The following statement is a full description of this invention, including the best method of performing it known to us:

{object redacted}
The invention relates to optical waveguides, and provides a coupling element of integrated construction for the input and output of light to and from an associated dielectric optical waveguide.

Optical arrangements can be manufactured as integrated constructions in an extremely small space, and in such a manner that they are protected from any thermal, mechanical or acoustic disturbances of external origin. For example, an article in "The Bell System Technical Journal", Vol. 48, 1969, No. 7, pages 2059 to 2069 describes how the use of integrated optical construction techniques can be used in the manufacture of waveguides, optical transmitters (lasers), modulators and arrangements for coupling light waves from one waveguide to another.

One object of the present invention is to provide an optical waveguide coupling elements of integrated construction for effecting coupling of light waves between free space and a waveguide.

The invention consists in an optical waveguide comprising a coupling element for the input and output of light into and from said optical waveguide, one end of said waveguide being supported on a carrier body and connected to a platelike optical waveguide of integrated optical construction formed on said carrier body, and a coupling element in the shape of a film-form, as hereinbefore defined, or a phase hologram being arranged on said platelike optical waveguide.

The term "film-form" is used to refer to a layer which is constructed to generate a prescribed wavefront from
from a light beam incident upon it. Such a film-form has a construction forming a lattice-like variation of refractive index or surface relief structure, which causes an incident light beam to be diffracted in accordance with a single diffraction order. The directions of transmission of individual beam components and of nodes which it is intended shall be transmitted can be determined by a position-dependent refractive index or surface relief structure.

The film-form, or the phase hologram, preferably exhibits a refractive index and/or surface relief structure such that for input purposes a light wave incident from space is concentrated in the waveguide, and that for output purposes light from the waveguide is radiated out in a predetermined direction.

This deflection to a predetermined direction for an output beam may be obtained because, for example, the surface structure of the coupling element has a sawtooth profile with sharp edges which acts in similar manner to a diffraction grating. The direction of diffraction can be determined by appropriate choice of the "grating constants".

Advantageously, the refractive index and/or surface relief structure are such that only a predetermined number of specific modes are coupled into and out of the element. This is achieved by virtue of the fact that when light waves pass through the coupling element, different optical trajectory lengths give rise to phase differences so that only specific modes are transmitted.

A small number of lower modes, preferably one mode, will be coupled into the waveguide in situations where the light waves are required for information transmission over long
distances. Then the losses experienced by the light waves in the waveguide, as well as the distortion in pulses being transmitted, are relatively small.

The invention will now be described with reference to the drawing, which schematically illustrates one exemplary embodiment of the invention.

In the illustrate embodiment a carrier body 1 is attached by means of cement 3. Attached directly to the axial end 8 of the waveguide 2 is a platelike waveguide 4, which has been manufactured by vaporising a transparent dielectric layer onto the carrier body 1 and the axial end 8 of the waveguide 2, this operation being followed by a shaping operation. Arranged on the platelike waveguide 4, there is a "film-form" 5, which is a photosensitive varnish layer painted onto the platelike waveguide 4 and given an appropriate structure by selective exposure through a mask and subsequent development and fixing, the surface structure preferably being in the form of sawtooth profiles 6 extending in circles whose radii increase with distance from the waveguide end 8. This achieves the result that a light beam 7 incident obliquely from above is deflected onto the circular area of the platelike waveguide 4 to which the end 8 of the waveguide 2 is connected.

If a light wave is injected via the waveguide 2 into the coupling element, then it is fed out in an upward direction towards the left, in the same direction as the light beam 7. A phase hologram is also suitable as a coupling element.

The coupling element can be manufactured by cementing the end 8 of the waveguide 2 to the carrier body, thereafter applying a transparent layer adjoining the end 8 of the waveguide 2.
forming this transparent layer into the platelike waveguide 4, before applying on said transparent layer 4 the photosensitive layer which ultimately acts as the film-form or phase hologram structure 5 used for input and output, this being established by selective exposure and subsequent developing and fixing of the layer 5.

The transparent layer 4 can advantageously be vaporised on using mask to produce a rectangular shaped platelike waveguide, or it may be given a rectangular form after the vaporising operation by the use of an etching process.

The refractive index or surface relief structure in the photosensitive layer may be produced by selected exposure and ensuing development and fixing by known methods.

Alternatively, the transparent layer may be of a photosensitive material which can serve as the platelike waveguide 4 and the film-form or phase hologram 5, selective exposure being effected to give the platelike waveguide the desired form and provide the requisite film-form or hologram structure at the same time.
The claims defining the invention are as follows:

1. An optical waveguide comprising a coupling element for the input and output of light into and from said optical waveguide, one end of said waveguide being supported on a carrier body and connected to a platelike optical waveguide of integrated optical construction formed on said carrier body, and a coupling element in the shape of a film-form as hereinbefore defined, or a phase hologram being arranged on said platelike optical waveguide.

2. An optical waveguide as claimed in Claim 1, in which said film-form or phase hologram has a refractive index and/or surface relief structure such that for input purposes a light wave arriving from space is concentrated in the waveguide, and that for output purposes light from said waveguide is radiated out in a predetermined direction.

3. An optical waveguide as Claimed in Claim 2, in which the refractive index and/or surface relief structure is so designed that only a predetermined number of specific modes are coupled into or out of the element.

4. An optical waveguide as claimed in any preceding Claim, in which the end of said waveguide is cemented to said carrier body.

5. An optical waveguide as claimed in Claim 4, in which said platelike optical waveguide connected to the end of
said optical waveguide is a transparent layer applied to said carrier body and shaped to form a waveguide.

6. An optical waveguide as claimed in Claim 5, in which said film-form or phase hologram is formed on said platelike waveguide by depositing a photosensitive layer thereon, and the necessary structure serving for the input and output function is manufactured by selective exposure, followed by development and fixing.

7. An optical waveguide as claimed in Claim 5 or Claim 6, in which said transparent layer has been vaporised on, using masks to form a platelike waveguide of rectangular shape.

8. An optical waveguide as claimed in Claim 5 or Claim 6 in which said transparent layer has been given a rectangular shape by an etching process.

9. An optical waveguide as claimed in any one of Claims 5 to 8, in which said transparent layer is a photosensitive transparent layer which serves both as said platelike waveguide and said film-form or phase hologram, a selective exposure process being used to simultaneously form the platelike waveguide shape and the film-form or hologram structure.

10. An optical waveguide substantially as described with reference to the drawings.
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