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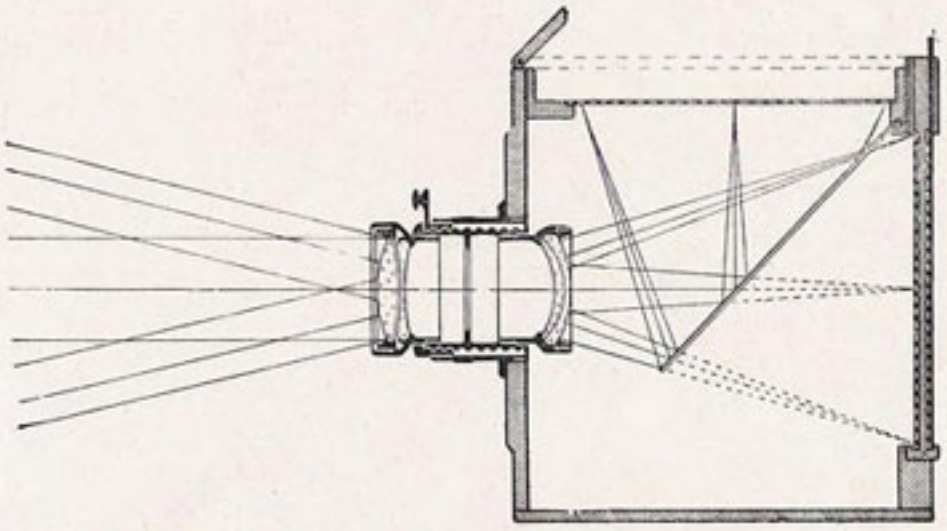
The TELE-TESSAR F/6.3



A Rapid Tele-photographic Lens

CARL ZEISS JENA

Snapshot taken at the London Zoological Gardens
by Mr. F. W. Bond
with Zeiss Tele-Tessar F/6.3, f = 25 cm (10 in.)

The Tele-Tessar, A Rapid Tele-photographic Lens.

The term "tele-photographic lens" is applied to that type of objective in which the image formed by a positive front component is magnified by means of a negative back component before its rays reach the ground glass screen, the two components standing a considerable distance apart. When the ultimate image is formed under these conditions the required camera extension becomes shorter, and, indeed, unter certain circumstances, very much shorter, than the focal length of the optical system (see Figs. 2 to 5 on page 5), whereas with the standard type of short-bodied objectives, such as the Tessar, the camera extension is approximately equal to the focal length (see Fig. 1 on page 5). It is to secure this advantage that designers of photographic lenses have not shunned the enormously increased difficulties which stand in the way of the optical correction of the tele-photographic combination as compared with the lens of standard type.

For a long time the invariable and only method adopted by the designers of tele-photographic objectives was to correct the converging and the diverging components independently to the highest possible degree, and in most cases a rapid camera lens of the standard type was employed as the converging component (see Figs. 4 and 5 on page 5). This mode of construction secured the valuable additional advantage that the tele-photographic combination was available not only for a certain focal length, but could also be made to furnish a pretty wide range of variable foci by the simple expedient of varying the distance between the front component and the back component. A drawback of the system is, that it imposes serious restrictions in the matter of the relative aperture and field angle owing to the rapidly increasing difficulties in the optical correction which any improvement in that direction brought in its train. These restrictions were acceptable so long as tele-photographic lenses were actually only used for photographing very distant objects, more particularly details of a landscape or buildings, and so long also as the really great advantage of being able to use very long focus lenses on hand-cameras with short extension was deemed sufficient, and took precedence over other considerations.

In course of time it became, however, necessary, to overcome the restrictions in the matter of the field angle and more especially in that of rapidity when a growing demand arose for long focus lenses enabling instantaneous photographs being taken with cameras having a short extension, a requirement which was notably suggested by the growing interest taken in the study of the habits of animals living in the wild state. For these and similar purposes a tele-photographic lens F/10 was brought out at the Zeiss Works, which subsequently became known as the 'Magnar'. This lens marked a considerable development; for, though

its rapidity sufficed for many forms of instantaneous photography, coupled as it is with a useful field of view of approximately 20°, it may yet be used on a hand-camera the extension of which does not exceed one-third of the focal length, so that a Magnar of a focal length of 45 cm. (18 in.) may be used on a conveniently sized hand-camera with an extension of 15 cm. (6 in.) only. To secure this improvement in the performance of the Magnar one quality of the previously existing type of tele-photographic objectives had to be sacrificed; it ceased to be capable of assuming a wide range of variable focal lengths. The converging and diverging components of the Magnar were no more corrected independently. This was done only for a fixed distance between the components, and it was thus possible to ensure a better correction in the combination as a whole for a particular focal length, and incidentally to obtain a wider angle and the required rapidity for instantaneous photography.

But, the abandonment of a variable range of focal lengths notwithstanding, a short extension and a long focus on the one hand and great rapidity coupled with a crisp definition and a good angle, embody generally speaking, more or less incompatible requirements. Any yielding in the demands upon the shortening of the camera extension provides fresh possibilities for correcting defects which stand in the way of an improved rapidity and an increase of the angle. Though the Magnar has met with great appreciation and is still deservedly popular as a special lens within the limits which we have indicated, there has nevertheless been a growing interest in a tele-photo objective coming nearer to the conception of an all-round rapid lens, having accordingly a greater rapidity and embracing a wider angle, in exchange for a less shortened camera extension than that obtaining in the case of the Magnar. An effort to satisfy this requirement is embodied in the **Tele-Tessar***).

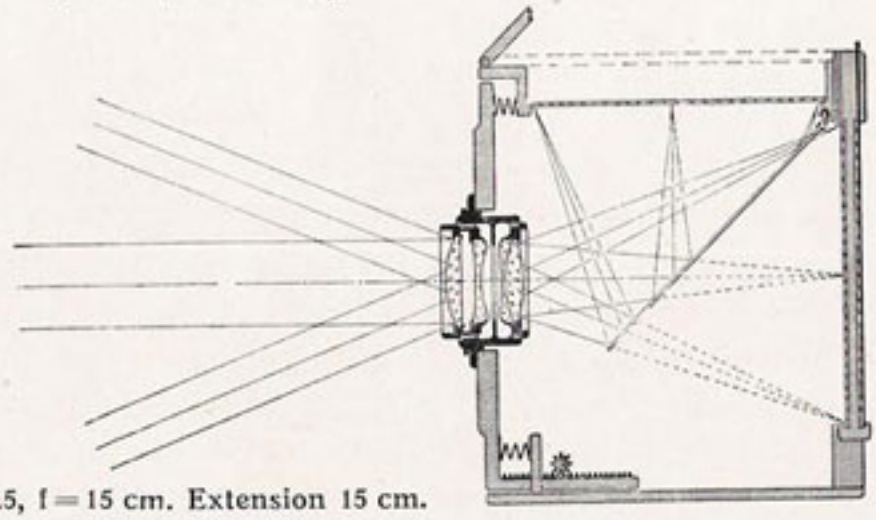
From the subjoined table and the diagrammatic illustrations on page 5 it will be seen how the Tele-Tessar fills the above mentioned gap in our series of objectives.

12×9-cm.**) Objectives shown diagrammatically overleaf		Tessar	Tele-tessar	Magnar	Tele-comb. a	Tele-comb. b
Focal Length		15 cm	25 cm	45 cm	50 cm	90 cm
Relative aperture		F/4.5	F/6.3	F/10	F/30	F/54
Rapidity ratio, F/4.5 being taken as 100		100	50	20	2	0.7
Angle 2 w subtended by object showing on 12×9-cm. plate	Diagonal 15 cm.	53°	33.5°	19°	17°	9.5°
	Long side 12 cm.	43.5°	27°	15°	13.5°	7.5°
Size of object showing on long side of plate	at 100 m. distance	80 m	48 m	26.5 m	24 m	13.5 m
	at 3 m. distance	2.3 „	1.3 „	0.7 „	0.6 „	0.3 „
Size of picture showing a	house 10 m. high at 100 m.	1.5 cm	2.5 cm	4.5 cm	5 cm	9 cm
	head 25 cm. high at 3 m.	1.3 „	2.3 „	4.4 „	5 „	10.7 „
Scale of reduction n	at 100 m. distance	666×	400×	220×	200×	110×
	at 3 m. distance	19×	11×	5.7×	5×	2 1/3×

*) All patent rights reserved. **) 12×9-cm. plate equals approximately the size of a 1/4 plate.

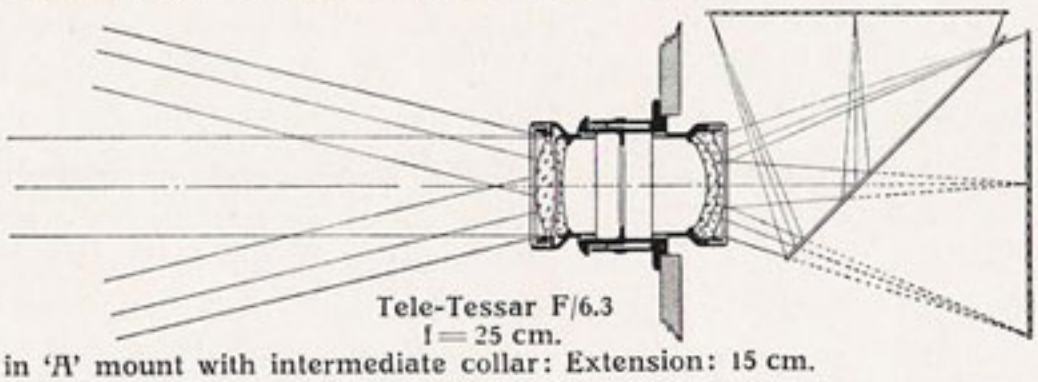
12×9-cm. plate Hand-camera set to ∞

in position for vertical pictures, i. e. side of plate in diagram 12 cm.
(Scale. 1/5 full size.)



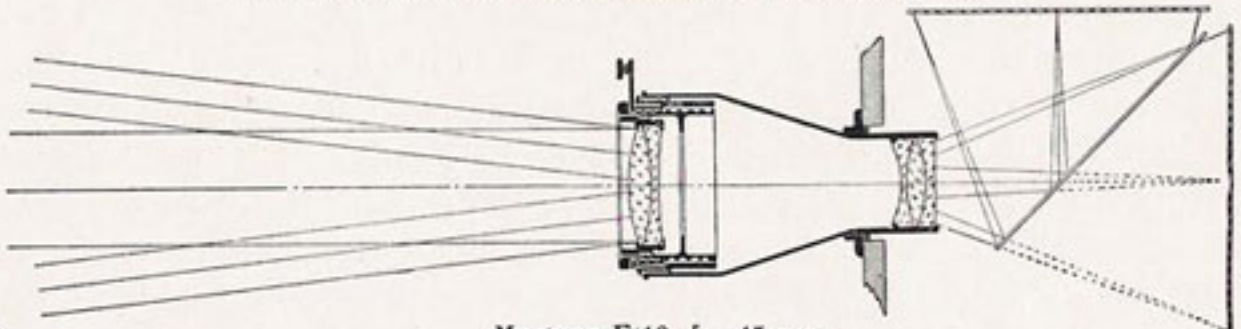
Angular extent of objects shown
$2w = 43\frac{1}{2}^0$, i. e. 80 m at 100 m. distance

Tessar F/4.5, f = 15 cm. Extension 15 cm.



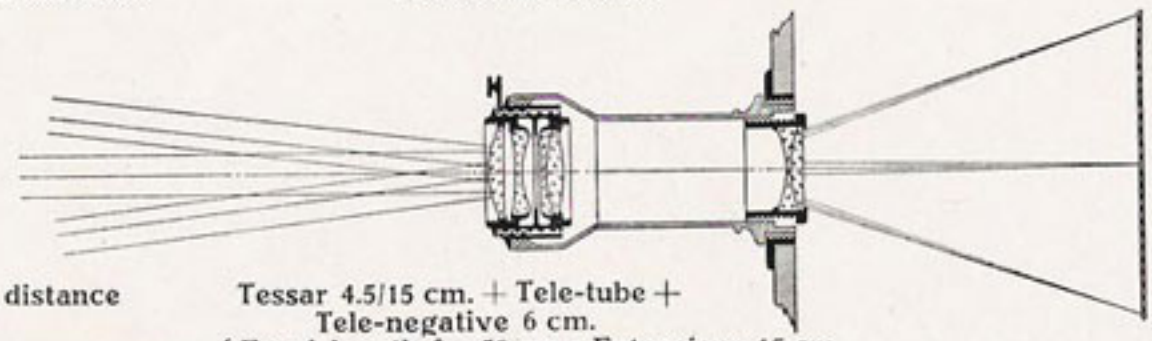
$2w = 27^0$, 48 m. at 100 m. distance

Tele-Tessar F/6.3
f = 25 cm.
in 'A' mount with intermediate collar: Extension: 15 cm.



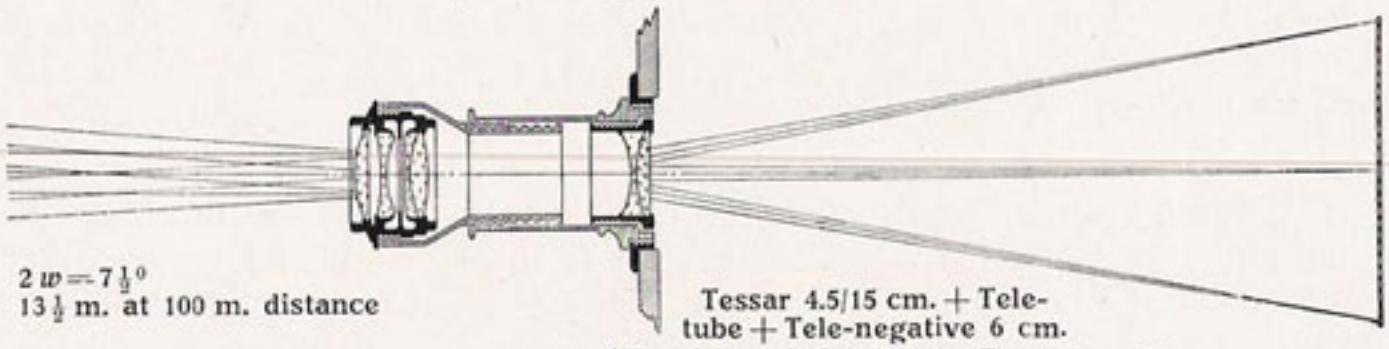
$2w = 15^0$,
$26\frac{1}{2}$ m. at 100 m. distance

Magnar F/10, f = 45 cm.
Extension: 15 cm.



$2w = 13\frac{1}{2}^0$
24 m. at 100 m distance

Tessar 4.5/15 cm. + Tele-tube + Tele-negative 6 cm.
Set for { Focal length f = 50 cm.; Extension: 15 cm.
Relative aperture about F/30



$2w = 7\frac{1}{2}^0$
$13\frac{1}{2}$ m. at 100 m. distance

Tessar 4.5/15 cm. + Tele-tube + Tele-negative 6 cm.
Set for { Focal length f = 90 cm.; Extension: 30 cm.
Relative aperture about F/55

The sharply defined and flat portion of the field of the Tele-Tessar at full aperture embraces quite 30° (with narrow stops about 40°). Thus, a focal length of 25 cm. may be reckoned for a 12×9-cm. plate camera. Within the limits of this field angle the definition of the new objective is about equal to that of a good anastigmatic lens. The residual spherical aberrations and the image defects with respect to points away from the axis are small, notwithstanding the fact that, in order to obviate that undesirable decline of the light towards the boundary of the field of view which frequently arises in long-bodied objectives, the back component has been given an unusually large diameter and consequently the oblique pencils have a large aperture, which ordinarily tends to accentuate the errors due to oblique incidence. The distance between the last lens surface and the focal plane is about equal to half the focal length, the total length from the front lens surface to the principal focal plane is about 4/5 of the focal length, the mount being so arranged that the camera extension for infinity is about 3/5 of the focal length.

In their general construction the Tele-Tessar and the Tessar, though widely different in important details, have fundamental similarities. In both cases the essential means of correction consist of an air lens with a diverging effect in the front component and a cemented surface with a converging effect in the back component. It is this fundamental agreement which has led to the term 'Tessar' being incorporated in the name of the new tele-objective. The full name with the prefix 'Tele' places it in the category of so-called tele-photo lenses, since it is now common usage to include under this term all objectives which can be used on a camera extension which is materially shorter than the focal length of the combination, the term being extended to those objectives which, like the Tele-Tessar, fulfil requirements other than providing solely a means of photographing from a distance.

Range of Uses to which the Tele-Tessar may be put.

This may be gathered from a mere careful scrutiny of the tabular synopsis on page 8 and the diagrams on page 5. For the present four focal lengths of the Tele-Tessar are manufactured, each mounted in the usual styles. We recommend the lenses for use with the four principal sizes of hand cameras, viz. 9×6 cm. (3¼×2½ in.), 12×9 cm. (4¼×3¼ in.), 15×10 cm. (6½×4¾ in.), 18×13 cm. (7½×5 in.), taking the focal length of the Tele-Tessar equal to about twice the long side of the plate. This renders it roughly two-thirds as long again as the focal length of the corresponding universal lens, say the Tessar F/4.5, which one would choose for the same plate size according to the rule 'Focal length equal to diagonal of plate'. The Tessar and Tele-Tessar adapted for the same size of plate demand accordingly similar camera extensions and can, as

a rule, be interchanged; and, if mutually adjusted, they may even be used on cameras with fixed extension.

The weight and dimensions of the tele-photo lens naturally demands a substantially made camera with a well supported lens panel, and suggest that they are best used with folding cameras and reflex cameras with fixed or variable extensions. The relative aperture F/6.3 suffices to obtain well exposed pictures in fair weather with focal plane shutters operating at the highest speeds commonly employed ($^1/_{500}$ to $^1/_{1000}$ sec.), so that the lenses may be used for recording sporting events.

To the **amateur photographer** the Tele-Tessar will therefore generally appeal as a supplement to the shorter universal lens on his folding camera with focal plane shutter, especially if this happens to be a reflex camera, as a means of taking genre pictures or records of the habits of animals in the wild state, and occasionally also for taking views of landscapes and buildings, where the composition of the picture admits of the longer focus being employed. The Tele-Tessar will in such cases give its user the well-known benefit of a much improved pictorial perspective, since in his effort to show on the plate the selected portion of the scene he may recede to nearly twice the distance from the principal object as when using the short-focus universal lens. The focal length of 25 cm. (10 in.) required for use on a 12×9-cm. plate camera being equal to the distance of distinct vision of a normal eye, pictures taken with this camera, when viewed unmagnified with the unaided eye, will show the objects in their true and natural relief.

The **sports and press photographer** will often have occasion to make use of the lens, since very often he is compelled to operate from a greater distance than he would adopt from choice.

Portrait photographers will find in the longer foci of the Tele-Tessar, especially that of 40 cm. (16 in.) focus, an instrument which, by reason of its long focus and its all-sufficient rapidity, is comparable to his accustomed studio lenses, but nevertheless will enable him to use an 18×13 cm. or $7^1/_2$×5 in. camera of standard size and weight, such as still comes within the limits of portability. Equipped in this way, he will be able to apply elsewhere all the rules respecting the proper standpoint, the perspective, and the pictorial effect, such as he has developed in his studio experience, without having to modify them, especially when operating outdoors.

TELE-TESSAR F/6.3 . . . . focal length f =		18 cm.	25cm.[1])	32 cm.	40 cm.
		(all lengths in centimetres)			
		(3½ × 2½ in.)	(4¼ × 3¼ in.)	(6½ × 4¾ in.)	(7½ × 5 in.)
Recommended for plate sizes		9×6	12×9	15×10	18×13
Diameter of image circle with narrow stop	when set to ∞ . .	13.5	18.5	24	30
	when set to 3 m. .	14.5	20.5	27	35
In Normal Mount N — Diam. of lens flange		5.3	6.4	8.0	9.0
In Normal Mount N — Diam. of lens screw		3.7	4.8	6.0	7.0
In Normal Mount N — Length of objective from inside of flange	outwards . .	3.7	5.3	7.4	9.6
	inwards . . .	2.0	2.6	2.7	2.9
In Normal Mount N — Extension from inside of flange to ground glass .	for ∞ about .	10.5	14.5	18	22
	for 3 m. about	11.5	16.5	22	28
In Sunk Mount B — Diam. of lens flange		5.6	6.4	8.0	9.0
In Sunk Mount B — Diam. of lens screw		4.0	4.8	6.0	7.2
In Sunk Mount B — Length of objective from inside of flange	outwards . .	2.9	3.0	3.9	5.7
	inwards . . .	2.7	5.0*	6.2*	6.8
In Sunk Mount B — Extension from inside of flange to ground glass .	for ∞ about .	11	17*	21.5*	26.6
	for 3 m. about	12.5	19*	25.5*	32.6
In Focussing Mount A — Diam. of lens flange		6.0	6.8	8.5	—
In Focussing Mount A — Diam. of lens screw		4.4	5.2	6.5	—
In Focussing Mount A — Length of objective from inside of flange	outwards . .	2.2	2.5	2.9	—
	inwards . . .	3.4	5.5	7.2	—
In Focussing Mount A — Extension from inside of flange to ground glass .	for ∞ about .	12.0	17	22.5	—
	for 3 m. about	13	19.5	26.5	—
In Focussing Mount A — The focussing range extends	from ∞ to about	250	300	300	—
In Instantaneous Compur Shutter — Diam. of lens flange		5.3	6.4	8.0	9.0
In Instantaneous Compur Shutter — Diam. of lens screw		3.7	4.8	6.0	7.0
In Instantaneous Compur Shutter — Length of objective from inside of flange . . .	outwards . .	3.6	4.4	6.2	7.9
	inwards . . .	2.1	3.5	3.9	4.7
In Instantaneous Compur Shutter — Extension from inside of flange to ground glass .	for ∞ about .	10.5	15	19	23.5
	for 3 m. about	11.5	17	22.5	29.5
Size of picture showing on the plate	a ship 100 m. long at 1000 m.	1.8	2.5	3.2	4.0
	a house 10 m. wide, at 100 m.	1.8	2.5	3.2	4.0
	a man 1.7 m. high, at 10 m. .	3.1	4.4	5.6	7.1
	a head, 25 cm. high, at 3 m.	1.6	2.3	3.0	3.8
Size of object showing on long side of above plate sizes	at 1000 m. distance .	500 m.	480 m.	470 m.	450 m.
	at 100 m. distance .	50 m.	48 m.	47 m.	45 m.
	at 10 m. distance .	5 m.	4.8 m.	4.7 m.	4.5 m.
	at 3 m. distance .	1.4 m.	1.3 m.	1.25m.	1.2 m.
Scale of reduction *n* resulting at a	distance of 1000 m. .	5555×	4000×	3100×	2500×
	distance of 100 m. .	555×	400×	310×	250×
	distance of 10 m. .	55×	40×	30×	24×
	distance of 3 m. .	15.7×	11×	8.4×	6.5×

[1]) Also f = 26 m., relative aperture F/6 6, made for some special 12×9 cm. plate cameras.

*) If required, we supply intermediate rings, by the interposition of which between lens flange and the mount the lengths marked with an asterisk may be shortened, viz:
in the case of the Tele-Tessar f = 25 cm., by up to 28 mm., in that of the Tele-Tessar f = 32 cm. by up to 56 mm.

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