr. Crossley, I cannot help feeling that the art of induction piloting is yet in its infancy. We are all familiar with the desirability of a sharp null point in radio direction finding, and it would seem possible to do the same thing for an induction system. For example, if instead of a single cable with earth return, a pair of parallel insulated cables are laid, spaced apart say twenty meters (60 feet), and joined at their far ends, then a single pick-up coil, mounted amidships in a vertical fore-and-aft plane, would be unaffected when the vessel was directly over the center of the cable system, but would begin to receive with the slightest deviation to either port or starboard of this line, and the reception curve in a vertical plane normal to the direction of the cables would resemble Figure 9, but with an absolute null point at the center. A further advantage of this arrangement would be that the cable system is now insulated, and the station ammeter and a ground detector would furnish instant information of any mishap to the cable.

Over a suitable network of submerged cables, traversed by currents of controlled intensity and phase relation, any imaginable magnetic field might be made to hover, so molded as to produce any desired effect upon a coil system carried by a vessel. Clearly, we are at the very inception of a new art.

I am inclined to question the statement that "the effect of the 500-cycle current thru the cable has a special concentrating effect upon the return current path thru water, whereby it tends to bring this return path close to the cable." If this were so, it would be equivalent to putting one conductor of the circuit in a tube constituting the return conductor, and this, since the time of André Marie Ampère (who, by the way, deserves inclusion in Mr. Crossley's general history), has been recognized as a combination without external magnetic field.

Robert H. Marriott (by letter): Located, as I am, across the United States from New York, the notice of the reading of Mr. Crossley's paper did not reach me until the day of the meeting. This accounts for a brief discussion by telegram which readers may desire to have explained in some detail.

It appears that we are at the point where we have the science without the art or the theory without the practice, or the demonstrations without the service. Service is what the public needs and what the engineer and scientist want to deliver.

Many things have been said and repeated in scientific dignified terms. A little variation, such as less dignity in expression, may help to bring out what is best.

To make this anticipated art what we believe it should and can be, will require perseverance, energy, and then more perseverance. We should profit by our experience in the development of radio to prevent lost motion, friction and procrastination.

The "cable theory" family has grown up, the "demonstration" family has grown up, but the "service" children apparently have never survived beyond the "lust'ry yelling period." Expert diagnosticians would probably attribute the pre-natal or early demises to lack of vitality, malnutrition or unsuitable environment. Young physicians freshly equipped with a large quantity of second-hand information might offer more interesting theories.

It looks as if Congress would have to furnish nearly all the food by appropriations. Depending on steamship companies for any appreciable nourishment may result in arrested development, cripples or more deaths.

A policy which makes the success or failure dependent on only one factor, namely, sufficient appropriation by Congress, should result in success, while a policy depending on a number of factors such as several steamship companies' appropriations plus congressional appropriations may result in failure and loss of successive appropriations.

Since the United States is now a maritime nation and the efficiency of its merchant marine depends, in part, on how easily and quickly the vessels enter and leave the ports of the United States, it is quite proper for Congress to see to it that their entrances and exits are made easy.

Ample current in the cable would make it easy for the steamship companies to do their part. Sixty cycle power of sufficiently high voltage, from commercial mains, would reduce first cost and operating costs. Duplicate low resistance cables would

increase reliability and serve for a wide range of developments and refinements for commercial and military purposes.

Dealing with the first thought,—short-sighted instrument manufacturers and others may be against making it simple and inexpensive for the steamships to receive the pilot signals, because the more complicated and expensive the receivers are, the more manufacturers or service companies could charge the steamship companies or Government in profits on single units or for maintenance.

However, experienced manufacturers and service companies know that handicapping an art in its infancy results in an unprofitable, uncertain demand or no demand, while a healthy established art is a certain market for improvements.

Steamship managements and steamships are complex and there are numerous managements and numerous ships. Installing anything new on the ships means that accounts must be shifted, orders must be shifted, habits must be shifted, prejudice must be shifted, and materials must be shifted. Those accounts, orders, habits, prejudices, and materials have inertia and there are lots of those inertias, and they are not all alike. Lots of inertia means that a big force must be applied to get service or that the new thing must be designed to cause minimum shift in accounts, orders, habits, prejudices, and materials. Plenty of current in the cable seems to be the key to the situation.

A big force such as a compelling law is probably not a possibility at this time. Therefore, the practical thing to do, seems to be to minimize the difficulties attached to installing, operating, and maintaining receivers on vessels. Simple receivers can be used if there is enough current in the cable.

Using weak audio frequencies in the cable means that amplifiers will be required on ship board. The first cost of amplifiers alone may cause some of the various human elements in a steamship management to hesitate, postpone, dicker, or cancel the project. Also various individuals connected with the management usually make private inquiries of radio operators, inspectors, engineers, and their amateur friends and relatives. From these various sources they can get stories to the effect that amplifiers howl, the bulbs burn out, the batteries run down, the transformer circuits break open, the apparatus must be kept dry, a great deal of skill is required to locate the coils and apparatus properly and to operate them, lighting circuits and sparking generators and electrolysis and striking metal of the ship's machinery and vibration make noises in the amplifier, two amplifiers

will not work alike, and one amplifier will not work twice alike. Also they can get more or less contradictory stories to the effect that amplifiers are wonderful things which anybody can operate. One class of salesmen may try to sell amplifiers to the steamship companies, which he claims will give no trouble, while another class of salesmen may try to sell them a service on the basis that a service company is necessary to instal the entire receiving system properly, instruct the users, and maintain the system. Another class of salesmen may try to sell them a service which also includes operation by their radio operators. As a result, the steamship management may be more or less divided in opinion and have a general idea that an inexpensive system might not be in working order when needed and a more expensive service might run them ashore instead of in the channel. The net result would probably be for most of the steamship companies to wait for some other company to try it first. Such waiting means delay if not failure because fogs do not occur relatively often. For example, at a given port, fogs which could not be traversed may not exist more than a total of one hundred hours per year or a little over one per cent. of the time. This may mean that a given vessel would have only one chance in a hundred of having an opportunity to use its apparatus in that port. And if only a few vessels were equipped there might be a long time between convincing demonstrations or a general discouragement as to the "worthwhileness" of the device, while with hundreds of vessels equipped, the cable price should be quickly saved to the nation. Such valuable services would keep up an enthusiastic interest and service.

The equipment of numerous vessels seems to be necessary to render sufficient service to create a permanent practice and public service. It appears that the surest and most effective procedure for such a port as New York, is to install a cable supplied with sufficient current to be receivable on shipboard with a simple durable coil and a pair of telephone receivers and a duplicate auxiliary cable for use in case the first cable is damaged. In a port like New York the cable would probably be damaged by anchors until a large number of ships were equipped with receivers so they would have no excuse for anchoring. These simple receivers would be so inexpensive and durable as to remove hesitation on the part of the steamship companies.

As the development of this art is for the public service, the Government could also quite properly expedite the equipping

and reduce the ratio of expense to service by such expedients as follows:

(a) Giving steamship companies the data for construction of receiving coils.

(b) Advising steamship companies where coils and telephones can be purchased.

(c) Loaning sets of coils and telephones to each steamship company.

(d) Loaning coils and telephones to the masters, mates, and pilots to be used between pilot ship and dock.

(e) By operating the cable at certain hours on heavy sailing days for practice.

(f) By notifying the vessels as to when these practice signals are to be sent and requesting reports on how they were received.

A year of such procedure could result in more than a majority of the United States vessels being equipped and a number of instances of saving in time and money.

This latter situation should make a law possible if necessary, which law would compel all United States vessels to be equipped.

The co-operating with the steamship companies in this respect and the removal of the need to anchor should automatically stop the fouling of the cable.

With the art once established, the steamship companies would want improvements such as visual indicators, automatic devices, and special services and apparatus from service companies and manufacturers. Military branches would have at their disposal means for developing useful devices and for the guiding of the government craft in war and peace times.

Five years from now, New York harbor can have forgotten it was ever without pilot cable service or it can be expecting such a service some day.