an automatic stop would use it; hence the need of learning the lesson of this European experience through a visit by a member of the board or some other competent person to England and France.

Up to date the board has examined descriptions of 495 devices or systems; 245 of this number have been laid aside as not coming within the terms of the joint resolution. They deal with devices intended to improve the condition of railway tracks, automatic car couplers, automatic steam and air hose couplers, safety cars, and other devices calculated to prevent the telescoping of cars in railway wrecks, and otherwise mitigate the severity of collisions, as well as numerous other devices which in no way pertain to the block-signal system nor to the question of automatic train control. Of the remaining inventions the board has been furnished with descriptions of 175 which relate directly to block signals, cab signals, or automatic train stops; 55 of this number have already been disposed of and 120 are now in the course of examination. In nearly all of the 55 cases which have been passed upon the board has unanimously decided that the alleged inventions have not sufficient merit to warrant further attention. In most of these cases the plans and specifications that have been furnished indicate that the inventors are manifestly unacquainted with the requirements of railroad service, their devices being merely repetitions of what has been previously invented.

The actual signals by which engineers are informed of danger ahead may be divided into two distinct classes: Fixed signals and cab signals. Into the first class belong all signals which are fixed along the roadway, such as semaphore blades, discs, lamps, etc. Cab signals are given direct on the cab of the locomotive.

Much has been said and written about the merits of each type. Cab signals are much less expensive; they are brought much closer to the engineer thus making their unobservance less liable. Further a cab signal may be both visible and audible, thus appealing both to the engineer's vision and hearing. Cab signals have been endorsed by the Board of Trade of England, and have been adopted on some of the largest English roads. It is my belief that cab signals will play a very important part in future signalling on account of their low cost. A cab signal can be installed on a locomotive for $150. An automatic block signal of the fixed signal type costs about $350. In this country there is one locomotive to every five miles of track. The cab signal expense per mile of road is about $30 per mile, plus $40 per mile for contact rails, or about $70 per mile. In the automatic block signal installation the fixed signals average about two signals per mile; therefore you have an initial expense of $70 per mile in one case and $700 per mile in the other. Out of 250,000 miles of railroads only about 10,000 miles have been equipped with automatic block signals, not because they are not desired by railroads, but because they are prohibitive on account of their cost, this cost even running up to as high as $2,000 per mile. It is my conviction that the railroads of this continent, each and every one of them, are badly in need of an improved signal system, and as soon as the cost is reduced to such a point that the railroads can afford the same, they will quickly adopt it. This reduction in cost is only possible by the use of a cab signal. Furthermore, a satisfactory cab signal must be developed to make any progress whatever with an automatic stop, because the fundamental principle of the cab signal and the automatic stop is the same—both must have some means to either mechanically or electrically connect some fixture along the roadway with a fixture on the moving train. Automatic stops and cab signals may be divided into four general classes, based upon the method used in transmitting to the engine or moving train the impulse necessary to operate the automatic stop and give a signal indication in the cab. These, with the various subdivisions, are as follows:—

1. Mechanical trip, overhead and ground.
2. Insulated engine parts.
3. Contact rails, continuous and intermittent.
4. Inductive, alternating current and Hertzian wave.

The committee reporting to the Railway Signal Association say:—

Devices of this type are most generally arranged to transmit to the moving train the operating impulse to apply the automatic stop by means of a hanging arm or weight arranged to strike a valve or handle placed on the top of the cab or car and apply the air, in case the signal should be passed when in the stop position.

These systems must of necessity be arranged for the hanging arm or weight to come within the maximum clearance line, and in such position would be apt to strike, with probably fatal results, a man riding on the top of a car. The absence of the arm will result in a failure to stop a train when a signal which in indicating stop is run by. Up to the present time, as understood by the committee, these devices do not conform to several of what they regard as essential requirements for a safe and reliable automatic stop and cab signal system. These requirements have been given at the end of this report, and the overhead arrangement of mechanical trip automatic stopping devices do not comply with Nos. 1, 2, 3, 4, 6, 7, and 11.

Mechanical Trips—Ground Arrangement.

Devices of this type are arranged with a movable arm or inclined plane, which when in the operating position is made to come in contact with parts suitably located on the moving train and cause the brakes to be applied, when the train runs by a signal that is indicating stop. The difficulty met with in operating devices of this type is that the parts on the ground or those on the engine must extend inside of or beyond the permissable clearance lines, in which position they are likely to be broken or knocked out of place, for the parts placed on the ground and the parts on the train are likely to be hit by objects other than the engaging arm, and the brakes be applied when they should not. Ice and snow seriously interfere with the operation of devices of this kind, and these systems, so far as the committee is aware, do not at present meet requirements Nos. 1, 2, 3, 4 and 7.

Insulated Engine Parts.

With these systems it is usual to insulate one truck from the other of the engine or car, insulate an engine from its tender, or insulate one wheel from the other by means of a split axle or insulated wheel centre. Pressed fibre is the material by which this insulation is most generally accomplished. With any of the above mentioned arrangements it is necessary that the indication be conveyed to the moving train during the interval of time in which the insulated part is passing over a short insulated section of rail or an insulated joint in the track. The operating impulse is, therefore, momentary and is not continuous. The principal difficulty met with in systems of this kind is to properly construct and maintain the insulation of the engine parts and to insure that the parts on the moving train will operate properly in the short interval of time available. These systems, it has been found, do not conform to essential requirements Nos. 1, 2, 3 and 11, as recommended by the committee.

Contact Rails—Continuous Type.

Devices of this type are arranged to conduct the operating signal impulse to the moving train by means of a shoe attached to the train making contact with a third rail placed alongside of the main rail, between the main rails, or above, or on the side of the train. The difficulty experienced with devices of this type is to secure a continuous contact on the third rail, for, unless this is done, the device operates and the brakes are applied when there is an opening in the third rail, irrespective of whether or not the operating conditions make it necessary or desirable that the train brakes be applied. The continuous type of contact rail system, as at present understood by the committee, do not conform to requirements Nos. 1, 2, 3, 4 and 11.

Contact Rails—Intermittent Type.

With these systems the contact is usually of moderate length, and is placed at a point where it is desired to convey the operating signal impulse to the moving train. These points are at the commencement of a block, or where a home or dwarf signal is placed. The indication given on the train is continued from the time a train passes one contact to the passing of the next conact, or to one where the indication